Biodiversity by Design: The attributes of ornamental plants in urban forest parks

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Abstract

Most bird species in urban parks depend on native plant community due to their selective dietary and nesting needs and are vitally affected by invasion of exotic plant community. Against this background, this study aims to investigate the significance of ornamental plants as birds’ food plants and cover in forest parks. The study will investigate the attributes of ornamental plants in term of the plant parts by adopting field observation techniques on a study area for duration of six months. The findings established that native species provide better food plants for urban birds and reaffirm that forest parks should cater for both human and bird habitats through selection of native plants; and be adopted as an urban conservation strategy.

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Keywords: Urban biodiversity; ornamental plants; birds’ food plants

1. Introduction

The Malaysian tropical rainforests, especially lowland dipterocarp forests, contain one of the highest diversity of flora and fauna among global terrestrial ecosystems. Although Malaysia represents only two per cent of the total land area of the world, it has made a significant contribution of six per cent to the world’s biodiversity (Yong, 1998). Malaysian forests are crucial for sustaining and providing a diversity of habitats for wildlife. Most species are endemic and the diversity includes over 1,000 species of

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butterflies, 600 bird species, 280 mammalian species, 140 snake species and 165 frog species (ibid). However, rapid urbanization has created massive pressure on land resources, thus depleting the green forested areas and adversely destroying the nation’s biodiversity. Although the loss of biodiversity due to development is a worldwide phenomenon, the issue is more acute in developing countries including Malaysia. Rapid urbanisation in the Klang Valley has resulted in a significant loss of bird habitats due to the reduction and fragmentation of forested areas. Consequently, this has severely disrupted important birds’ movements across natural corridors (Willmer, 2000). This issue is compounded by the rearrangement of their habitat resources (food, water, shelter and space) replaced by secondary forests and invaded plant species.

As Malaysia aims to reach high-income status by 2020, there is an urgency to accelerate the pace and intensity of urbanisation. As currently, Malaysia is only partway along the urbanisation journey where its urbanisation level of 67 per cent and GNI per capita of RM22,000 falls short of the more developed countries. The current Malaysian government is ahead in recognising the economic importance of cities and committed to pursuing a strategy to achieve high-income status. By embarking on the Economic Transformation Programme (ETP), the government intends to propel economic transformation by implementing specific targets via the twelve National Key Economic Areas (NKEAs).

However, it is important to bear in mind that urbanisation is not only about economic growth. Cities need to be equipped to accommodate the demands and needs of present dwellers for good quality of life, including their need for recreational pursuits. As one of the NKEA, Greater KL/KV is more geographical focus. It is an aspiration for Greater KL/Klang Valley to drive rapid growth in parallel with upgrading the city’s liveability, hence a priority for Malaysia’s next decade. While urbanising intensively, Greater KL/Klang Valley also emphasises on improving liveability.

The importance of biodiversity planning in urban areas has been recognized by the Malaysian government. Numerous urban conservation strategies and programs have been taken to mitigate biodiversity loss, including establishing new man-made habitats. Unfortunately, most of these efforts are futile as they often do not fulfill the birds’ feeding habits and behaviour, and are often lacking in the vitality provided by the natural habitats (Kemp, 2004). Besides, there is a lack of guiding models on habitat design for the city and neighbourhood hierarchy (Tyrvainen et al, 2002).

The new approach for conservation of urban biodiversity needs to be more holistic, addressing the societal needs of urban community for recreation and nature appreciation, including wildlife, instead of preserving a few selected species. The distinction is more pronounced in an urban environment where the importance of habitats depends on their value to the urban residents (Kemp, 2004). There is a consensus that sustainable urban communities can be created by promoting ecological integrity that provide for economic viability and social equity (Grant, 1996). The Town and Country Planning Association of the United Kingdom (2004) noted that supporting a richness of biodiversity is one way to building more sustainable urban community.

This research aims towards understanding the contribution of ornamental plants (native and exotic plants), as food plants and shelter for resident birds for human interaction. The research objectives are to identify the native and exotic plant species that cater the resident birds for food plants and shelter in urban forest parks, and to compare the efficacy of native and exotic plant species as food plants and shelter for resident birds.
2. Literature review

2.1. Urban forest parks for sustainability

Changing land uses brought on by urbanization have resulted in a change of vegetation pattern and structure. Remnants from dipterocarp and secondary forests, orchards and plantations are presently being utilized as urban forest parks by urban community for nature appreciation. Providing a collection of forest vegetation in park setting for the enjoyment of urban community, forest parks provide a two-fold strategy for biodiversity conservation and sustainable community. Several literatures indicated that interaction with nature including friendly wildlife and viewing gives a pleasing quality of calmness, relaxation and a sense of pleasure (Kaplan and Kaplan, 1989; Brannon and Feist, 1997; Kuo, 2003). Notwithstanding the degradation and loss of dipterocarp forests, forest parks still support a high diversity of wildlife if their ecological features are retained (Gilbert, 1989; Adams, 1994; Hadidian, 1992).

A bird inventory conducted in the Forest Research Institute of Malaysia (FRIM), recorded 181 bird species from 45 families, mostly comprising lowland species while 26 migratory species were sighted from September to April 2002. (Ong, 2003). However, an abundance of generalist bird species observed indicate a high level of habitat disturbances as only the invasive species with a generalist feeding habits can survive in a disturbed urban environment. Displaced birds which depend on specialised diets often fail to survive due to the restructuring of vegetation from native endemic vegetation to invasive and exotic vegetation (Rosli, 2001).

The local authorities, led by Kuala Lumpur City Hall, had embarked on a series of collaborative efforts with National Landscape Department and FRIM, amongst others (as part of Greater KL/ Klang Valley and Local Agenda 21 initiatives), to mitigate the growing issue of biodiversity loss. As bird population and diversity tend to be directly proportional to the volume of native vegetation, the KL City Hall has emphasised planting of native fruit tree species. A total of 10,000 trees have been planted nationwide since 2008, out of which constitute 45% of forest trees. These include Diospyros sp. Syzygium gratum, Dipterocarpus temppehes and Dracontommelon sp. Only heavy standard trees comprising semi instant trees with minimum height of 4 m and diameter between 50- 75 mm were planted.

2.2. Birds’ habitat needs and feeding habits

There is a dearth of birds in most urban parks as most trees were cleared prior to development, giving rise to the ‘silent park’ syndrome (Howes, 2009). As the stability of any bird population depends on the habitat’s ability to provide food, cover (shelter, nesting, roosting) and water (Rosli, 2004), it is imperative that only selective vegetation be included in any designs of urban forest parks.

The generalist bird species are often omnivorous and feed on both plants and fauna, while specialist bird species eating habit are either herbivorous or carnivorous. Presently, most of the trees planted are often chosen for their colourful flowers, attractive shapes or shady canopies. As bird species have their specific food requirements that changes with life stages, planting a range of food plants will encourage a higher biodiversity. Thus, planting designs should include supply of food plants that provide continuous source of seeds, berries, nuts, nectar and insects (Flint, 1985; Ong, 2003).

2.3. Landscape ecology approach in planting design

Studies on landscape ecology indicate that planting design is a primary influence on the success of green spaces (Rosli, 2004; Walker, 1991). In habitat design, ornamental plants are valued as food plants that provide food and shelter to birds. Three broad categories of ornamental plants comprise native,
naturalistic and exotic plants (Cook, 2002; Mel, 2006). Planting design to encourage bird diversity should incorporate the following:

2.3.1. Species diversity
Providing a variety of evergreen and deciduous plant species will encourage more bird species to forage the forest. Similarly, plants bearing fruits, seeds, nectar, grain, berries and nuts, at various seasons of the year will ensure a continuous food supply to sustain the birds’ population.

2.3.2. Structural diversity
Based on resource partitioning, planting many layers of vegetation allows birds to select the layer to which they can best adapt for survival. Vertical and horizontal structural diversity of planting design allow greater diversity of habitats to optimize

2.3.3. Plant materials
Selection of plant materials in habitat design are divided into two categories which are; (a) native and naturalistic plant species and (b) plants for food and shelter.

2.3.3.1. Native and naturalistic plants
As native plants are more closely matched to local soils and micro climate, they are most suitable as food plants for birds (Howes, 2009). Meanwhile, Cook (2002) noted that native and naturalistic plant species support ten to fifty times more native wildlife than exotic plants. Table 1 provides a comparison between native and naturalistic plants, and exotic plants.

Table 1. Comparison between native and naturalistic plants, and exotic plants

| Characteristic         | Native and naturalistic plants                                                                 | Exotic plants                                                                 |
|------------------------|-----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| Origin                 | Native plants grow naturally locally whilst naturalistic plants are imported and adapted to local climate over years. | Introduced species. Normally, bought accidental or benign from other countries or regions. |
| Condition              | Natural balance keeps species in check, allowing it to thrive in optimum conditions.          | Conquer surrounding as natural pests, diseases or climate conditions which kept the plants in check in their homeland are absent here. |
| Contribution           | Close association with other members of plant community, improve soil quality, reduce erosion. | Mostly native plant community do not benefit from association. Some are parasitic. |
| Habitat value          | Most species provide food and shelter for birds, butterflies and other wildlife               | Some provide food and shelter                                                  |
| Pest and disease       | Resistant to most pest and diseases                                                           | Some diseases cannot be controlled by local climate or pest control           |
| Maintenance level      | Need low maintenance gardening.                                                              | High maintenance.                                                             |

Source: Adapted from Malaysia National Landscape Guidelines (2008)

2.3.3.2. Food plants and shelter
These include trees, shrubs and ground covers that produce prolific fruits, berries, nectar, grains and nuts throughout the year. *Ficus sp.* is best known as food source to birds (Ong, 2003). Some *Ficus sp.* have fruiting seasons throughout the year, thus filling the gap when other trees are not fruiting.

Bird species has specific needs for nesting, roosting, and protection. Besides plant height and canopy cover, factors including leaf shape, aroma and colour should be considered in habitat design. Dense
canopy of trees with multi-branches offer protection for numerous bird species. However, as shelter needs are species-specific, the limiting factor for each bird species needs to be identified at the preliminary stage of life cycles. Table 2 provides examples of food plants suitable for bird habitats.

| Role of plant | Category of plant         | Examples of plant species         |
|---------------|---------------------------|-----------------------------------|
| Food plants   | Fruits (Frugivorous)      | *Artocarpus bilimbi*              |
|               | Nectar (Nectivorous)      | *Spathodea campanulata*           |
|               | Grains (Granivorous)      | *Sandorium koetjape*              |
|               | Attract insects (Insectivorous) | *Psidium guajava*             |
| Shelter       | Multi-stem plants        | *Adenanthera pavonina*            |
|               | Single-stem plants       | *Cananga odorata*                |
|               | Dense canopy             | *Cinnanomum inners*              |
|               | Thin canopy              | *Cerbera odallum*                |
|               | Evergreen                | *Cinnanomum inners*              |
|               | Deciduous                | *Alstonia angustiloba*            |

Source: Adapted from Malaysia National Landscape Guidelines (2008)

![Plants structural diversity](image)

Source: Nik Hanita (2010)

3. Research Methodology

3.1. Study area

The study was conducted in Forest Research Institute Malaysia (FRIM) located in the suburb of Kuala Lumpur city. It evolved from a dipterocarp lowland forest to an urban forest park, covering 600 hectares.
of land area, including Bukit Lagong Forest Reserve. It received an average of 2800 mm of rainfall with daily temperature ranging between 23 -33 degree. It is also an established recreational park for nature lovers. Spatially, FRIM Kepong is divided into the Wild Flora area and the Designed Area (conserved ex-situ method) for research in conservation of genetic resources and exhibitions. Figure 2 (a, b) provides a location and zoning Plan of Forest Research Institute of Malaysia (FRIM).

This study area was selected based on the (a) documentation of a landscape master plan, (b) association of native, naturalistic and exotic plant species, (c) well represented diversity of birds and (d) recorded human disturbances. There is a total of 181 bird species (from 45 families) foraging in four main habitats (garden, forest/edge, grass land and wetland) (Ong, 2003). Table 3 provides data on zonings based on bird habitats and plant conservation areas.

![Location Plan](image1.png)
![Zoning Plan](image2.png)

Fig. 2. (a); (b) Location and Zoning Plan of Forest Research Institute of Malaysia (FRIM)

Table 3. Zoning, bird habitats and plant conservation areas

| Area   | Habitat type   | Specific Bird Habitat                                      | Plant Conservation Area                                      |
|--------|----------------|------------------------------------------------------------|-------------------------------------------------------------|
| Zone A | Forest edge    | None                                                       | Fruit Tree Arboretum, Bambusetum mixed in forest            |
| Zone B | Forest edge, Wetland |                                                 | Fruit Tree Arboretum, Monocot Arboretum                  |
| Zone C | Garden         | Echno-botanic Garden, Cryptogamic Garden                  | Echno-botanic Garden, Cryptogamic Garden                    |
| Zone D | Forest edge, Field | Nature Trail, Rover Track                                  | Nature Trail, Coniferatum                                  |
| Zone E | Field          | Rover Track                                                | Forest                                                      |
| Zone F | Garden, Forest edge, Field | Rover Track, trail mixed with picnic areas          | Trail, Forest                                               |
| Zone G | Garden, Forest edge | Rover Track, Arboretum                                    | Dipterocarp and Non-Dipterocarp Arboretum, Forest         |

Source: Adapted from Ong, (2003); Amar Singh (2009)
3.2. Research method

The non-participant observation method was used to identify plant and bird species in FRIM. This method was selected in order to observe and describe the behavior of birds in an everyday basis. In order to find out the everyday basis, the key is to immerse (see and hear) the surrounding area. Therefore, the observational procedure is the appropriate method to be conducted in order to accomplish the research objectives.

The researchers referred to the FRIM zoning plan to identify the strategic locations for data collection on bird species observation. The observations were conducted between 8.00 am to 10.30 am on both weekdays and weekends for a period of six months. Through literature survey, it was found that the best time to watch birds’ activities is between 8.00 a.m. until 10.30 a.m. This is because, the bird species are most active during the early morning but when the noon approaches until dusk; they become passive and most of their activities die.

Listing of bird species was chosen based on Amar Singh (2009) and Ong (2003) methods. There are three categories for levels of abundance; 1-Rare (fewer than five records), 2- Uncommon but seen regularly and 3- Common to abundant.

3.3. Research equipment and procedure

This research was conducted by a structured, non-participative observation using a set of binocular, a digital camera, an observation guide, a checklist and notepad for observation purposes. Observations were conducted between 8.00 am to 10.30 am on both weekdays and weekends. The observations on weekends were made to fully optimise observation on disturbances level and its’ effects to the birds’ play time and food findings. Apart from that, the researchers also did the observation during slightly drizzle day to identify the most reliable plant species that birds utilise as a shelter or cover. Thus, it helps to recognise the most appropriate plant species as food plants and shelter in the urban forest park.

3.4. Scope and limitation

This research is focusing on the contribution of native, naturalistic and exotic ornamental plants towards birds’ habitats in the urban park. Therefore, the listed bird species is based on common resident birds and the plant species observed were limited to the species that can be seen in this urban park.

4. Results and discussion

Table 4 and 5 provide the list of bird species identified in FRIM Kepong and observations made on their dietary habits. Table 4 shows the bird species, its dietary habits and location of habitats that were observed in FRIM, Kepong. The findings indicate that the dietary habits of the most bird species comprises of frugivorous, granivorous and insectivorous.

Table 5 shows the most common bird species and the attraction to plant parts as food resource in FRIM, Kepong. The results shows that the plant parts as food resource in FRIM comprise of fruits, grains and plant parts that able to attract insects. These findings support Rodger et al (1991) observation that most urban birds are generalist species and have a high tolerant and adaptability to human environment and disturbance.
4.1. Birds species and attraction to plants observation

Table 4. Bird species observed in FRIM Kepong

| Bird Species                                      | Dietary Habits         | Habitats  |
|---------------------------------------------------|------------------------|-----------|
| Oriolus chinensis (Black-naped Oriole/Burung Kunyit Besar) | Frugivorous and insectivorous | Zone F    |
| Copsychus saularis (Magpie Robin/Murai Biru Siberia)     | Insectivorous          | Zones C, D, E, F and G |
| Aplonis panayensis (Philippine Glossy Starling/Perling Mata Merah) | Frugivorous            | Zones A, B, D and F |
| Acridotheres tristis (Common Myna/Tiong Gembala Kerbau)     | Insectivorous and frugivorous | Zones B, D and F |
| Passer montanus (Eurasian Tree-sparrow/Ciak Rumah)         | Granivorous and insectivorous | Zone B    |
| Lonchura punctual (Scaly-breasted Munia/Pipit Pinang)       | Granivorous            | Zones B and D |

Source: Adapted from Ong, (2003); Amar-Singh (2009)

Table 5. The most common bird species list and the attraction to plant parts as food resource in FRIM

| Bird Species                                      | Plant Parts | Attract Insect |
|---------------------------------------------------|-------------|----------------|
|                                                     | Fruits | Nectars | Grains |
| Oriolus chinensis (Black-naped Oriole/Burung Kunyit Besar) | X     | X     | X     |
| Copsychus saularis (Magpie Robin/Murai Biru Siberia)     | X     | X     |        |
| Aplonis panayensis (Philippine Glossy Starling/Perling Mata Merah) | X     | X     | X     |
| Acridotheres tristis (Common Myna/Tiong Gembala Kerbau)     | X     | X     | X     |
| Passer montanus (Eurasian Tree-sparrow/Ciak Rumah)         | X     |        |        |
| Lonchura punctual (Scaly-breasted Munia/Pipit Pinang)       | X     |        |        |

4.2. Plant species observation

The plant species observation was conducted from October 2011 to March 2012. Based on documented data on plant species from FRIM Kepong and the National Landscape Guideline of Malaysia, the types of plant species were listed to compare the efficiency of native and exotic plant species.

Figure 3 and 4 elaborate on native and exotic plant species and the plant parts that function as food plants and shelter. Overall, as plant parts for food source, the native plant species recorded the higher frequency compared to exotic plant species (Figure 3). This indicates that native plant species are more significant in providing the food sources rather than exotic plant species. From the graph, it could be clearly seen that among all parts of native and exotic plant species, the ability to attract insects as food sources is the highest, followed by nectars, fruits and grains. However, the plant parts of native species registered the total higher ability to provide food sources than exotic species. Figure 4 shows the contribution of plant parts for native and exotic species as shelter. From the graph, it is shown that the physical characteristic of plant parts with dense canopy provides highest contribution as a shelter for bird habitat. This is followed by multi-stem and evergreen plants. On the contrary, the single-stem plants, thin canopy and deciduous plant parts have shown the lower frequency of the plant parts ability to provide...
It was observed that native plant species totally contribute the greater ability to provide both as food source and shelter rather than the exotic plant species.

Details on the list of native and exotic plant species for food and shelter in FRIM are shown in Appendix A and B.

Fig. 3. Frequency on contribution of plant parts for native and exotic plant species as food plants
Source: Sabrina and Nik Hanita (2012)

Fig. 4. Frequency on contribution of plant parts for native and exotic plant species as shelter
Source: Sabrina and Nik Hanita (2012)
The findings indicate that native plants provide more benefits to the most urban birds as food plants and shelter for cover from bad weather and predators. It discussed; (a) comparison between native and exotic plant species, (b) comparison between native plant parts and (c) comparison between exotic plant parts as to investigate the attributes of ornamental plants in term of the plant parts in providing food resource for urban bird species. There are four plant parts that attract bird species as food resource; attract insects, nectars, fruits and grains. Based from the findings, the researcher concluded that native plant parts are the most valued plant species in providing food resource more than just one bird species.

For physical characteristics; (a) multi-stem and single-stem plants, (b) dense and thin canopy, and (c) evergreen and deciduous plants. Native and exotic plants providing a similar pattern as shelter for urban birds. The optimal nesting is a must because the causes of danger to the young one are from every angle. Fortunately, native plants are more outstanding as food resources especially in urban areas.

The physical characteristics of plant species are important in order to provide most suitable and available food plants and shelter for birds. As stated earlier, the native plants with multi-stem able to provide a dense canopy as well as able to nourish bird species all year round will influence the success as bird habitats.

5. Conclusion

The findings established that native plant species provide better all year-round food resources according to frequency of plant parts (to attract insects, fruits, grains, nectar) comparatively, for urban birds based on their physical characteristics (multi-stem plants, dense canopy and evergreen). The attributes of ornamental vegetation also contribute to provide the habitat elements such as food plant and cover for urban birds. Thus, it helps to improve the bird habitat and promote the biodiversity in urban forest parks. It enhances the functional and significant values of urban park especially in providing space for active, semi-active or passive activities to urban dwellers. This is especially true where bird watching can be one of the activities that contribute psychological values to urban living by means of providing the sustainable urban environment to urban community. Other than that, the significant values of urban parks contribute to provide a good quality of environment by preserving nature for wildlife and urban dwellers.

Practitioners especially landscape architects could incorporate the ecological approach in any attempts to conserve wildlife habitat and encourage biodiversity in urban forest parks. In urban park design, ecological planning that integrates the native plant data is a crucial necessity in order to maintain and balance the biodiversity; and to benefit the urban bird species. Practitioners should aware on what species they should focus, the physical characteristics of the plant species and its dietary types. Other than that, the selection of ornamental plants comprises of variation of plant types (ground covers, vine tangles, low plants, small shrubs or canopy trees) also help the space to fully utilise; either to provide food resources or shelter in order to offer biodiversity for sustainable urban community.

As part of urban ecosystem, forest parks provide numerous tangible and non-tangible benefits for societal needs and ecosystem health. The findings reaffirm that urban forest parks should cater for both human-centered activities and as bird habitats through selection of native plants. It is envisaged that the study will contribute to the knowledge of landscape architecture discipline and be adopted as an urban conservation strategy towards sustainable urban living. Future research on the benefits of conserving birds’ habitat to both human and wildlife, and how it can get advantage from the connections to the overall landscape should be more explored.
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### Appendix A.

Table 6. Native plant species and parts for food and shelter in FRIM

| PLANT SPECIES                        | PLANT PART       | For Food Source | For Shelter |
|--------------------------------------|------------------|-----------------|-------------|
|                                       |                 | F N G AI MP SP  | DC TC E D   |
| Adenanthera pavonina (Pokok Saga)    |                  | X X X X         | X           |
| Agathis borneensis (Dammar Mnyak)    |                  | X X X X X       | X           |
| Alstonia angustiloba (Pulai)         |                  | X X X X         | X           |
| Amesiodendron chinens (Amesiodendron)|                  |                 | X X X       |
| Ardisia elliptica (Mata Pelandok)   |                  | X X X X X       | X           |
| Arystera littoralis (Bedara Emping/Menasi) |            | X X X X         | X           |
| Baeckea frutescens (Cucur Atap)      |                  | X X X X         | X           |
| Barringtonia asiatica (Putat Laut)   |                  | X X X X         | X           |
| Callerya atropurpurea (Milletia atropurpurea/Tulang Daing) | | X X X X | X |
| Calophyllum inophyllum (Penaga Laut) |                  | X X X X         | X           |
| Cananga odorata (Kenanga)            |                  | X X X X X       | X           |
| Cassia siamea (Johor/Kassod Tree)    |                  | X X X X         | X           |
| Casuarina equisetifolia (Rhu Laut)   |                  | X X X           | X           |
| Cerbera odollam (Pong-pong)          |                  | X X X           | X           |
| Cinnamomum iners (Kayu Manis)        |                  | X X X           | X           |
| Crateva magna (Dala/Dalur)           |                  | X X X           | X           |
| Crataxylum formosum (Mempai/Derum)   |                  | X X X           | X           |
| Dillenia indica (Simpoh India)       |                  | X X X           | X           |
| Dillenia ovata (Simpoh Beludu)       |                  | X X X           | X           |
Table 6. Native plant species and parts for food and shelter in FRIM (Cont’d)

| Native Plant Species                          | Food & Shelter | Food & Shelter | Shelter & Food | Shelter & Shelter | Shelter & Shelter |
|-----------------------------------------------|----------------|----------------|----------------|-------------------|-------------------|
| Dillenia suffruticosa (Simpoh Air)            | X              | X              | X              | X                 | X                 |
| Dryobalanops aromatica (Kapur)                | X              | X              | X              |                   |                   |
| Dryobalanops oblongifolia (Keladan)           | X              | X              | X              |                   |                   |
| Dyera costulata (Jelutong)                    | X              | X              | X              |                   |                   |
| Elateriospermum tapos (Perah)                 | X              | X              | X              |                   |                   |
| Erythrina orientalis (Dedap)                  | X              | X              | X              |                   |                   |
| Fagraea crenulata (Birah/Malabira)            | X              | X              | X              |                   |                   |
| Fragaea fragrans (Tembusu Padang)             | X              | X              | X              |                   |                   |
| Ficus benjamina (Beringin/Weeping Fig)        | X              | X              | X              |                   |                   |
| Ficus microcarpa (Bayan)                      | X              | X              | X              |                   |                   |
| Ficus ngii (F.macellandii/Alii Fig or Banana-Leaf Fig) | X | X | X |                   |                   |
| Firmiana malayana (Mata Lembu)                | X              | X              | X              |                   |                   |
| Garcinia atroviridis (Asam Gelugur)           | X              | X              |                |                   |                   |
| Garcinia hombroniana (Berus)                  | X              | X              | X              |                   |                   |
| Gardenia carinata (Kembang Cina)              | X              | X              | X              |                   |                   |
| Gardenia tubifera (Cempaka Hutan)             | X              | X              | X              |                   |                   |
| Gymnostoma nobile (Casuarina nobile/Ru Ronang) | X              | X              | X              |                   |                   |
| Hibiscus tiliaceus (Bebaru)                   | X              | X              | X              |                   |                   |
| Hopea odorata (Merawan Siput Jantan)          | X              | X              | X              |                   |                   |
| Kopsia singaporensis (Kopsia Putih)           | X              | X              | X              |                   |                   |
| Lagerstroemia floribunda (Kedah Bungor)       | X              | X              | X              |                   |                   |
| Lagerstroemia langkawiensis (Langkavi Bungor) | X              | X              | X              |                   |                   |
| Lagerstroemia speciosa (Lagerstromea flos-reginea/Bungor Raya) | X | X | X |                   |                   |
| Lepisanthes alata (Perupok/Ceri Terengganu)   | X              | X              | X              |                   |                   |
Table 6. Native plant species and parts for food and shelter in FRIM (Cont’d)

| Species                        | X | X | X | X | X | X |
|-------------------------------|---|---|---|---|---|---|
| Lepisanthes rubiginosa (Mertajam) |   |   |   |   |   |   |
| Maingaya malayana (Oliver)    | X | X | X |   | X | X |
| Melaleuca cajuputi (Gelam/Kayu Putih) | X | X | X | X | X | X |
| Melia excelsa (Sentang)       |   |   |   |   |   |   |
| Mesua ferrea (Penaga Lilin)   | X | X | X | X |   |   |
| Michelia champaca (Cempaka Kuning) | X | X | X | X | X | X |
| Mimusops elengi (Tanjung)     | X | X | X |   | X | X |
| Neolitsea zeylanica (Medang Pasir) | X | X | X | X |   | X |
| Peltopherum pterocarpum (Batai Laut) | X | X | X | X |   | X |
| Pentaspadon motleyi (Pelong Licin) | X | X | X | X |   | X |
| Phyllanthus emblica (Melaka)   | X | X | X | X | X | X |
| Pisonia alba (Mengkudu Siam)  |   |   |   |   | X | X |
| Pouteria obovata (Planchonella obovata’Menasi) | X | X | X | X |   |   |
| Podocarpus nerifolius (Podo Bukit) | X | X | X |   | X | X |
| Podocarpus polystachyus (Podo Laut) | X | X | X | X | X | X |
| Pometia pinnata (Kasai)       | X | X | X | X | X | X |
| Pongamia pinnata (Mempari)    |   |   |   |   | X | X |
| Pteleocarpa lamponga (Tembusu Tikus) | X | X | X |   | X | X |
| Pterocarpus indicus (Angsana) | X | X | X | X |   | X |
| Sandoricum koetjape (Sentol)  | X | X | X | X |   | X |
| Saraca cauliflora (Saraca. Thaipingensis/Gapis) | X | X | X | X |   | X |
| Shorea sumatrana (Singkawang Air) | X | X | X |   | X | X |
| Shorea roxburghii (Meranti Temak) | X | X | X |   | X | X |
| Sterculia foetida (Kelumpang Jari) | X | X | X | X | X | X |
| Sterculia parviflora (Kelumpang Burung) | X | X | X | X | X | X |
| Streblus asper (Kesinai)      | X | X | X |   | X | X |
Table 6. Native plant species and parts for food and shelter in FRIM (Cont’d)

| PLANT SPECIES                        | PLANT PART        | For Food Source | For Shelter |
|--------------------------------------|-------------------|-----------------|-------------|
| Syzygium campanulatum (Eugenia oleina/Kelata Paya) | X X X X X X |                |             |
| Syzygium polyanthum (Eugenia polyantha/Salam)       | X X X X X X |                |             |
| Terminalia catappa (Ketapang)               | X X X X X |                |             |
| Terminalia pyrifolia (Mentalam)            | X X X X |                |             |
| Vitex pubescens (Leban)                    | X X X X |                |             |

F=Fruit; N= Nectar; G=Grain; AI=Attract Insect
MP= Multiple-stem; SP=Single stem; DC=Dense Canopy; TC=Thin Canopy; E=Evergreen; D=Deciduous

Appendix B.

Table 7. Exotic plant species and parts for food and shelter in FRIM

| PLANT SPECIES                | PLANT PART | For Food Source | For Shelter |
|-----------------------------|------------|-----------------|-------------|
| Acacia auriculiformis (Akasia Kuning) | X X X X X X |                |             |
| Acacia confusa (Akasia Taiwan)    | X X X X X |                |             |
| Acacia holosericea (Akasia Perak) | X X X X X |                |             |
| Acacia mangium (Akasia Daun Lebar) | X X X X |                |             |
| Amherstia nobilis (Pride of Burma) | X X X |                |             |
| Andira inermis (Brown Heart)     | X X X |                |             |
| Arfeuillea arborescens (Hop Tree) | X X X |                |             |
| Artocarpus incisus (Sukun)       | X X |                |             |
| Baphia nitida (Camwood)          | X X X |                |             |
| Bauhinia spp. (Tapak Kuda)       | X X X X |                |             |
| Bixa orellana (Inai Keling)      | X X X |                |             |
| Caesalpinia ferrea (Brazilian Ironwood) | X X X |                |             |
| Callistemon viminalis (Beros Botol/Weeping Bottle) | X X X |                |             |
| Cassia fistula (Golden Shower)    | X X X X |                |             |
| Casuarina junghuhniana (Ru Cemara) | X X X |                |             |
| Chrysophyllum cainito (Saah)      | X X X |                |             |
| Plant Name | Common Name                        | Presence | Note 1 | Note 2 | Note 3 | Note 4 |
|------------|------------------------------------|----------|--------|--------|--------|--------|
| Durian     |                                    | X        |        |        |        |        |
| Coccoloba uvifera (Sea Grape) | X        | X       |        |        |        |        |
| Couroupita guianensis (Pokok Peluru Meriam) | X        |        |        |        |        |        |
| Dalbergia oliveri (Tamalan) | X        | X       |        |        |        |        |
| Dalbergia latifolia (Indian Rosewood) | X        | X       | X      |        |        |        |
| Delonix regia (Semarak Api) | X        | X       | X      |        |        |        |
| Dillenia philippinensis (Simpo) | X        | X       |        |        |        |        |
| Diospyros discolor (Buah Meri) | X        | X       | X      |        |        |        |
| Enterolobium saman (Samanea saman/Hujan-hujan) | X        | X       |        |        |        |        |
| Erythrina variegata (Dedap Batik) | X        | X       | X      |        |        |        |
| Erythrina glauca (Dedap Hijau) | X        | X       | X      |        |        |        |
| Erythrophleum guineense (Ordeal Tree) | X        | X       | X      |        |        |        |
| Ficus celebensis (Ficus Daun Halus) | X        |        |        |        |        |        |
| Ficus elastic (Bunoh Seteroh) | X        |        |        |        |        |        |
| Ficus roxburgii (Ara) | X        | X       |        |        |        |        |
| Filicium decipiens (Kiara Payung) | X        | X       | X      |        |        |        |
| Gliricidia sepium (Bunga Jepun) | X        | X       |        |        |        |        |
| Gnetum gnemon (Meninjau) | X        | X       | X      |        |        |        |
| Gymnostoma rumphianum (Weeping Ru) | X        | X       |        |        |        |        |
| Hura crepitans (Payung Indonesia) | X        | X       |        |        |        |        |
| Jacaranda filicifolia (Jambul Merak) | X        | X       | X      |        |        |        |
| Khaya grandifolia (African Cedar) | X        |        |        |        |        |        |
| Khaya senegalensis (Khaya) | X        | X       | X      |        |        |        |
| Lagerstroemia indica (Inai Merah) | X        | X       | X      |        |        |        |
| Maniltoa browneoides (M.gammipara/Pokok Sapu Tangan) | X        | X       | X      |        |        |        |
| Michelia alba (Cempaka Putih) | X        | X       | X      |        |        |        |
| Muntingia calabura (Pokok Ceri) | X        | X       |        |        |        |        |
| Paraserianthes falcatoria (Batai) | X        | X       | X      |        |        |        |
| Plant Name                                      | F | N | G | AI | MP | SP | DC | TC | E | D |
|------------------------------------------------|---|---|---|----|----|----|----|----|---|---|
| *Pithecellobium dulce* (Duri Madras)           | X | X | X | X  |    |    |    |    |   |   |
| *Plumera spp.* (Kemboja)                       |   |   |   |    | X  | X  |    |    |   |   |
| *Polyalthia longifolia var pendula* (Mempisang/Asahoka) | X |   |   |    | X  |   |    |    |   |   |
| *Ravenala madagascariensis* (Pisang Kipas)     |   | X | X | X  |    |    |    |    |   |   |
| *Salix babylonica* (Janda Merana)              |   | X | X | X  |    |    |    | X  |   |   |
| *Spathodea campanulata* (Pancut-pancut)        | X |   | X | X  |    |    |    |    | X |   |
| *Stenobium stans* (Yellow Bell)                |   | X | X | X  | X  |    |    |    |   |   |
| *Swietenia macrophylla* (Melia azedarach/Mahogany) | X |   | X |    |    |    |    |    |   |   |
| *Tabebuia ochracea* (Golden Trumpet Tree)      |   | X | X | X  |    |    |    |    |   |   |
| *Tabebuia pallida* (Tecoma Pallida/Pink Tecoma) |   | X | X | X  |    |    |    |    |   |   |
| *Tabebuia pentaphylla* (Tabebuia)              | X |   | X | X  | X  |    |    |    |   |   |
| *Tamarindus indica* (Asam Jawa)                |   | X | X | X  | X  |    |    |    |   |   |
| *Terminalia buceras* (Black Olive)             | X | X |   | X  | X  | X  |    |    |   |   |
| *Xanthostemon chrysanthus* (Jambu Kuning)      | X |   | X |    |    |    |    |    |   |   |
| *Ziziphus mauritiana* (Pokok Bidara)           | X |   | X | X  |    |    |    |    |   |   |

*F* = Fruit; *N* = Nectar; *G* = Grain; *AI* = Attract Insect
*MP* = Multiple-stem; *SP* = Single stem; *DC* = Dense Canopy; *TC* = Thin Canopy; *E* = Evergreen; *D* = Deciduous