EFFECTS OF FOREST RESTORATION ACTIVITIES ON THE SPECIES DIVERSITY OF GROUND FLORA AND TREE SEEDLINGS

ORANUT KHOPAI

A THESIS SUBMITTED TO THE GRADUATE SCHOOL IN
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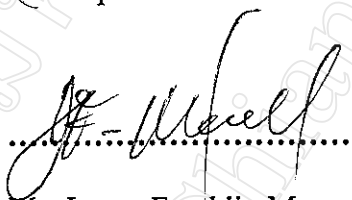

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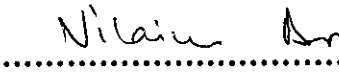

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Abbreviations and Synonyms

C97 : Control plot with no planted trees and forest restoration activities in 1997

C98 : Control plot with no planted trees and forest restoration activities in 1998

cm : centimetre

g : gram

h : height

km^2 : square kilometres

NGO : non government organization

No. : number

P97 : Planted with native trees in 1997, weeding with hand tools and applying fertilizer

P98 : Planted with native trees in 1998, weeding with hand tools and applying fertilizer

Thesis Title	Effects of Forest Restoration Activities on the Species Diversity of Ground Flora and Tree Seedlings
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ABSTRACT

This study was carried out to determine if planting native trees species and associated activities i.e. weeding and fertilizing in forest restoration, increases diversity of ground flora and tree seedlings. This research was conducted at a deforested area, previously covered by evergreen forest in Doi Suthep-Pui National Park. The study site consisted of 4 experimental plots: 2 planted plots with native tree seedlings in 1997 and 1998 (plots P97 and P98), with fire protection, application of fertilizer, and weeding, and 2 control plots in each year (plots C97 and C98), which no trees planting and any other activities except fire protection. In the planted tree plots, there was no cutting of naturally established seedlings. Glyphosate was used to clear the sites before planting and weeds were cleared around the planted trees and naturally established seedlings using hand tools. About 100 g of fertilizer was applied to both natural and planted seedlings when planted. After planting, weeds were cleared using hand tools once per month in the rainy season. Fertilizer was applied (100 g/tree) immediately after weeding. The

vegetation, including planted trees, ground flora, naturally established trees (including seedlings, saplings, and mature trees) was surveyed using a walking survey and circular sample units, 2.5 m radius which covered 24% of each subplot, three times: in the dry season, the middle and the end of the rainy season. From all surveys, 136 plant species (except planted trees) were found; 95 species in plot P98 , 71 species in plot C98 , 33 species in plot P97 , and 41 species in plot C97 . The total number of species of ground flora and naturally established trees found in plot P98 was 75 and 29, 51 and 27 in plot C98, 28 and 5 in plot P97, and 37 and 4 in plot C97. The total number of species of planted trees found was 30: 22 species in plot P98 and 14 species in plot P97.

In the first year after tree planting, the species richness and evenness of the ground flora in plot P98 increased when compared with plot C98, probably because weeding removed dominant perennials, allowing invasion of plot P98 by annual herbs especially in the family Compositae. Two years after tree planting, the diversity of the ground flora species in plot P97 had decreased, however, because the planted tree canopy closed, and reduced opportunities for establishment of new species of ground flora. Ground flora diversity was higher in plot C97, but evenness was lower than plot P97, since fire had removed most of the dominant weed species. Weeding and fertilizing accelerated the establishment of natural tree seedlings and increased the density of naturally established trees in the planted plots, although the increase in the number of naturally established seedling species found was equal in the 1997 plots and did not differ significantly in species richness of natural trees in both the plots 1997 and 1998. Most of the planted tree species were in good health and fast growing. All of the planted tree species except *Nyssa javanica* and *Garcinia mckeaniana*, were suitable species to plant for forest restoration in this area.

ชื่อเรื่องวิทยานิพนธ์	ผลของกิจกรรมต่างๆ ในการฟื้นฟูสภาพป่าต่อความหลากหลายของไม้พื้นล่างและกล้าไม้
ชื่อผู้เขียน	นางสาวอรนุช ค้อไผ่
วิทยาศาสตรมหาบัณฑิต	สาขาวิชาวิทยาศาสตร์สิ่งแวดล้อม

คณะกรรมการสอบวิทยานิพนธ์

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บทคัดย่อ

ในการศึกษาครั้งนี้มีวัตถุประสงค์เพื่อทดสอบว่า การปลูกพรรณไม้ท้องถิ่นและการกำจัดวัชพืชและใส่ปุ๋ยในการฟื้นฟูสภาพป่ามีผลต่อการเพิ่มขึ้นของไม้พื้นล่างและกล้าไม้หรือไม่ โดยได้ทำการศึกษาในพื้นที่ของป่าเสื่อมโทรมซึ่งเคยเป็นป่าดิบของอุทยานแห่งชาติดอยสุเทพ-ปุย พื้นที่ศึกษาแบ่งออกเป็น 4 แปลงการทดลอง คือ 2 แปลงที่มีการปลูกพรรณไม้ท้องถิ่นในปี ค.ศ. 1997 และ 1998 (แปลง P97 และ P98) ซึ่งมีการป้องกันไฟ ใส่ปุ๋ย และกำจัดวัชพืช และอีก 2 แปลง เป็นแปลงควบคุมของแต่ละปี (แปลง C97 และ C98) ซึ่งไม่มีกิจกรรมใดๆ นอกจากการป้องกันไฟ ในแปลงที่มีการปลูกพรรณไม้ท้องถิ่นมีวิธีการปลูกเหมือนกัน คือ ไม่มีการตัดกล้าไม้ธรรมชาติที่ขึ้นอยู่แล้ว ใช้ไกลฟอเสทเพื่อจัดเตรียมพื้นที่ก่อนการปลูกและมีการกำจัดวัชพืชรอบๆ กล้าไม้ที่เกิดขึ้นเองตามธรรมชาติและกล้าไม้ที่ปลูกโดยใช้มือถอน ใส่ปุ๋ยประมาณ 100 กรัมให้กับกล้าไม้ที่เกิดขึ้นเองตามธรรมชาติ และกล้าไม้ที่ปลูก หลังจากการปลูกแล้วจะมีการกำจัดวัชพืชโดยใช้มือถอนเดือนละหนึ่งครั้ง ในฤดูฝน และใส่ปุ๋ย 100 กรัมทันที ทำการสำรวจกล้าไม้ที่ปลูก ไม้พื้นล่าง ต้นไม้ที่เกิดขึ้นเองตามธรรมชาติ (กล้าไม้ ลูกไม้ ต้นไม้) โดยการเดินสำรวจทั่วแปลงและวางแปลงวงกลม รัศมี 2.5 เมตร ครอบคลุมพื้นที่ร้อยละ 24 ของแต่ละแปลง ทั้งหมด 3 ครั้ง คือ ในฤดูแล้ง กลางและปลายฤดูฝน พบว่ามีพรรณไม้ทั้งหมด (ยกเว้นกล้าไม้ที่ปลูก) 136 ชนิด คือ แปลง P98, C98, P97 และ C97 มี 95, 71, 33, และ 41 ชนิด ตามลำดับ ซึ่งแบ่งเป็นจำนวน

ชนิดของไม้พื้นล่างและต้นไม้ที่เกิดขึ้นเองตามธรรมชาติดังนี้ P98 พบ 75 และ 29 ชนิด, C98 พบ 51 และ 27 ชนิด, P97 พบ 28 และ 5 ชนิด, และ C97 พบ 37 และ 4 ชนิด พบชนิดของกล้าไม้ที่ปลูก ใน P98 และ P97 จำนวน 22 และ 14 ชนิด

ในปีแรกหลังจากการปลูก แปลง P98 มีจำนวนชนิดและความสม่ำเสมอ (Evenness) ของไม้พื้นล่างมากเมื่อเปรียบเทียบกับแปลง C98 อาจจะเนื่องมาจากไม้เนื้ออ่อนที่มีอายุหลายปีซึ่งเป็นไม้โดดเด่นได้ถูกกำจัดไป ทำให้ไม้เนื้ออ่อนที่มีอายุสั้นเกิดขึ้นแทนที่ได้โดยเฉพาะในวงศ์ทานตะวัน อย่างไรก็ตาม หลังจากการปลูกสองปี ในแปลง P97 ความหลากหลายของไม้พื้นล่างลดลง เพราะว่า กล้าไม้ที่ปลูกมีการเจริญเติบโตอย่างรวดเร็วจนเรือนยอดใกล้ชิดกันซึ่งลดโอกาสในการเกิดขึ้นใหม่ของไม้พื้นล่าง ในแปลง C97 มีความหลากหลายของไม้พื้นล่างมากแต่มีความสม่ำเสมอของไม้พื้นล่างน้อยกว่าแปลง P97 เพราะว่าไฟได้กำจัดชนิดวัชพืชที่โดดเด่นออกไป การกำจัดวัชพืชและใส่ปุ๋ยช่วยในการเร่งรัดการเกิดขึ้นของกล้าไม้ธรรมชาติและเพิ่มความหนาแน่นของต้น ไม้ที่เกิดขึ้นเองตามธรรมชาติในแปลง P98 และ P97 แม้ว่าการเพิ่มขึ้นของจำนวนชนิดกล้าไม้ที่เกิดขึ้นเองตามธรรมชาติจะมีจำนวนเท่ากันในแปลงทดลองปี1997 (แปลงปลูกและแปลงควบคุม) และไม่แตกต่างกันอย่างมีนัยสำคัญของจำนวนชนิดกล้าไม้ที่เกิดขึ้นเองตามธรรมชาติในแปลง 1997 และ แปลง 1998 ส่วนใหญ่ของกล้าไม้ที่นำมาปลูกมีสุขภาพดีและมีการเจริญเติบโตอย่างรวดเร็ว ชนิดพรรณไม้ที่นำมาปลูกมีความเหมาะสมที่จะใช้ปลูกในการฟื้นฟูสภาพป่าในพื้นที่แห่งนี้ ยกเว้น คางคาก (*Nyssa javanica*) และ มะดะ (*Garcinia mckeaniana*)

INTRODUCTION

Rationale

Deforestation is one of the main causes of biodiversity loss and is one of the most important environmental problems in Thailand today. Unofficial estimates put Thailand's natural forest cover at less than 20% (Leungaramsri & Rajesh, 1992). Thailand's forest cover has been reduced from 53.3% (273,508 km^2) in 1961 to 25.26% (135,606 km^2) in 1995, averaging about 4,056 km^2 lost per year. The rate of forest destruction was highest in the northern region totaling 4,991 km^2 from 1989 to 1993 (RFD, 1995). The current estimate of forest cover, both plantations and natural forest, is 110,010 km^2 or 22.8% of the country (FAO, 1997).

Tree planting is recognized as an important activity to restore degraded forests and has been organized by both government and non-government organizations and by local communities. Initially forest restoration programs concentrated on establishing monocultures of commercially valuable tree species such as acacia, pines, teak, etc. Establishment of plantations has not been successful for wildlife conservation and watershed protection. Furthermore, monoculture plantations lack the high biodiversity found in natural forests. A comparison of ground flora diversity among different types of tree plantations and primary forest, showed the highest diversity in natural forest (Karimuna, 1995). If forest restoration areas have high plant species diversity, succession towards natural forest will be accelerated because various types of food and habitat are provided to attract wildlife such as birds,

monkeys, deer, etc., where ultimately a restored and balanced ecosystem is established.

After realizing that monoculture plantations are of low value for wildlife conservation and watershed protection, attitudes towards reforestation are changing. Planting native trees is now recommended for reforestation projects because they promote biodiversity (Wightman, 1997). In 1993, to celebrate His Majesty King Bhumibol Adulyadej's Golden Jubilee, the government, NGOs, and the private sector, became involved in tree planting projects. The aim was to plant 50 millions trees on 8,273 km^2 of deforested land. The project specified use of a wide variety of native forest tree species. However, the policy could not be implemented effectively, since there was lack of knowledge about how to grow and plant seedlings of native tree species (Elliott *et al.*, 1996). Furthermore, the effects of forest restoration programs on biodiversity have not been investigated by experiments, thus the outcome of such programs with regard to wildlife conservation is unknown.

The Forest Restoration Research Unit (FORRU) was established in November 1994 to address this problem. It is a co-operative project between Chiang Mai University (CMU) and Doi Suthep-Pui National Park (under the Royal Thai Forest Department (RFD)). The unit is situated near the Headquarters of Doi Suthep-Pui National Park (18°50'N, 98°50'E) at about 1,000 m elevation. There are two types of forest; deciduous and evergreen, in a monsoon climate (Maxwell, 1988). The work of the first 3-year phase of the FORRU project (1994-97) cataloged and described the seeds, fruits, and seedlings of tree species choosing from more than 600 tree species

found in the park (Elliott and Maxwell, 1995). Seed germination trials and preliminary seedling planting trials in deforested areas were carried out. The second phase of the project investigated so-called "framework species method" to complement natural regeneration in deforested areas. The aim is to develop efficient propagation systems, planting methods, and post-planting management systems to enable use of native tree species for reforestation of deforested areas.

Framework species are native trees which are fast growing with dense spreading crowns that rapidly shade out competing weeds. They are also attractive to seed-dispersing wildlife (especially birds and bats) and they should be easily propagated in the nursery. FORRU has identified 3 important groups of framework species: figs (*Ficus* spp., Moraceae) (which should account for 20% of trees planted) and species of the families Fagaceae and Leguminosae (each accounting for 10-15% of planted trees). The rest of trees planted can be other species matching the framework criteria (FORRU, 1998).

Such framework species were planted in a deforested area near Mae Sa Mai village in Doi Suthep-Pui National Park and have been cared for after planting with weed control, fertilizer application, and fire protection. To maintain the planted areas, new seedlings are planted to replace dead ones 1 year and, if necessary, 2 years after planting. Monitoring their survival and growth is done at least twice per year in the first 2-3 years after planting. In addition, naturally establishing seedlings and ground flora in both planted and control sites are also monitored.

Hypothesis

This study monitored the species diversity of the ground flora and naturally establishing tree seedlings to determine how they are affected by tree planting with weeding, and fertilizer application. It tested the hypothesis that tree planting and associated activities will increase the species diversity of the ground flora and encourage natural establishment of tree seedlings.

Objectives

The main objectives of this study were:

1. To compare and analyze the species composition and diversity of natural seedlings, saplings, and ground flora in both control and planted sites
2. To record the forest succession process in a plantation of framework tree species, and
3. To compare the rate of survival, growth, and health of planted trees and naturally established trees in the experimental plots.

Future implications of the study

The results of this study will provide basic ecological knowledge on the use of native trees to accelerate forest succession and promote and preserve plant diversity.

LITERATURE REVIEW

The high biodiversity of tropical forests is well known, since they contain more than 50% of the total species of plants and animals in the world (WRI, 2000). At present, tropical forests and woodlands are being destroyed at a rate of approximately 15.4 million ha per year, principally due to agricultural expansion, uncontrolled livestock grazing, logging, and fuel wood collection (World Resource Institute/IIED, 1988; FAO, 1993; Parrotta *et al.*, 1997). This is resulting in about 27,000 animal and plant species becoming extinct per year (Myers, 1993; OEPP, 1996). Biologists expect that, without significant conservation efforts, Earth will loose 20% of species within the next 30 years and 50% by the end of the next century. Many countries have recognized the value of rehabilitating degraded tropical area, to utilize natural resource for sustainable development and maintain biodiversity. Techniques have been established to achieve such objectives, such as assisted natural regeneration (ANR) (Dalmacio, 1986; RECOFTC, 1994) and the Miyawaki method (Miyawaki, 1993; Fujiwara, 1993). Such techniques for rehabilitating selected degraded areas will ultimately depend of the priorities of the stakeholders, the costs and benefits associated with available rehabilitation techniques, and the economic, social, and environmental values of these land resources in their current and desired future states (Lamb, 1994; Parrotta *et al.*, 1997).

Assisted or accelerated natural regeneration (ANR) was suggested by Dalmacio and is already practiced for accelerated reforestation of degraded uplands and *Imperata* grassland in the Philippines (Dalmacio, 1986; Durst, 1990). The basic

concept of ANR emphasizes protection and nurturing of tree seedlings and saplings already existing on degraded sites, rather than establishment of entirely new forest plantations. ANR requires tree seedlings and saplings on degraded sites to be marked and assisted in their survival and growth by one or more of the following activities: 1) pressing or cutting of competing grasses, 2) weeding around existing seedlings and saplings, 3) fire protection, and 4) enrichment planting. The advantages of ANR are not only accelerated secondary succession of forest, but also maintenance of species diversity, provision of useful products and many ecological values. In ANR implementation can often be accomplished for as little as one-third the cost of conventional reforestation.

In Thailand, ANR has not been successful because knowledge of how to assist the natural regeneration of each species is lacking. Literature on fruit production, seed germination, seed banks, and tree seed dispersal is much needed. Different species require different ANR methods. Suitable methods may include planting *Beilschmiedia* sp. (Lauraceae) under the shade of existing herbaceous vegetation, direct sowing of *Prunus cerasoides* (Rosaceae), and for *Eugelhardia spicata* (Juglandaceae), cutting weeds (particularly grasses and ferns) or shading them out with nurse trees (Hardwick *et al.*, 1997).

However, there have been reports of forest restoration through natural regeneration using some ANR techniques. Rehabilitation of abandoned logging and shifting cultivation areas at Ban Laeng forest community in Huay Ma Fuang watershed, Rayong Province, has succeeded. Good results were obtained using *Hevea*

brasiliensis (rubber, an economic exotic species) as an upper canopy, *Dipterocarpus alatus* and *Hopea* sp. (native trees) as a middle layer, and vegetables as a ground layer. Villagers are allowed to gather firewood and non-timber forest products but are not allowed to cut planted trees. These are the key elements in reforestation, which support good environmental conditions and promote sustainable natural resource management (Vithvatchutikul, 1994).

Fire protection is very important in forest restoration in most places. In teak (*Tectona grandis*, Verbenaceae) plantations with planting of fast growing trees, in Lampang Province, two species of planted trees had very low survival and the remaining trees died, except teaks, three years after planting, because they were burnt. However, teak coppicing and native trees species established after that (Sukwong, 1978 and 1994). In an Akha (Ekoh) community, Phaka Sukjai village, in Mae Chun District, Chiang Rai Province, remaining forest (pine mixed with evergreen forest, 1,100 m above sea level), dominated by *Imperata cylindrica,* recovered when villagers participated seriously in fire protection with no cutting, cultivating, and burning trees (Durno and Warner, 1994).

Weeding around existing seedlings and saplings, and enrichment planting were used for forest restoration in the Ping watershed, Jomthong and Hod district, Chiang Mai province. After six years, the existing trees grew rapidly as a middle layer with planted trees (Saidee, 1994).

Living stumps in deforested areas can accelerate reforestation because some trees species can coppice and grow rapidly after they are cut. This technique was used to restore deciduous dry dipterocarp forest, along with fire protection, in Ban Bing Pra community forest, Chokchai and Pukthongchai District, Nakornratchasima Province. Native trees were planted on bare land around the villages and Bing Pra Temple. Ten years later, those existing stumps became trees and there was secondary succession. Moreover, wildlife, such as birds, returned (Kunnavuttho, 1994). On abandoned land, in the Measa watershed, Chiang Mai Province, in hill evergreen forest, five to ten years after shifting cultivation, sites which had existing stumps, had more species of trees and ground flora, than sites where stumps had been dug out (Kaenchun, 1994).

Studies of natural regeneration, after clear felling in teak forest, in Lumphang province, show that the forest has a high potential to recover. In the first year there was coppicing of many types of trees which became saplings three years later, enough for forest regeneration, and they were mature trees within six years, finally. Moreover, commercial timber species were found, such as *Tectona grandis, Xylia xylocarpa* var. *kerrii, Lagerstroemia* sp., and *Pterocarpus macrocarpus* (Sukwong, 1978 and 1994).

The Miyawaki method has been used successfully to restore forest in many places in Japan and in other places in Southeast Asia (Miyawaki, 1993). The technique includes:

1) species selection using as many native canopy species as possible, based on the potential natural vegetation at each site by the phytosociological method,
2) mixed plantations,
3) use of potted seedlings with well developed root systems (with heights of up to 80 cm.),
4) soil preparation, including provision of good drainage and use of organic fertilizers such as compost, weeds, dropped, broken blocks, etc,
5) dense planting (3-9 individuals per square meter),
6) mulching with rice straw, leaves, etc., for protection against soil dryness, soil erosion and loss of nutrients, and
7) no management after two or three years from planting (Miyawaki, 1984; Fukiwara, 1984 and 1993).

Miyawaki (1993) and Said (1993) reported the first assessment of planting native seedlings (such as *Shorea* spp., *Dipterocarpus* spp., *Hopea* spp., etc.) and using some techniques of the Miyawaki method at Bintulu, Sarawak State, Malaysia. The percent survival of such seedlings on areas of soil erosion and compaction after planting for a year, was very high (approximately 71%). Moreover, percent survival was 89.2 % where 1 m wide strips of vegetation had been removed with half-meter-wide strips of existing vegetation retained to provide shade to the planted seedling. In addition, the planted seedlings grew well, and had well-developed crowns after weeding and using rice straw as a mulch (Miyawaki, 1993). Six months after planting native seedlings 50 cm tall, using oil palm leaves as a mulch, at a shopping center

JAYA JUSCO in Malacca, Malaysia, they had grown to 150-270 cm (Miyawaki, 1993; Fujiwara, 1993).

Ecological rehabilitation of forest and biodiversity conservation has been achieved in North Queensland using the framework species method (Tucker and Murphy, 1997). This method uses 20-30 of the fleshy-fruited local species known to be frugivore attractants, with good site captures abilities. Framework species are established as a perching resource and a bait crop to entice seed dispersing wildlife from adjacent areas, relying on these dispersers to accelerate the establishment of other species and life forms. All rehabilitation sites were blanket sprayed with a non-residual herbicide prior to planting. Plantings are located in national parks, along rivers, in degraded areas, along former roads, and along existing forest margins on cattle ranches. It was concluded that plant colonization might be accelerated by establishing combinations of fleshy-fruited native trees from different stages of normal forest succession, which attract seed-dispersing birds and mammals.

STUDY SITE DESCRIPTION

Four experimental plots were established within Doi Suthep-Pui National Park at 18° 52'N 98° 49'E on ridges above the village of Mae Sa Mai at altitudes of 1,207 m above sea level, 5-10% of slope, and 350° of aspect (Figures 1 and 2). These plots were formerly covered by primary evergreen forest, but had been cleared and cultivated for many years for crops such as opium poppy, cabbages, corn, and fruit trees. A few cultivated trees remained within the plots.

The study site consisted of 2 plots of planted trees with native tree seedlings in 1997 and 1998 (plots P97 and P98) with weeding, application of fertilizer, and fire protection, and 2 control plots in each year (plots C97 and C98), which no tree planting and any forest restoration activities except fire protection.

In two plots of planted trees, about 100 g of fertilizer was applied to each sapling when planted. There was no cutting of naturally established tree seedlings. The weeds were cleared around the planted trees and naturally established trees using hand tools. A non-residual herbicide (e.g. glyphosate) was used to clear the site before planting.

Subplots in 1997 measured 20 m x 20 m. including the plots P97 and C97 (Figures 3 and 4). In plot P97, 25 native tree seedlings were planted in June 1997 (Appendix 1). Weeds were cleared using hand tools once per month in the rainy season. Fertilizer was applied (about 100 g/tree) immediately after weeding. The

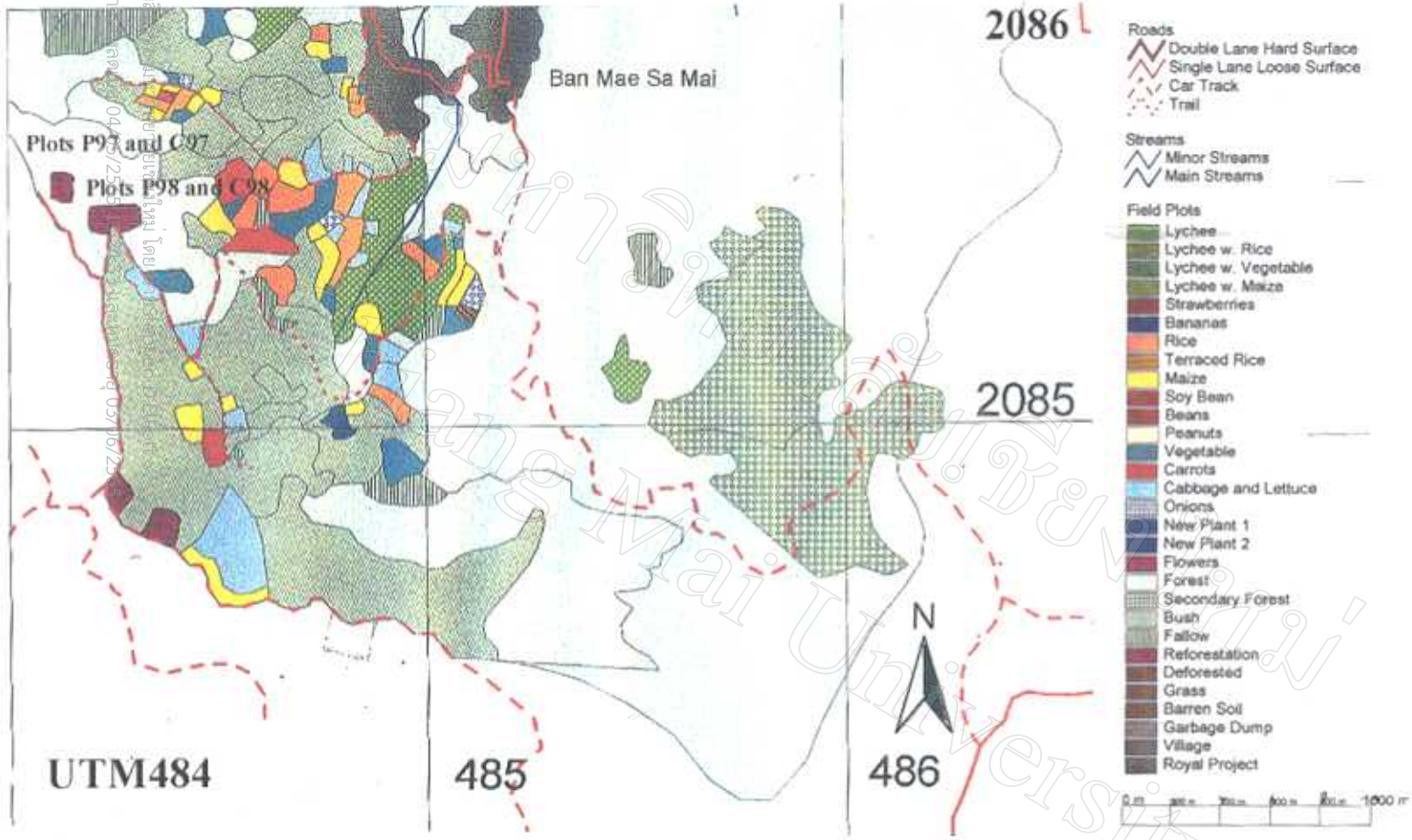
subplots suffered a partial burning in the dry season of 1998, which reduced tree density. Surviving trees, however, continued to grow well.

The 1998 subplots measured 40 m x 40 m and also consisted of the plots P98 and C98. Twenty-nine native tree saplings were planted in June 1998 (Appendix 2). Planting and silvicultural treatments were the same as for the 1997 subplots (Figures 5 and 6).

The treatments in each plot are summarized in Table 1.

Table 1. Summary of treatments in each experimental plot.

Plot	Activities
P98 (40 m X 40 m)	Before and when planting 1. No cutting of naturally established tree seedlings, saplings, and trees. 2. A non-residual herbicide was used to clear the plot before planting. 3. Planting with native trees (29 species, 500 trees/rai or 3,125 trees/ha) in June 1998 with 100 g of fertilizer applied, when planted. 4. Fire break. After planting 1. Weeding with hand tools once per month, in the rainy season and application of fertilizer (about 100 g/tree) immediately after weeding, and weed used as mulch. 2. Fire break before dry season.
C98 (40 m X 40 m)	No planting, weeding, and fertilizing except fire break
P97 (20 m X 20 m)	The same with plot P98, but native trees were planted in June 1997 (25 species, 250 trees/rai or 1,563 trees/ha) and there was a partial burn in the dry season of 1998.
C97 (20 m X 20 m)	The same as plot C98, but partial burn in the dry season of 1998



Source; Stuetz, 2000.

Figure 1. Map showing part of Doi Suthep-Pui National Park, Mae Sa Mai village, and location of the experimental plots.

Figure 2. Mae Sa Mai village viewed from plot P98 (13th November 1999).

Figure 3. Plot P97 (13th November 1999) that suffered a partial burning in the dry season of 1998 and reduced tree density, but surviving tress continued to grow well and with the canopy closing.

Figure 4. Plot C97 (13th November 1999) dominated by *Mucuna bracteata*, *Pteridium aquilinum*, and *Eupatorium adenophorum* after fire in the dry season of 1998.

Figure 5. Plot P98 (13th November 1999) with fast-growing planted trees, especially *Melia toosendan*.

Figure 6. Plot C98 (13th November 1999) dominated by *Pteridium aquilinum*, *Imperata cylindrica*, and *Thysanolaena latifolia*.

METHODOLOGY

Materials and Equipment

Measuring tape (1.5 m and 5 m)

Plant press

Strong knife and scissors

Nails and hammer

PVC poles (1 m)

Metal labels

Data Collection Methods

Planted and naturally established trees

Naturally established trees, including seedlings, saplings, and mature trees were surveyed by both walking survey and circular sample units, but planted trees were surveyed only in the circular sample units. The sample units (2.5 m radius) were randomly located and covered about 24% of each subplot, totaling 30 circles. Five and 10 circles were established in each of the planted and control subplots of 1997 and 1998 plots, respectively.

Planted trees and naturally established seedlings (100 cm < h < 130 cm), saplings (h > 130 cm, diameter < 4.5 cm) and trees (h > 130 cm, diameter > 4.5 cm)

were labeled to make them easily to find in the subsequent surveys. Their height and health were measured with a measuring tape and scored.

The health scale was divided into 4 levels:

0 = dead

1 = not healthy, no leaves but still alive

2 = normal, but may have some yellow leaves, brown spots, insect damage, etc.

3 = very good

Ground flora

The herbaceous ground flora (h < 100 cm) was surveyed using circular sample units. The Braun Blanquet scale was used to quantify abundance of the herbaceous ground flora (Shimwell, 1971; Goldsmith *et al.*, 1986) that is as follows:

+ = less than 1 %, sparsely or very sparsely present, cover very small

1 = 1-5 %, plentiful, but of small cover value

2 = 6-25 %, very numerous or covering at least 5 % of the area

3 = 26-50 %, any number of individuals covering ¼ to ½ of the area

4 = 51-75 %, any number of individuals covering ½ to ¼ of the area

5 = 76-100 %, covering more than ¾ of the area

Timing of the surveys

The vegetation was surveyed three times: in the dry season (late April 1999), in the middle of the rainy season (early August 1999), and at the end of the rainy season (early November 1999). Some specimens of ground flora, natural seedlings, and saplings were collected and identified at the CMU Herbarium, Department of Biology, Chiang Mai University.

Data Analysis

Ecological indices

Different aspects of ground flora communities, i.e. species richness, evenness, diversity, and distance coefficient between each sampling site were analyzed using the basic computer programs SPDIVERS.BAS and SUDIST.BAS (Ludwig and Reynolds, 1988).

Species richness

Species richness of naturally established trees was determined by direct count.

N0 = total number of ground flora species.

Species diversity (Hill's number)

The following indices were used to compute the diversity of ground flora at each experimental plot:

1. $N1 = e^{H'}$
2. $N2 = 1/\lambda$

Where: N1 = number of abundant species in the sample

N2 = number of very abundant species in the sample

H' = Shannon's Index

λ = Simpson's Index

Shannon's Index (H') is computed as:

$$H' = \sum_{i=1}^{s} (p_i \ln p_i)$$

Simpson's Index (λ) is computed as:

$$\lambda = \sum_{i=1}^{s} p_i^2$$

Where: Pi = proportion of individuals belonging to i^{th} species and is computed as:

$$p_i = n_i / N$$

Where: n_i = number of individuals of the i^{th} species

N = total number of individuals

S = number of species

Evenness (Modified Hill's Index)

$$E5 = \frac{(1/\lambda) - 1}{e^{H'} - 1}$$

Species/area curves

Frequency and probability spreadsheets were used to calculate and make curves for only the ground flora at each study site to find out whether the sampling sizes was big enough to represent a whole plot.

Similarity and different Indices

To compare the similarities and differences of ground flora in each experimental plot, the following indices were used:

Sorensen's Index (SI) for similarity coefficient

$$SI = 2C / (A+ B)$$

Where: C = number of species common to both community

A = total number of species in community A

B = total number of species in community B

Chord Distance (CRD) for difference coefficient

$$CRDjk = 2 (1-ccosjk)$$

Where: CRDjk = Chord distance between sample unit j(SUj) and sample unit k (Suk) which range from 0 to 2

ccos = Chord cosine is computed from

$$c\cos = \frac{\sum_{i=1}\{(Xij)x(Xjk)}{\left(\sum_{i=1} Xij^2\right)x\left(\sum_{i=1} Xik^2\right)}$$

Where: Xij = number of individuals of the ith species in sample unit j

Yik = number of individuals of the ith species in sample unit k

S = number of species

Relative Growth Rate (RGR)

The relative growth rate for the planted trees and naturally established seedlings, saplings, and trees which were labeled and scored, were calculated as follows:

Height Relative Growth Rate (RGR)

$$\text{RGR (\%increase in height per year)} = \frac{(\ln H1 - \ln H2)}{(t2 - t1)} x100x365$$

Where: REG = relative growth rate

H1 = height of species A in the first survey

H2 = height of species A in the last survey

T2 –T1= number of days between T1 and T2

ln = natural log

Health Average and % Survival Rate

Health average

$$Ha = (H1 + H2 + H3)/3$$

Where: Ha = Health average

H1 = Health score of plant species A in first survey

H2 = Health score of plant species A in second survey

H3 = Health score of plant species A in third survey

Percent Survival rate

$$\text{Percent survival rate} = (SN / TN) \times 100$$

Where: SN = Number survived

TN = Total number of species

RESULTS

Richness, Diversity, and Evenness

One hundred thirty six plant species (except planted tree species), including 103 ground flora and 48 naturally established trees were recorded in this study (Table 2). Plot P98 supported more species (95 species) than plot C98 (71 species), C97 (41 species) and P97 (33 species), respectively. A total of 29 planted trees species were found: 22 and 14 in plots P98 and P97 respectively. Lists of all species found in all subplots and walking surveys, excluding planted trees, in each plot is presented in Appendix 3.

Table 2. Total number of ground flora species, natural established trees, and planted trees found in all surveys.

Plot	Number of ground flora species found	Number of natural tree species found*	Total number of species found**	Planted tree species found***
P98	75	29	95	22
C98	51	27	71	-
P97	28	5	33	14
C97	37	4	41	-
all plots	103	48	136	29

Remarks

* = Including naturally established seedlings, saplings, and tress in both circle and walking surveys

** = Not including planted tress. Some of the ground flora and natural trees species were the same.

*** = 29 and 25 of planted trees were in both the plots P98 and P97 with 15 species the same in both the plots P98 and P97

Ground Flora

Ground flora species were abundant in all plots. Lists of all ground flora species recorded in all surveys and at each study plot are presented in Appendix 4.

Diversity indices of the ground flora (Table 3) shows that plot P98 had higher species richness (75), more abundant (N1 = 32.16) and very abundant (N2 = 19.12) species, and a more even distribution of ground flora species (E5 = 0.61) than plot C98. Although plot C97 had higher species richness and a greater number abundant (N1 = 19.22) and very abundant species (N2 = 11.51) than plot P97, it had fewer very common species because the evenness index of ground flora (E5 = 0.58) was less than in plot P97 (E5 = 0.66).

Table 3. Species richness, diversity (Hill's number), and evenness (modified Hill's ratio) in the 4 plots.

Plots	Species richness	Species diversity		Evenness (E5)
		N1	N2	
P98	75	32.16	19.12	0.61
C98	51	21.20	10.92	0.49
P97	28	15.70	10.62	0.66
C97	37	19.22	11.51	0.58

The most abundant ground flora species recorded in all surveys were *Pteridium aquilinum, Ageratum conyzoides, Eupatorium adenophorum, Mucuna bracteata,* and *Pennisetum polystachyon* (Table 4). Five species viz. *Ageratum conyzoides, Conyza sumatrensis, Bidens pilosa, Crassocephalum crepidiodes,* and *Rhynchelytrum repens,* were most abundant in both the planted plots but considerably less abundant in both the control plots.

Table 4. Percent cover of ground flora species recorded in all plots.

Species	P98	C98	P97	C97	Total	No. of plots recorded
Ground flora*						
Pteridium aquilinum	5	260	7	167	439	4
Ageratum conyzoides	208	5	67	13	293	4
Eupatorium adenophorum	110	25	33	103	271	4
Mucuna bracteata	2	25	23	220	270	4
Pennisetum polystachyon	10	0	193	33	236	3
Mitracapus villosus	150	22	47	0	219	3
Conyza sumatrensis	122	13	60	17	212	4
Bidens pilosa	55	15	87	43	200	4
Phragmitus vallatoria	107	90	0	0	197	2
Imperata cylindrica	33	150	0	7	190	3
Cyperus cyperoides	42	15	47	57	161	4
Thysanolaena latifoia	27	100	0	0	127	2
Crassocephalum crepidiodes	38	22	40	20	120	4
Eupatorium odoratum	52	47	3	17	119	4
Setaria parviflora	63	10	3	17	93	4
Rhynchelytrum repens	27	12	47	3	89	4
Microstegium vagans	8	73	0	0	81	2
Digitaria setigera	25	5	23	20	73	4
Artemisia indica	35	27	10	0	72	3
Polygonum chinense	7	0	13	40	60	3
Spilanthes paniculata	47	0	7	3	57	3
Clerodendrum glandulosum	5	28	3	20	56	4
Centella asiatica	43	10	0	0	53	2
Drymaria diandra	7	0	33	10	50	3
Mimosa diplotricha	0	0	0	50	50	1
Alectra avensis	48	0	0	0	48	1
Dioscorea glabra	7	32	0	0	39	2
Solanum nigrum	12	0	20	7	39	3
Blumea balsamifera	37	0	0	0	37	1
Galinsoga parviflora	17	0	10	10	37	3
Triumfetta pilosa	7	30	0	0	37	2

Triumfetta rhomboidea	0	0	3	33	36	2
Trichosanthes tricuspidata	0	0	0	33	33	1
Panicum notatum	7	17	0	7	31	3
Setaria palmifolia	17	10	0	0	27	2
Buddleja asiatica	25	0	0	0	25	1
Oroxylum indicum	7	0	0	17	24	2
Paspalum conjugatum	8	3	13	0	24	3
Millettia pachycarpa	0	0	0	23	23	1
Oxalis corniculata	3	0	20	0	23	2
Anaphalis margaritacea	12	8	0	0	20	2
Desmodium heterocarpon	5	15	0	0	20	2
Dioscorea alata	0	10	0	10	20	2
Solanum torvum	3	7	0	10	20	3
Seteria verticillata	0	17	0	0	17	1
Alpinia malaccensis	13	3	0	0	16	2
Sporobolus diander	13	0	3	0	16	2
Boehmeria chiangmaiensis	0	3	0	10	13	2
Neyraudia reynaudiana	13	0	0	0	13	1
Sida rhombifolia	0	0	3	10	13	2
Sonchus oleraceus	13	0	0	0	13	1
Acacia megaladena	2	10	0	0	12	2
Carex baccans	2	0	0	10	12	2
Eugenia albiflora	7	5	0	0	12	2
Asparagus filicinus	10	0	0	0	10	1
Cissampelos hispida	0	0	0	10	10	1
Commelina benghalensis	0	0	0	10	10	1
Dioscorea prazeri	0	10	0	0	10	1
Merremia vitifolia	0	0	0	10	10	1
Urena lobata	2	5	3	0	10	3
Desmodium velutinum	0	5	0	3	8	2
Pterocarpus macrocarpus	8	0	0	0	8	1
Aneilema sinicum	7	0	0	0	7	1
Arthraxon castratus	7	0	0	0	7	1
Boehmeria diffusa	0	0	0	7	7	1
Borreria laevis	7	0	0	0	7	1
Murdannia scapiflora	7	0	0	0	7	1
Rauvolfia verticillata	0	0	0	7	7	1
Capillipedium parviflorum	3	0	3	0	6	2
Argyreia aggregata	0	5	0	0	5	1
Embelia sessiliflora	0	5	0	0	5	1
Entada rheedii	0	5	0	0	5	1
Gmelina arborea	0	5	0	0	5	1
Helicteres elongata	0	5	0	0	5	1
Ixora cibdela	5	0	0	0	5	1
Kuniwatsukia cuspidata	5	0	0	0	5	1
Maesa montana	0	5	0	0	5	1
Melastoma normale	2	3	0	0	5	2
Paris polyphylla	0	5	0	0	5	1
Saccolepis indica	5	0	0	0	5	1
Smilax perfoliata	5	0	0	0	5	1
Sterculia villosa	0	5	0	0	5	1
Abrus pulchellus	0	3	0	0	3	1
Castanopsis argyrophylla	0	3	0	0	3	1
Codonopsis javanica	0	3	0	0	3	1
Dalbergia stipulacea	3	0	0	0	3	1

Firmiana colorata	0	3	0	0	3	1
Laggera pterodonta	3	0	0	0	3	1
Pteris biauria	3	0	0	0	3	1
Schima wallichii	0	3	0	0	3	1
Vernonia divergens	3	0	0	0	3	1
Aporusa villosa	2	0	0	0	2	1
Argyreia obtecta	2	0	0	0	2	1
Chamaecrista leschenaultiana	2	0	0	0	2	1
Crotalaria dubia	2	0	0	0	2	1
Cyrtococcum accrescens	2	0	0	0	2	1
Eleusine indica	2	0	0	0	2	1
Embelia subcoriacea	2	0	0	0	2	1
Erythrina suberosa	2	0	0	0	2	1
Mussaenda parva	2	0	0	0	2	1
Paederia wallichii	2	0	0	0	2	1
Phyllanthus urinaria	2	0	0	0	2	1
Wendlandia scabra	2	0	0	0	2	1
Total	1615	1202	824	1087	4728	
Total number of species	75	51	28	37	103	

* Percent cover average X 100

Three ground flora species: *Pteridium aquilinum, Mucuna bracteata,* and *Clerodendrum glandulosum,* were most abundant in plots C97 and C98, but they were less abundant in plots P97 and P98.

The most of abundant of ground flora species found in each plot are presented in Table 5. Ground flora species found in all 4 plots in all 3 surveys are presented in Appendices 5, 6, 7, and 8.

Table 5. The most abundant ground flora species found in each plot.

Plot	Abundant species	Percent cover average x 100 (from Table 4)
P98	*Ageratum conzoides*	208
	Mitracapus villosus	150
	Conyza sumatraensis	122
	Eupatorium adenophorum	110
	Phragmites vallatoria	107
C98	*Pteridium aquilinum*	260
	Imperata cylindrica	150
	Thysanolaena latifolia	100
	Phragmites vallatoria	90
	Microstegium vagans	73
P97	*Pennisetum polystachyon*	193
	Bidens pilosa	87
	Ageratum conyzoides	67
	Conyza sumatraensis	60
	Mitracarpus villosus	47
C97	*Mucuna bracteata*	220
	Pteridium aquilinum	167
	Eupatorium adenophorum	103
	Cyperus cyperoides	57
	Mimosa diplotricha	50

When considering abundant ground flora species in each plot (Table 5), abundant species in plot P98 was different from plot C98. Only one species (*Phragmites vallatoria*) was found in both plots, but it was more abundant in plot P98 (107) than in plot C98 (90). The abundant ground flora species were completely different between plots P97 and C97. Three abundant ground flora species (*Ageratum conyzoides, Conyza sumatraensis, and Mitracarpus villosus*) were found in both plots P98 and P97, but only 1 ground flora species (*Pteridium aquilinum*) was the same in plots C98 and C97.

Species/Area Curves of the Ground Flora

Species/area curves of the ground flora were determined by using frequency and probability spreadsheets (Figures 7, 8, 9, and 10). The abundance of ground flora species was quantified as Braun Blanquet score only in the circle subplots. Coleman's equation and RAREFRACTION were used to calculate species/area curve for the naturally established trees, but only for trees recorded in the circle subplots. The trees recorded in walking surveys were not analyzed and included to make species/area curves. Moreover, more trees were recorded in walking surveys than in the circle subplots, so the naturally established trees were not used to make the curves in this study, because they cannot be represented the result of the whole plots.

Both plots C98 and C97 (Figures 8 and 10) had an equal number of ground flora species (37 species), although the sampled area in the 1997 plots was 4 times smaller than in the 1998 plots. The slope of the species/area curves of plot P98 was 1.6 times steeper than in plot C98. It reflects a higher species richness of ground flora species in plot P98 (60 species) compared with that in plot C98 (37) (Figures 7 and 8). Furthermore, the number of ground flora species in plot P98 was 2.1 times higher than in plot P97 (Figures 7 and 9).

Figure 7. Ground flora species/area curves for plot P98 using frequency and probability spreadsheets.

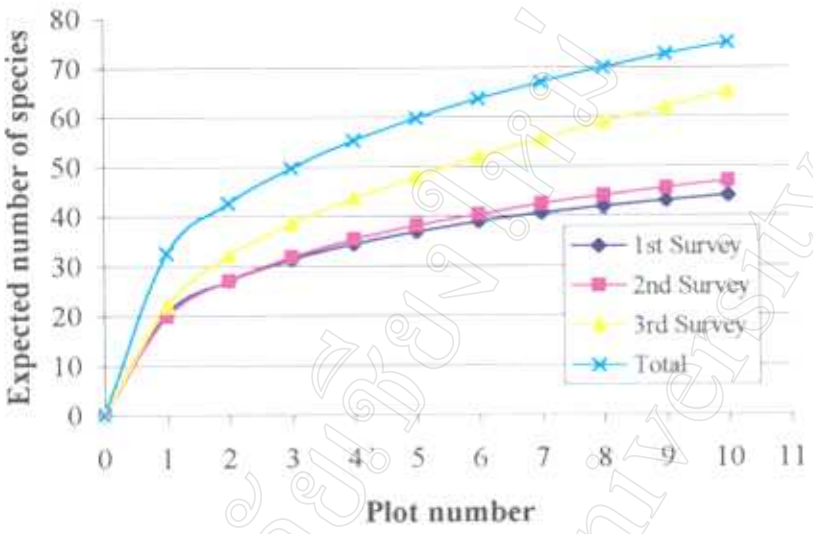


Figure 8. Ground flora species/area curves for plot C98 using frequency and probability spreadsheets.

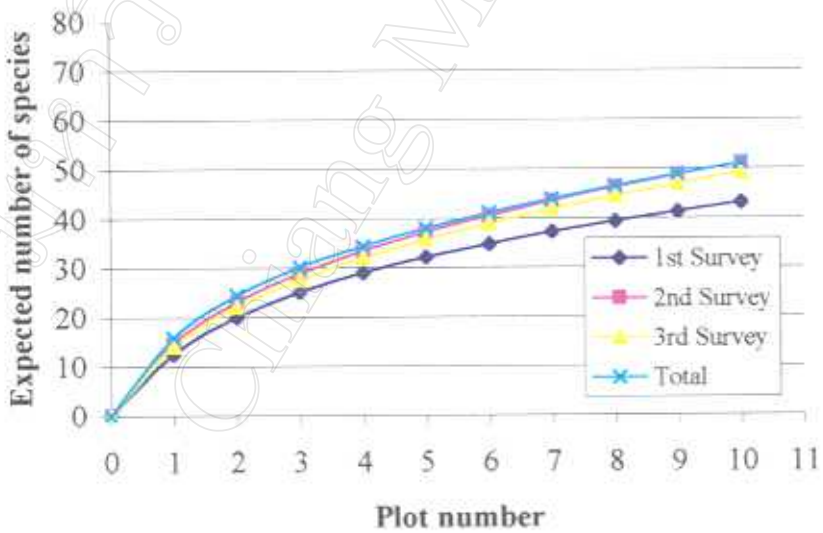


Figure 9. Ground flora species/area curves for plot P97 using frequency and probability spreadsheets.

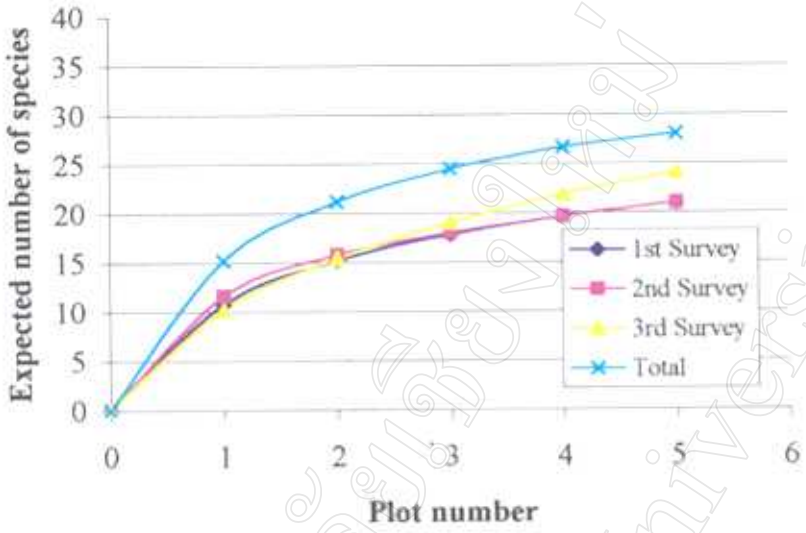
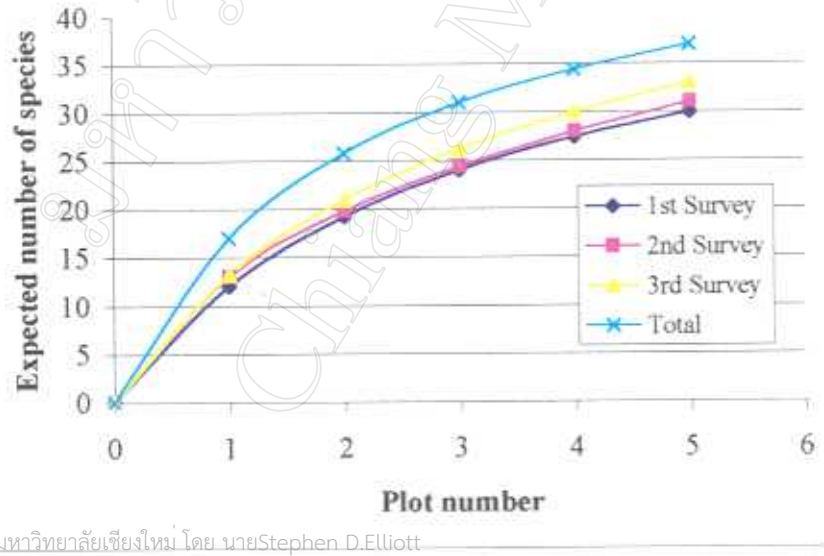


Figure 10. Ground flora species/area curves for plot C97 using frequency and probability spreadsheets.



Naturally established trees

A total of 49 species of naturally established seedlings, saplings, and mature trees were found in both circle plots and walking surveys. A list of naturally established seedlings, saplings, and mature trees found in all surveys at each plot is presented in Appendix 9.

The planted tree plots had slightly more species than in the control plots (Table 6). One hundred and forty two individuals of naturally established trees were recorded (Table 6). The most common naturally established tree species recorded was *Litsea cubeba.* The species richness of naturally established seedlings, saplings and mature trees was highest in plot P98, which also had the second highest total number individuals.

Table 6. Number of naturally established tree species recorded at each plot

Species	P98	C98	P7	C97	Total	No. of sites recorded
Naturally established trees (h > 1m)*						
Litsea cubeba	7	20	0	0	27	2
Acacia megaladena	9	7	0	0	16	2
Albizia chinensis	9	5	0	0	14	2
Glochidion sphaerogynum	2	5	0	0	7	2
Gmelina arborea	0	5	0	1	6	2
Markhamia stipulata	0	5	0	0	5	1
Antidesma acidum	3	1	0	0	4	2
*Prunus persica***	0	0	2	2	4	2
Albizia odoratissima	0	1	1	1	3	3
Dillenia parviflora	0	3	0	0	3	1
Eugenia albiflora	1	2	0	0	3	2
Melia toosendan	2	1	0	0	3	2
Artocarpus gomezianus	2	0	0	0	2	1
Berrya mollis	2	0	0	0	2	1
Buddleja asiatica	1	0	1	0	2	2
Castanopsis armata	0	2	0	0	2	1
Erythrina suberosa	1	1	0	0	2	2
Phoebe lanceolata	2	0	0	0	2	1
Phylanthus emblica	1	1	0	0	2	2

Pterocarpus macrocarpus	2	0	0	0	2	1
Schima wallichii	1	1	0	0	2	2
Wendlandia tinctoria	1	1	0	0	2	2
Lagerstroemia speciosa	0	0	1	0	1	1
Aporusa dioica	1	0	0	0	1	1
Aporusa villosa	1	0	0	0	1	1
Boehmeria chiangmaiensis	0	1	0	0	1	1
Bridelia glauca	0	0	1	0	1	1
Callicarpa arborea	0	1	0	0	1	1
Clerodendrum glandulosum	1	0	0	0	1	1
Cratoxylum formosum	0	1	0	0	1	1
Dalbergia discolor	1	0	0	0	1	1
Dalbergia stipulacea	0	1	0	0	1	1
Dillenia pentagyna	1	0	0	0	1	1
Diospyros glandulosa	1	0	0	0	1	1
Fernandoa adenophylla	1	0	0	0	1	1
Ficus hispida	0	1	0	0	1	1
Firmiana colorata	1	0	0	0	1	1
Garuga pinnata	1	0	0	0	1	1
Glochidion eriocarpum	1	0	0	0	1	1
Helicia nilagirica	1	0	0	0	1	1
Ixora cibdela	1	0	0	0	1	1
Maesa montana	0	1	0	0	1	1
Michelia baillonii	0	1	0	0	1	1
Mussaenda parva	0	1	0	0	1	1
Phoebe sp.	0	0	0	1	1	1
Securinega virosa	0	1	0	0	1	1
Sterculia villosa	0	1	0	0	1	1
Stereospermum colais	1	0	0	0	1	1
Turpinia pomifera	0	1	0	0	1	1
Total number of individuals	59	72	6	5	142	
Total number of species	29	27	5	4	49	

* Including naturally established seedlings, saplings, and mature trees in both circle plots and walking surveys

** An introduced fruit tree species planted by villagers

In order to find out if forest restoration activities increase naturally established seedlings, saplings, and mature trees, the rate of seedlings establishment between the first and last surveys must be compared (Table 7). Only planted trees taller than 1 meter were considered for in this analysis because they have high potential to develop into saplings and trees, and finally contribute to be the structure of the re-established forest. Naturally established trees were surveyed in both circle sample plots and walking surveys, but planted trees were recorded only in circle sample plots.

Table 7. Density and number of species of planted (h >1m) and naturally established trees found in circle sample plots and walking surveys.

	First Survey April 1999						Last Survey November 1999					
	Total C	Total P	C98	P98	C97	P97	Total C	Total P	C98	P98	C97	P97
CIRCLE PLOTS SURVEY												
Naturally established trees												
Density (No./ha)	441	340	661	407	102	204	509	543	713	611	102	407
No. Species	8	7	7	5	1	2	9	13	8	9	1	4
Planted trees												
Density (No./ha)	0	0	0	0	0	0	0	1698	0	1528	0	1935
No. Species	0	0	0	0	0	0	0	23**	0	13	0	13
Total												
Density (No./ha)	441	305	661	357	102	204	509	2241	713	2139	102	2342
No. Species	8	7	7	5	1	2	9	35*	8	21	1	18
WALKING SURVEYS												
Naturally established trees												
Density (No./ha)	287	223	335	256	66	66	358	287	413	335	99	66
No. Species	20	18	19	17	1	2	25	23	24	22	2***	2
TOTAL OF NATURALLY ESTABLISHED TREES IN CIRCLE PLOTS AND WALKING SURVEYS												
Density (No./ha)	728	528	996	613	168	270	867 (+19.09%)	830 (+57.20%)	1126 (+13.05%)	946 (+54.32%)	201 (+19.64%)	473 (+75.19%)
No. Species	23	23	22	22	2	3	29	33	27	29	3***	5

Remarks: * Planted trees and naturally established tree species were the same

** Planted trees species in plots 1998 and 1997 were the same

*** Two new species were found (not the same species in the first survey) so 2 species increased, but the total number of species found in plot C97 were 3 because one species in the first survey disappeared.

The number species of naturally established tree in the plots with planted trees (P) and control (C) in the first survey in April were equal (Total C = 23, Total P = 23) but the P plots had accumulated more species than the C plots by the last survey in November (Total C = 29; increased 6 species, Total P = 33; increased 10 species). Considering density, the C plots had a higher density (728 no./ha) than the P plots (528 no./ha) in both the first and last survey, but the P plots had a higher %rate of increase (830 no./ha; increased 57.20 %) than the C plots (867 no./ha; increased 19.09 %). Therefore, not only did tree planting and associated activities increase the species diversity of ground flora, but it also increased the % density of naturally established trees in the 1998 plots.

Similarly in plots P98 and C98 showed that the number of species of naturally established trees in the first survey were equal (plot C98 = 22, plot P98 = 22), but by the last survey, plot P98 had more species than plot C98 (plot C98 = 27; increased 5 species, plot P98 = 29; increased 7 species). As for density, plot P98 had a higher % rate of increase (946 no./ha; an increase of 54.32 %) than plot C8 (1126 no./ha; an increase of 13.05 %) although plot C98 retained a higher density through out the study.

In plots P97 and C97, which were partially burnt, only 3 and 2 naturally established tree species, respectively, were recorded in the first survey, but by the last survey plot P97 had more species than plot C97, even though the increase in species was equal (plot C97 = 2; increased 2 species, plot P97 = 5; increased 2 species). Due to the disappearance of *Prunus persica* (2 individuals, an introduced fruit tree species

planted by villagers) in the third walking survey in plot C97, density decreased (201 no./ha) and to less than that in plot P97 (473 no./ha). Furthermore, 2 other species were found in the last walking survey in plot C97, so the number of species found in this case was 3 (Table 7), but the total species found in all surveys was 4 (Table 2). The survey results of naturally established trees in all 4 experimental plots for all 3 surveys are presented in Appendices 10, 11, 12, and 13.

Planted trees (Framework tree species)

Forty-nine individuals of 13 species of planted tree species taller than 1 meter were recorded in both plots P98 and P97 (Table 8). The most common planted tree species found was *Hovenia dulcis* (6 individuals). The total density of planted trees was 1698 no./ha. Plot P98 had less density (1528 no./ha) than plot P97 (1935 no./ha) (Table 7). A list of all planted trees species found in all surveys and in plots P97 and P98 are presented in Appendices 14, 15, and 16.

Table 8. Number of planted trees species recorded at each plot.

Species	P98	C98	P97	C97	Total
Planted trees (h> 1m)					
Hovenia dulcis	4	0	2	0	6
Prunus cerasoides	3	0	2	0	5
Bischofia javanica	3	0	0	0	3
Gmelina arborea	2	0	1	0	3
Heynea trijuga	0	0	3	0	3
Manglietia garrettii	3	0	0	0	3
Melia toosendan	3	0	0	0	3
Sarcosperma arboreum	3	0	0	0	3
Erythrina suberosa	2	0	0	0	2
Phoebe lanceolata	0	0	2	0	2
Quercus semiserrata	2	0	0	0	2
Sapindus rarak	1	0	1	0	2

Spondias axillaris	2	0	0	0	2
Bridelia glauca	0	0	1	0	1
Castanopsis acumminatissima	0	0	1	0	1
Diospyros glandulosa	1	0	0	0	1
Ficus benjamina	0	0	1	0	1
Ficus subulata	0	0	1	0	1
Glochidion kerrii	0	0	1	0	1
Helicia nilagirica	1	0	0	0	1
Cinnamomum iners	0	0	1	0	1
Markhamia stipulata	0	0	2	0	2
Total number of individuals	30	0	19	0	49
Total number of species	13	0	13	0	0

The survey results of planted trees for 3 surveys in plots P97 and P98 are presented in Appendices 17 and 18).

Similarity and Difference Indices

Sorensen's Index

Sorensen's index was used as a similarity coefficient to compare between sample units because of its simplicity. The similarity coefficient equals 1, when two sampling units have identical species composition and 0 when they have no species in common.

All species found in each of experimental plots were computed to determine similarity coefficients (Table 9). It was found that plots P97 and C97 were the most similar (similarity coefficient = 0.65), followed by plot pairs P98 and P97 (0.50); P98 and C98 (0.49); C98 and P97 (0.46); P98 and C97 (0.43); and C98 and C97 (0.43).

Table 9. Similarity coefficients (Sorensen's Index) of ground flora in all four plots.

Experimental Plot Pairs	A	B	C	2C/(A+B)
P98-C98	75	51	31	0.49
P98-P97	75	28	26	0.50
C98-C97	51	37	19	0.43
P97-C97	28	37	21	0.65

The similarity coefficients in each plot were made with overlap diagrams (Figure 11). The green color that means the number of ground flora species in each plot are the same.

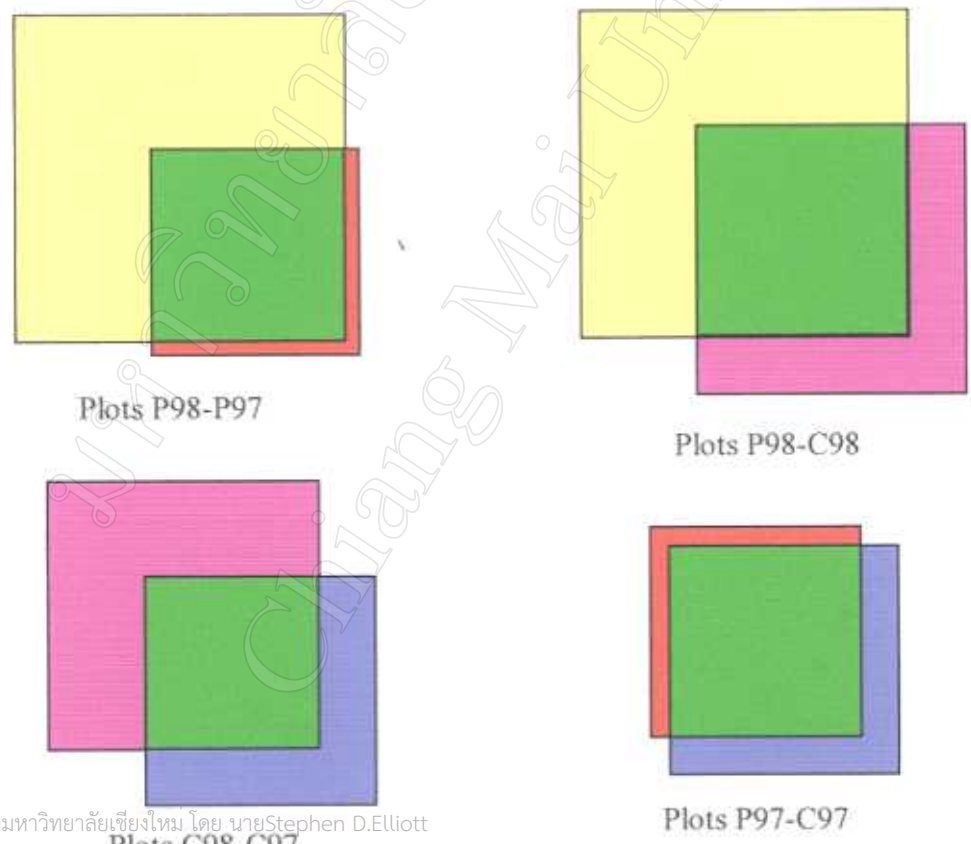


Figure 11. Ground flora species overlap diagrams from Sorensen's Index in the four plots.

Chord Distance (CRD)

Ludwig and Reynolds (1988) suggest using chord distance because it puts greater importance on the relative proportions of species in samplings units and correspondingly less importance on their absolute quantities. It is obvious that plots C98 and C97 are the most similar (lower distance value; 1.00) and plots C98 and P98 are the least similar (higher distance value; 1.34) (Table 10).

Table 10. Chord distance (CRD) between 4 experimental plots in plot x plot matrix form (ground flora).

Plot	C98	P98	C97
P98	1.20	1.01	1.24*
C98		1.34*	1.00
P98			1.16
C97			

Remark: * this value is not discussed because there is no point to compare the control plot from one year with the planted plot from another

Relative Growth Rate (RGR)

RGR were calculated for planted trees and naturally established tress taller than 1 meter in circle plots and walking surveys (Tables 11 and 12).

Table 11. Average relative growth rate (cm growth/cm of original height/year) of planted tree species recorded (h > 1m) in plots P98 and P97.

Species	P98	P97	Average
Planted trees (H > 1m)			
Bischofia javanica	97.5		97.5
Bridelia glauca		45.1	45.1
Castanopsis acumminatissima		102.7	102.7
Cinnamomum iners		141.24	141.24
Diospyros glandulosa	174.6		174.6

Erythrina subrumbrans		117.26		117.26
Ficus benjamina			shoot broken	-
Ficus subulata			57.26	57.26
Glochidion kerrii			113.8	113.8
Gmelina arborea		shoot broken	99.31	99.31
Helicia nilagirica		87.3		87.3
Heynea trijuga			131.35	131.35
Hovenia dulcis		90.68	151.44	121.06
Manglietia garrettii		175.24		175.24
Markhamia stipulata			111.8	111.8
Melia toosendan		181.12		181.12
Phoebe lanceolata			116.71	116.71
Prunus cerasoides		113.51	55.23	84.37
Quercus semiserrata		126.22		126.22
Sapindus rarak		274.17	67.5	170.835
Sarcosperma arboreum		83.47		83.47
Spondias axillaris		179.12		179.12
Total number of species		12	12	

Table 12. Average relative growth rate (cm growth/cm of original height/year) of naturally established tree species (h > 1m) in both circle plots and walking surveys in all plots.

Species	P98	C98	P97	C97	Average
Naturally established trees (h > 1m)[a]					
Acacia megaladena	48.98	38.86			43.92
Albizia chinensis	33.92	42.63			38.28
Albizia odoratissima		75.88	***	72.38	74.13
Antidesma acidum	100.14	56.98			78.56
Aporusa dioica	***				0
Aporusa villosa	shoot broken				0
Artocarpus gomezianus	22.23				22.23
Berrya mollis	101.75				101.75
Boehmeria chiangmaiensis		88.83			88.83
Bridelia glauca			*,**		0
Buddleja asiatica	66.12		97.62		81.87
Callicarpa arborea		48.75			48.75
Castanopsis armata		**,***			0
Clerodendrum glandulosum	***				0
Cratoxylum formosum		***			0
Dalbergia discolor	50.99				50.99
Dalbergia stipulacea		103.8			103.8
Dillenia parviflora		66.04			66.04
Dillenia pentagyna	47.87				47.87
Diospyros glandulosa	132.77				132.77
Erythrina suberosa	98.47	88.04			93.26
Eugenia albiflora	***	72.9			72.9
Fernandoa adenophylla	***				0
Ficus hispida		***			0
Firmiana colorata	***				0
Garuga pinnata	120.32				120.32
Glochidion eriocarpum	60.4				60.4

Glochidion sphaerogynum	***	48.79			48.79
Gmelina arborea		69.09		***	69.09
Helicia nilagirica	65.8				65.8
Ixora cipdela	31.98				31.98
Lagerstroemia speciosa			27.21		27.21
Litsea cubeba	70.62	77.95			74.29
Markhamia stipulata		63.76			63.76
Maesa montana		***			0
Melia toosendon	84	***			84
Michelia baillonii		49.6			49.6
Mussaenda parva		55.77			55.77
Phoebe lanceolata	***				0
Phoebe sp.				***	0
Phylanthus emblica	88.1	76.65			83.38
Prunus persica			29.35	*	29.35
Pterocarpus macrocarpus	1.77				1.77
Schima wallichii	76.26	41.55			58.91
Securinega virosa		103.25			103.25
Sterculia villosa		35.68			35.68
Stereospermum colais	**,***				0
Turpinia pomifera		76.96			76.96
Wendlandia tinctoria	72.11	60.06			66.09
Total number of species	20	22	3	1	49

Remarks
a = Including naturally established seedlings, saplings, trees
* = Could not calculate because it was found only in the first survey
** = Could not calculate because it was found only in the second survey
*** = Could not calculate because it was found only in the third survey

Most of the planted trees and naturally established seedlings species grew well (Tables 11 and 12). The native tree species with the highest RGR was *Melia toosendan* (181.21 cm/cm/year) followed by *Manglietia garrettii* (175.24 cm/cm/year), *Diospyros glandulosa* (174.60 cm/cm/year), and *Sapindus rarak* (170.84 cm/cm/year) (Table 5.10). Surprisingly, *Erythrina subumbrans*, usually a fast-growing tree species, had low RGR in this survey, because most of individuals had their shoots broken by the wind. Although most naturally established tree species grew well, their RGR were lower than planted tree species. Two planted framework tree species viz. *Gmelina arborea* and *Markhamia stipulata*, had higher RGR than naturally established trees of the same species. Therefore, weeding and applying fertilizer caused the increased RGR of these two trees species.

Health Average and %Survival Rate

The average health and % survival rate for planted trees and naturally established trees taller than 1 meter both in circle plots and walking surveys in each plot are presented in Tables 13 and 14, respectively.

Most of these trees had 100 % survival rate. *Phoebe lanceolata* had the lowest % survival rate (Table 13). Furthermore, 4 species were recorded as dead in the first survey viz. *Garcinia mckeaniana* (2 individuals), *Nyssa javanica* (1 individual), *Phoebe lanceolata* (1 individual), and *Aphanamixis polystachya* (1 individual).

The average health for planted trees and naturally established tree was only slightly different in *Diospyros glandulosa*.

Table 13. Average health and % survival rate of planted tree species found (h >1 m) in plots P98 and P97.

Species	P98		P97		Average	
	Average Height	% Survival	Average Height	% Survival	Average Height	% Survival
Planted trees (h > 1m)						
Bischofia javanica	2.83	100				
Bridelia glauca			2.80	100		
Castanopsis acumminatissima			3	100		
Cinnamomum iners			3	100		
Diospyros glandulosa	2.90	100				
Erythrina subumbrans	2.85	100				
Ficus benjamina			2.80	100		
Ficus subulata			3	100		
Glochidion kerrii			3	100		
Gmelina arborea	*	*	3	100		
Helicia nilagirica	2.70	100				
Heynea trijuga			3	100		
Hovenia dulcis	2.83	100	3	100		

Manglietia garrettii	2.85	100				
Markhamia stipulata			3	100		
Melia toosendan	3	100				
Phoebe lanceolata	2.84	100	2	66.67	2.42	83.34
Prunus cerasoides	2.5	100	2.9	100	2.7	100
Quercus semiserrata	2.5	100				
Sapindus rarak	2.76	100	3	100	2.88	100
Sarcosperma arboreum	3	100				
Spondias axillaris	2.9	100				
Total species	13		13			

* cannot be calculated because it was not found in the first survey

Table 14. Average height and % survival rate of naturally established trees (h > 1 m) in each plot.

Species	P98		C98		P97		C97	
	Health Average	%Survival	Health Average	%Survival	Health Average	%Survival	Health Average	%Survival
Naturally established trees (h > 1 m)								
Acacia megaladena	3	100	3	100				
Albizia chinensis	2.8	100	3	100				
Albizia odoratissima			3	100	*	*	3	100
Antidesma acidum	3	100	3	100				
Aporusa dioica	*	*						
Aporusa villosa	3	100						
Artocarpus gomezianus	3	100						
Berrya mollis	2.8	100						
Boehmeria chiangmaiensis	2.8	100						
Bridelia glauca	*	*						
Buddleja asiatica	3	100			2.8	100		
Callicarpa arborea			3	100				
Castanopsis armata			*	*				
Clerodendrum glandulosum			*	*				
Cratoxylum formosum			*	*				
Dalbergia discolor	3	100						
Dalbergia stipulacea			3	100				
Dillenia parviflora			3	100				
Dillenia pentagyna	3	100						
Diospyros glandulosa	3	100						
Erythrina suberosa	3	100	3	100				
Eugenia albiflora	*	*	3	100				
Fernandoa adenophylla	*	*						
Ficus hispida			*	*				
Firmiana colorata	*	*						

Garuga pinnata	3	100						
Glochidion eriocarpum								
Glochidion sphaerogynum	*	*	2.94	100				
Gmelina arborea			3	100				
Helicia nilagirica	3	100						
Ixora cibdela	3	100						
Lagerstroemia speciosa					3	100		
Litsea cubeba	3	100	2.98	100				
Markhamia stipulata			3	100				
Maesa montana			*	*				
Michelia baillonii			3	100				
Melia toosendon	3	100	*	*				
Mussaenda parva			3	100				
Phoebe lanceolata	*	*						
Phoebe sp.							*	*
Phylanthus emblica	3	100	3	100				
*Prunus persica***					2.75	100	0	0
Pterocarpus macrocarpus	3	100						
Schina wallichii	3	100	3	100				
Securinega virosa			3	100				
Sterculia villosa			3	100				
Stereospermum colais	*	*						
Turpinia pomifera			3	100				
Wendlandia tinctoria	2.8	100	2	100				
Total species	21		21		3		1	

* cannot be calculated because it was not found in the first survey

** an introduced fruit tree species planted by villagers

DISCUSSION

In the 1998 plots, the total species richness including ground flora and naturally established trees was higher in plot P98 than plot C98. In contrast, plot P97 had a lower total species richness of ground flora than C97 but a higher total species richness of naturally established trees (Table 2). These results may have been caused by tree planting and associated activities. Another factor in the 1997 plots was fire.

In the 1998 plots, applying fertilizer and weeding encouraged the growth of planted native species and supported an increase in species and diversity of the ground flora. It is suggested that weeding produced gaps in the herbaceous ground fora, allowing the establishment of a wider range of species. Five species: *Ageratum conyzoides, Conyza sumatrensis, Bidens pilosa, Crassocephalum crepidiodes,* and *Rhynchelytrum repens* became especially abundant in the planted plots but less abundant in the control plots (Table 4). Most of them (except *Rhynchelytrum repens*, Gramineae) are fast-growing annual herbs in the family Compositae, with small seeds which readily germinate on exposed soil after weeding. Therefore, they can survive and flourish even in frequently weeded plots. Planting trees and associated activities, especially weeding, probably caused the increase in abundance of these ground flora species. Weeding removed dominant herbs and created patches of bare earth which favoured seed germination of these species.

The abundant ground flora species in the control plots were *Pteridium aquilinum* (Dennstaedtiaceae), *Mucuna bracteata* (Leguminosae, Papilionoideae) and

Clerodendrum glandulosum (Verbenaceae) (Table 4). These ground flora species are perenial herbs which were not weeded in the control plots, so their percent cover was higher than in the planted plots.

Three ground flora species: *Eupatorium adenophorum* (Compositae), *E. odoratum* (Compositae), and *Setaria parviflora* (Gramineae) were very abundant in plot P98 and less abundant in plot C98 (Table 4). This result was inverted in the 1997 plots since these species were less abundant in plot P97 and most abundant in plot C97. These results might indicate that these species are affected by fire, because there was partial fire in plots P97 and C97. It means that these 3 ground flora species were very abundant after tree planting and weeding, but their abundances decreased after fire occurred.

Considering the 5 most abundant ground flora species in plots 1997 and 1998 (Table 5), the most dominant ground flora species in the 1998 plots (except *Phragmites vallatoria*, Gramineae) were quite different. So by eye, the plots appeared very different. Also there was completely different abundances in ground flora species in the 1997 plots. It means that the main ground flora compositions of plant communities changed after tree planting and weeding. Comparing the 5 most abundant ground flora species between the planted and control plots, there were 3 species viz. *Ageratum conyzoides* (Compositae), *Conyza sumatraensis* (Compositae), and *Mitracarpus villosus* (Rubiaceae) found in the planted plots, but only 1 ground flora species (*Pteridium aquilinum*, Dennstaedtiaceae) was found in the control plots (Table 5). It means that even though there was no tree planting and any activities in

the control plots, the main ground flora composition of plant communities changed after fire occurred.

The number of ground flora species in plot P98 was 2.1 times higher than in plot P97 (species/area curves, Figures 7 and 9) and was equal (37 species) in both plots C98 and C97 (species/area curves, Figures 8 and 10), although the area sampled of the 1998 plots was 4 times bigger than in the 1997 plots.

In plots P98 and P97, it can be explained that plot P98, which was left for one year after planting, had double the number of ground flora species compared with plot P97, which was left more than plot P98 for one time. It means that fire was a factor in the re-establishment of ground flora communities in plot P97 because, although plot P97 had recovered after fire for one year, the number of ground flora species was not different from plot P98, which had been left for one year after being burnt. Therefore, fire reduced the number of ground flora species in plot P97.

In addition, plot C98, which was left for one year, had an equal number of ground flora species, compared with plot C97, which had recovered over a longer period than plot C98. This means that number of ground flora species did not changed in plot C97.

The species richness of the ground flora increased in plots P98, P97, and C97 after each subsequent survey (Figures 7, 9, and 10). In plot C98, the second survey recorded more species than the third survey (Figure 8). The first survey was done in

the dry season, which had the lowest ground flora species richness because annual herbs (fast growing and dominant in only the rainy season) were not present. The species richness of the ground flora gradually increased in the second survey and became highest in the third survey which were done in the middle and late rainy season, respectively. This result was probably caused by fire protection because, although weeding and applying fertilizer increased species diversity of the ground flora, if fire had occurred, many species would have been removed. However, in the first survey, the number of ground flora species in plot P97 was the same as in the second survey (21 species). This means that fire slowed down the re-establishment of some ground flora species. However, as time goes by, the number of ground flora species started to increase again, as in the third survey, due to normal re-establishment. In plot C98, the second survey recorded 2 more species (51) than in the third survey (49), the first survey (43), and equal in the total number of ground flora species found (51). It reflected that due to no weeding and fire, the number of ground flora species was highest in the middle of the rainy season and gradually decreased in the late rainy season and dry season in plot C98.

Different methods of measuring similarity and difference coefficients, yield different results. Between plots C98 and C97, the similarity coefficient was lowest (0.43, indicating less similarity, Table 9), but CRD was also lowest (1.00, indicating less difference, Table 10). The highest similarity coefficient was in plot pair P97 and C97, but they had CRD (1.16) lower than the plot pairs P98 and P97 (1.01), and C98 and C97 (1.00). Only the plot pair P98 and P97 had a high similarity coefficient (indicating high similarity) and also high CRD (indicating less difference). These

contradictory differences in results are common when using Sorensen's index and CRD. Sorensen's index is a great advantage in terms of rapid assessment, but it does not take into account the abundance of each species. CRD does take into account relative abundance of different species. In this survey, the biggest differences occurred between the dominant or abundant species and these are given more weight when using CRD. However, Sorensen's index and CRD should be used together in vegetation analysis to find the similarities between communities and to get more accurate results.

In addition, ground flora species overlap diagrams were made to visualize changes during the succession process in each experimental plot pair (Figure 11). In plot pair P98 and C98, CRD was highest (1.20, indicating less similar, Table 10). Plot P98 accumulated more ground flora species than plot C98 which was also observed from the residual yellow in plot P98 compared with the remaining blue area in plot C98. This means that tree planting and weeding caused a gradually shifting of the ground flora to a different composition. Also the ground flora composition was fairly different in plot pairs C98 and C97, with no tree planting and weeding. However, the difference was reduced after planting which could be noticed from plot pair P98 and P97. Plot P98 accumulated more ground flora species than plot P97 (large yellow area). The number of ground flora species in plot P97 was a smaller subset of essentially the same ground flora species as in plot P98. It means that the number of ground flora species increased after tree planting and weeding, although fire occurred in plot P97, the number of ground flora species did not change. Most of the ground flora species in plot P97 were also found in plot P98. In plot pairs P97 and C97, the

similarity coefficient of ground flora species was highest (0.65, Table 9). This result was probably caused by fire, because the succession process was the same in both plots, although the dominant ground flora species were different. Before fire occurred, the dominant herbaceous weeds in the 1997 plots were *Conyza sumatrensis* and *Cyperus cyperoides*, and also with very common species e.g. *Bidens pilosa*, *Crassocephalum crepidioides*, *Solanum nigrum*, and *Triumfetta pilosa*. After fire occurred, *Bidens pilosa* and *Conyza sumatrensis* were still found as the dominant herbaceous weeds in plot P97, but the dominant ground flora species changed in plot C97 (only *Cyperus cyperoides* was found, Table 5). I still found *Bidens pilosa* in plot P97, because it is an annual herb and common in abandoned areas and silvicultural plots (Saelee, 2000).

Plot P97 had lower ground flora species richness than plot C97. Although the 1997 plots suffered a partial burning in the dry season of 1998, but surviving planted trees in plot P97 continued to grow well. The remaining trees developed broad canopies and shaded the herbaceous vegetation (after burning), which needed light to grow. This should have resulted in a less diverse ground flora in plot P97.

However, contrasting results was reported in studying understorey floristic composition between closed- and open-canopy plots, at a bauxite-mined site, at Porto Trombetas in western Para State, Brazil (Parrotta *et al.*, 1997). It was found that species richness (except grasses) of vines and herbs was significantly greater in the closed- than the open-canopy treatment, but density of grasses was nearly seven times greater in the open-canopy treatment. It was similar result in plot C98 that dominated

by 2 glasses species viz. *Imperata cylindrica* and *Thysanolaena latifolia* (Gramineae) (Table 5).

In plot C97 where there was no forest restoration activities and no trees planting, the area was opened after burning, allowing many herbaceous species to grow up. This might explain why the species richness of the ground flora was higher in plot C97 than plot P97. However, a few ground flora species dominated in plot C97: *Pteridium aquilinum, Mucuna bracteata,* and *Eupatorium adenophorum* (which are perennials herbs) after burning (Table 5) as indicated by the evenness (E5) in plot P97, which was higher than in plot C97 (Table 3). These ground flora species indicated that there were severe disturbances of this experimental plot (Oberhauser, 1997). This means that fire removed annual herbs.

In addition, weeding had a positive effect on naturally established seedlings and planted trees as well, because they could take enough water and nutrients from the soil, so they could survive and grow well. Furthermore, weeding provided more opportunities for natural seedlings to establish. Therefore, plot P98 with weeding had higher species richness of naturally established seedlings than plot C98 (Table 7).

Another factor could have been the dominance of *Eupatorium adenophorum* in plot P98 which was not dominant in plot C98. Adhikari (1996) showed that site dominated by *Eupatorium adenophorum* had higher density of naturally established tree seedlings than other types of dominant ground flora and provided the best

conditions for tree seedling establishment. This might also help to explain the higher density of natural trees establishing in plot P98.

In the 1997 plots, the increase in naturally established seedlings was equal but plot P97 accumulated more species than plot C97. Furthermore, the densities of natural trees in the planted plots were higher than in the control plots. It means that not only applying fertilizer but also weeding encouraged the growth of naturally established seedlings and increased natural tree density in the planted tree plots, even though there had been fire in the 1997 plots.

Most naturally established trees grew well in the control plots, but some had less growth than the planted trees of the same species e.g. *Gmelina arborea* and *Markhamia stipulata,* which had low RGR (Tables 11 and 12). Weeding and fertilizing might have caused the differences in RGR between the planted and naturally established trees.

The health of natural trees and planted trees species was very good (Table 13 and 14). The natural and planted tree species had high % survival rate except some planted tree species which were recorded as dead in the first survey viz. *Garcinia mckeaniana*, *Nyssa javanica*, *Phoebe lanceolata*, and *Aphanamixis polystachya*. However, *Phoebe lanceolata* and *Aphanamixis polystachya* were found in the other circle plots and in the other surveys, but *Garcinia mckeaniana* and *Nyssa javanica* were found just in the first survey. The % survival rate of *Garcinia mckeaniana* and *Nyssa javanica* could not be compared and should not be planted in this area.

Furthermore, there was coppicing in many individuals of *Buddleja asiatica* (h < 1 m, treelet) only in plot P98 in all 3 walking surveys. Tree planting with weeding and fire protection probably caused this result.

Experimental design

In addition to the fact that sampling size was not big enough to represent the whole plot (for the ground flora), which can be seen from all species/area curves, which increased slightly. However, I could not survey the ground flora species in the whole area like the natural trees, which were recorded in both circular plots and walking surveys because the ground flora species could not be counted as individuals. The ground flora in each species could not be scored if the sample units were big.

Future Implications

We should consider value of biodiversity and ecology when we would like to restore forest. The results showed that planting using native trees with associated fire protection, weeding, and fertilizer application not only encouraged the establishment of natural seedlings, but also increased the diversity of ground flora species. Although this research was a preliminary study, the success of forest restoration will be recorded if the project is monitored continuously for at least three years. This research is one way how to accelerate forest succession. In other forest restoration projects, native trees species should be studied in other areas to find potential framework species in those areas before making decisions to restore forest. Also

aftercare techniques i.e. fire protection, weeding in the rainy season, and applying fertilizer should be considered and applied to support the growth and survival of planted and naturally established trees.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

It could be concluded that:

1. In the first year after tree planting, the species richness and evenness of the ground flora in plot P98 increased when compared with plot C98, probably because weeding removed dominant perennials herb, allowing invasion of plot P98 by annual herbs, especially in the family Compositae.

2. Two years after planting, the diversity of the ground flora species in plot P97 decreased because the planted tree canopy closed, which also shaded out and reduced opportunities for establishment of new species of ground flora. Ground flora diversity was higher in plot C97, but evenness was lower than in plot P97.

3. Weeding and fertilizing accelerated the establishment of natural seedlings and increased natural plant density in the planted plots, although the increase in species of naturally established seedlings was equal in the 97 plots and the number of natural tree species found did not differ significantly in both 1998 and 1997 plots.

4. Most planted native tree species were in good health and growing fast. All of them, excluding *Nyssa javanica* and *Garcinia mckeaniana*, were suitable and proper species to plant for forest restoration in this area.

Recommendations

1. The experiment should be monitored continuously every year for 10 years to see more indications of results of planted native trees in forest restoration.

2. Further research is necessary to study the reappearance of wildlife in different plots.

3. Fire, grazing, and all agricultural activities must be forbidden in all reforested sites.

REFERENCES

Adhikari, P. B. 1996. *Relationship between Forest Regeneration and Ground Flora Diversity in Deforested Gaps in Doi Suthep-Pui National Park.* M.S. Thesis, Graduate School, Chiang Mai University, Thailand; 68-70.

Dalmacio, V. M. 1986. *Assisted Natural Regeneration*: A strategy for cheap, fast, and effective regeneration of denuded forestlands. DENR Region 8, Tacloban City. Philippines; 18.

Durno, J. and K. Warner. 1994. *Community Management and Forest Natural Regeneration*: The Case Study in E-kho Tribe. In Proceedings on Forest Restoration through Natural Regeneration. RECOFTC, Kasetsart University Bangkok; 21-31. (In Thai)

Durst, B.P. 1990. *Assisted Natural Regeneration.* Forest Service, Washington Office, Department of Agriculture, Washington, D.C., USA; 24.

Eilliott, S., D. Blakesley,V. Anusarnsunthron, J. F. Maxwell, G. Pakkad, and P. Navakitbumrung. 1997. *Selecting Tree Species for Restoring Degraded Forests in Northern Thailand.* Paper presented at the Workshop on Rehabilitation of Degraded Tropical Forest Lands, 3-7 February 1997; Kuranda, Australia.

Eilliott, S., V. Anusansunthron, S. Kopachon, D. Blakesly, and N. Garwood. 1996. *Research towards the Restoration of Northern Thailand's Degraded Forests.* In: Symposium on Accelerating Native Forest Regeneration on Tropical Lands. (Abstracts). IUFRO/WB/USDA-Forests Service; 8.

Elliott, S. and J. F. Maxell. 1995. Doi Suthep. pp. 210-214 in S.D. Davis, V.H. Heywood, and A.C. Hamiton (eds). Centers of Plant Diversity A Guide and Strategy for their Conservation Volume 2: Asia, Australia, and the Pacific. The World Wide Fund for Nature and IUCN-The World Conservation Union.

FAO. 1993. *Forest Resources Assessment 1990.* Tropical Countries. FAO Forestry paper 112. United Nations Food and Agriculture Organization, Rome; 61.

FAO. 1997. State of the World's Forests. Rome, Italy; 22-36.

FORRU (The Forest Restoration Research Unit). 1998. *Forest for the Future.* Department of Biology, Faculty of Science, Chiang Mai University, Thailand. 3; 49-56.

Fujiwara, K. 1984. *Investigation of the Growth Process of Environmental Forest in the Industrial Area in Camellietea japonicae.* In Abstracts, International Symposium on Urban Ecosystems and Environmental Science, Yokohama National University, Japan; 20-22.

Fujiwara, K. 1993. *Rehabilitation of Tropical Forests from Countryside to Urban Areas.* In H. Lieth and M. Lohmann (eds). Proceedings of the Symposium on Restoration of Tropical Forest Ecosystems, 1991. University of Osnabruck, Osnabruck; 119-131.

Goldsmith F. B., C. M. Harrison, and A. J. Morton. 1986. *Description and Analysis of Vegetation.* in P. D. Moore and S. B. Chapman (eds), Methods in Plant Ecology. Blackwell Scientific Publications, Oxford, England; 450.

Hardwick, K., J. Healey, S. Elliott, N. C. Garwood, and V. Anusarnsunthorn. 1997. *Understanding and Assisting Natural Regeneration Processes in Degraded Seasonal Evergreen Forests in Northern Thailand.* For. Ecol. Manage. 99; 203-214.

Kaenchun, C. 1994. *Secondary Succession in the Evergreen Forest.* In Proceedings on Forest Restoration through Natural Regeneration. RECOFTC, Kasetsart University Bangkok; 34 (In Thai).

Karimuna, L. 1995. *A Comparison of Ground Flora Diversity Between Forest and Plantation in Doi Suthep-Pui National Park.* M.S. Thesis, Graduate School, Chiang Mai University, Thailand; 10-19.

Kunnavuttho, M. 1994. *Forest Restoration by Stump.* In Proceedings on Forest Restoration through Natural Regeneration. RECOFTC, Kasetsart University Bangkok; 48 (In Thai).

Lamb, D. 1994. *Reforestation of Degraded Tropical Forest Lands in the Asia-Pacific Region.* J. Trop. For. Sci. 7; 1-7.

Leugaramsri, P. and N. Rajesh. 1992. *The Future of People and Forests in Thailand after the Logging Ban.* Project for Ecological Recovery, Bangkok, Thailand; 1-38.

Ludwig, J. A. and J. F. Reynolds. 1988. *Statistical Ecology*: A Primer on Methods and Computing. John Wily & Sons, New York; 85-103.

Maxwell, J. F. 1988. *The Vegetation of Doi Suthep-Pui National Park*, Chiang Mai Province, Thailand; Tiger Paper 15:4, 6-14.

Miyawaki, A. 1993. *Restoration of native tree forests from Japan to Malaysia.* In H. Lieth and M. Lohmann (eds). Proceedings of the Symposium on Restoration of Tropical Forest Ecosystems, 1991. University of Osnabruck, Osnabruck; 5-24.

Myers, N. 1993. *Biodiversity and the Precautionary Principle.* Ambio 22: 2-3, 74-79.

Oberhauser, U. 1997. *Second Forest Regeneration Beneath Pine* (Pinus kesiya) *Plantations in the Northern Thai Highlands*: A Chronosequence Study. For. Ecol. Manage. 99, 182.

OEPP. 1996. *Thailand's Biodiversity.* Ministry of Science, Technology, and Environment; Bangkok, Thailand; 31.

Parrotta, A. J., H. O. Knowles, and J. M. Wunderle Jr. 1997. *Development of Floristic Diversity in 10-year-old Restoration Forests on Bauxite Mined Site in Amazonia.* For. Ecol. Manage. 99, 21-42.

Parrotta, A. J., J. W. Trunull, and N. Jones. 1997. *Catalyzing Native Forest Regeneration on Degraded Tropical Lands.* J. For. Ecol. Manage. 99,1-7.

RECOFTC. 1994. *Forest Restoration through Natural Regeneration.* RECOFTC, Kasetsart University, Bangkok, Thailand; 96.

RFD (Royal Forest Department). 1995. *Forest Statistics of Thailand.* Royal Forest Department, Bangkok; 17-22.

Saelee, P. 2000. A Handbook for Tree Lovers: Glasses. Ban and Suan Press, Bangkok; 34 (In Thai).

Said, B.A. 1993. *The Rehabilitation of Tropical Rainforests Ecosystem.* In H. Lieth and M. Lohmann (eds). Proceedings of the Symposium on Restoration of Tropical Forest Ecosystems, 1991. University of Osnabruck, Osnabruck. Germany; 109-117.

Saidee, P. 1994. *Forest Restoration Using Enrichment Tree Planting.* In Proceedings on Forest Restoration Through Natural Regeneration. RECOFTC, Kasetsart University, Bangkok; 43-45 (In Thai).

Stuetz, W. 2000. *Assessment of Organochlorine Pesticide Resiudes in Human Milk of Hill Tribes Living in Northern Thailand.* MS. Thesis. Hohenheim-Kasetsart-Chiang Mai Universities, Interdesciplinary Research Project, Hohenheim University, Stuttgart.

Sukwong, S. 1978. *Natural Reproduction 3 Years after Clear Felling in Teak Forest.* Technical Paper No. 8, Department of Forest Biology, Faculty of Forestry, Kasetsart University. Bangkok; 8-10.

Sukwong, S. 1994. *Potential of Deciduous Forest in Natural Regeneration.* In Proceedings on Forest Restoration Through Natural Regeneration. RECOFTC, Kasetsart University Bangkok; 7 (In Thai).

Swaine, M. D. and Whitman, T. C. 1998. *On the Definition of Ecological Species Groups in Tropical Rain Forests.* Vegetatio. 75, 81-86.

Tucker, N. and T. Murphy. 1997. *The Effects of Ecological Rehabilitation on Vegetation Recruitment: Some Observations from the Wet Tropics of North Queensland.* For. Ecol. Manage. 99, 133-152.

Vithvatshutikul, P. 1994. *Rehabilitation of Forest and Watershed at Band Laeng, Rayong Province.* In Proceedings on Forest Restoration Through Natural Regeneration. RECOFTC, Kasetsart University Bangkok; 14 (In Thai with English abstract).

Wightman, R. E. 1997. *Nursery Production and Seedling Establishment Techniques for Five Native Tree species in the Atlantic Lowlands of Costa Rica.* Ph.D. Thesis. North Carolina State University, USA; 3-18,23-31,64-65.

World Resource Institute/IIED. 1988. *World Resource 1988-89*. Basic Books, New York; 372.

WRI. 2000. www. wri.org/wri/forest/tropical.html

APPENDICES

Appendix 1. List of planted FORRU trees species in plot P97.

No.	Species No. of FORRU	Botanical Name	Family
1	12	*Diospyros glandulosa* Lace	Ebenaceae
2	13	*Sapindus rarak* DC.	Sapindaceae
3	18	*Hovenia dulcis* Thunb.	Rhamnaceae
4	29	*Ficus microcarpa* L.f. var. *microcarpa* forma *microcarpa*	Moraceae
5	39	*Ficus subulata* Bl. var. *subulata*	Moraceae
6	60	*Aphanamixis polystachya* (Wall.) R. Parker	Meliaceae
7	62	*Quercus semiserrata* Roxb.	Fagaceae
8	71	*Prunus cerasoides* D. Don	Fagaceae
9	78	*Gmelina arborea* Roxb.	Verbenaceae
10	86	*Eurya acumminata* DC. var. *wallichiana* Dyer	Theaceae
11	101	*Phoebe lanceolata* (Nees) Nees	Lauraceae
12	119	*Horsfieldia amygdalina* Warb. var. *amygdalina*	Myristicaceae
13	128	*Garcinia mckeaniana* Craib	Guttiferae
14	157	*Heynea trijuga* Roxb. *ex* Sims	Meliaceae
15	179	*Glochidion kerrii* Craib	Euphorbiaceae
16	181	*Styrax benzoides* Craib	Styracaceae
17	187	*Bridelia glauca* Bl.	Euphorbiaceae
18	204	*Markhamia stipulata* (Wall.) Seem. *ex* K. Sch. var. *kerrii* Sprague	Bignoniaceae
19	215	*Litsea salicifolia* Nee *ex* Roxb.	Lauraceae
20	216	*Eriobtrya bengalensis* (Roxb.) Hk. f. forma *bengalensis*	Rosaceae
21	218	*Cinnamomum iners* Reinw. *ex* Bl.	Lauraceae
22	219	*Mangifera caloneura* Kurz	Anacadiaceae
23	236	*Horsfieldia thorelii* Lec.	Myristicaceae
24	240	*Planchonella punctata* Flet.	Sapotaceae
25	317	*Erythrina subumbrans* (Hassk.) Merr.	Leguminosae, Papilionoideae

Appendix 2. List of planted FORRU trees species in plot P98.

No.	Species No. of FORRU	Botanical Name	Family
1	4	*Bischofia javanica* Bl.	Euphorbiaceae
2	5	*Melia toosendan* Sieb. & Zucc.	Meliaceae
3	7	*Manglietia garrettii* Craib	Magnoliaceae
4	12	*Diospyros glandulosa* Lace	Ebenaceae
5	13	*Sapindus rarak* DC.	Sapindaceae
6	18	*Hovenia dulcis* Thunb.	Phamnaceae
7	60	*Aphanamixis polystachya* (Wall.) R. Parker	Meliaceae
8	62	*Quercus semiserrata* Roxb.	Fagaceae
9	66	*Spondias axillaris* Roxb.	Anacardiaceae
10	71	*Prunus cerasoides* D. Don	Rosaceae
11	72	*Ficus altissima* Bl.	Moraceae
12	78	*Gmelina arborea* Roxb.	Verbenaceae
13	86	*Eurya acumminata* DC. var. *wallichiana* Dyer	Theaceae
14	101	*Phoebe lanceolata* (Nees) Nees	Lauraceae
15	104	*Helicia nilagirica* Bedd.	Proteaceae
16	105	*Sarcosperma arboreum* Bth.	Sapotaceae
17	119	*Horsfieldia amygdalina* Warb. var. *amygdalina*	Myristicaceae
18	123	*Aglaia lawii* (Wight) Sald. & Rama.	Meliaceae
19	128	*Garcinia mckeaniana* Craib	Guttiferae
20	146	*Nyssa javanica* (Bl.) Wang.	Nyssaceae
21	157	*Heynea trijuga* Roxb. *ex* Sims	Meliaceae
22	204	*Markhamia stipulata* (Wall.) Seem. *ex* K. Sch. var. *kerrii* Sprague	Bignoniaceae
23	218	*Cinnamomum iners* Reinw. *ex* Bl.	Lauraceae
24	236	*Horsfieldia thorelii* Lec.	Myristicaceae
25	268	*Phoebe lanceolata* (Nees) Nees	Lauraceae
26	309	*Quercus kerrii* Craib var. *kerrii*	Fagaceae
27	317	*Erythrina subumbrans* (Hassk.) Merr.	Leguminosae, Papilionoideae
28	325	*Eugenia albiflora* Duth.*ex* Kurz	Myrtaceae
29	335	*Castanopsis calathiformis* (Skan) Rehd. & Wils.	Fagaceae

Appendix 3. List of plant species found (exculding planted native tree species) in all circular plots and walking surveys.

No.	Botanical Name	Family	Habit	P98	C98	P97	C97
1	*Abrus pulchellus* Wall. *ex* Thw. ssp. *pulchellus*	Leguminosae, Papilionoideae	v		x		
2	*Acacia megaladena* Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	x	x		
3	*Ageratum conzoides* L.	Compositae	h	x	x	x	x
4	*Albizia chinensis* (Osb.) Merr.	Leguminosae, Mimosoideae	t	x	x		
5	*Albizia odoratissima* (L. f.) Bth.	Leguminosae, Mimosoideae	t		x	x	x
6	*Alectra avensis* (Bth.) Merr.	Scrophulariaceae	h	x			
7	*Alpinia malaccensis* (Burm. f.) Rosc.	Zingiberceae	h	x	x		
8	*Anaphalis margaritacea* (L.) Bth. & Hk. f.	Compositae	h	x	x		
9	*Aneilema sinicum* Lindl.	Commelinaceae	h	x			
10	*Antidesma acidum* Retz.	Euphorbiaceae	l	x	x		
11	*Aporusa dioica* (Roxb.) M.-A.	Euphorbiaceae	t	x			
12	*Aporusa villosa* (Lindl.) Baill.	Euphorbiaceae	t	x			
13	*Argyreia aggregata* Roxb.	Convolvulaceae	wc		x		
14	*Argyreia obtecta* (Choisy) Cl.	Convolvulaceae	v	x			
15	*Artemisia indica* Willd.	Compositae	h	x	x	x	
16	*Arthraxon castratus* (Griff.) Nara. *ex* Bor	Gramineae	h	x			
17	*Artocarpus gomezianus* Wall. *ex* Trec.	Moraceae	t	x			
18	*Asparagus filicinus* Ham. *ex* D. Don	Liliaceae	h	x			
19	*Berrya mollis* Wall. *ex* Kurz	Tiliaceae	t	x		x	
20	*Bidens pilosa* L. var. *minor* (Bl.) Sherff	Compositae	h	x	x		x
21	*Blumea balsamifera* (L.) DC.	Compositae	h	x			
22	*Boehmeria chiangmaiensis* Yaha.	Urticaceae	l		x		x
23	*Boehmeria diffusa* Wedd.	Urticaceae	h				x

24	*Borreria laevis* (Lmk.) Griseb.	Rubiaceae	h	x			
25	*Bridelia glauca* Bl. var. *glauca*	Euphorbiaceae	t			x	
26	*Buddleja asiatica* Lour.	Loganiaceae	l	x		x	
27	*Callicarpa arborea* Roxb.var. *arborea*	Verbenaceae	t		x		
28	*Capillipedium parviflorum* (R.Br.) Stapf	Gramineae	h	x		x	
29	*Carex baccans* Nees	Cyperaceae	h	x			x
30	*Castanopsis argyrophylla* King *ex* Hk. f.	Fagaceae	t		x		
31	*Castanopsis armata* (Roxb.) Spach	Fagaceae	t		x		
32	*Centella asiatica* (L.) Urb.	Umbelliterae	h	x	x		
33	*Chamaecrista leschenaultiana* (DC.) Degener	Leguminosae, Caesalpinoideae	h	x			
34	*Cissampelos hispida* For.	Menispermaceae	v				x
35	*Clerodendrum glandulosum* Colebr. *ex* Lindl.	Verbenaceae	h/l	x	x	x	x
36	*Codonopsis javanica* (Bl.) Hk. f.	Companulaceae	v		x		
37	*Commelina benghalensis* L.	Commelinaceae	h				x
38	*Conyza sumatrensis* (Retz.) Walk.	Compositae	h	x	x	x	x
39	*Crassocephalum crepidiodes* (Bth.) S. Moore	Compositae	h	x	x	x	x
40	*Cratoxylum formosum* (Jack) Dyer ssp. *pruniflorum* (Kurz) Gog.	Guttiferae	t		x		
41	*Crotalaria dubia* Grah. *ex* Bth.	Leguminosae, Papilionoideae	h	x			
42	*Cyperus cyperoides* (L.) O.K.	Cyperaceae	h	x	x	x	x
43	*Cyrtococcum accrescens* (Trin.) Stapf	Gramineae	h	x			
44	*Dalbergia discolor* Bl. *ex* Miq.	Leguminosae, Papilionoideae	t	x			
45	*Dalbergia stipulacea* Roxb.	Leguminosae, Papilionoideae	wc	x	x		
46	*Desmodium heterocarpon* (L.) DC. ssp. *heterocarpon* var. *heterocarpon*	Leguminosae, Papilionoideae	h	x	x		
47	*Desmodium velutinum* (Willd.) DC. ssp. *velutinum* var. *velutinum*	Leguminosae, Papilionoideae	h		x		x

48	*Digitaria setigera* Roth *ex* Roem. & Shult. var. *setigera*	Gramineae	h	x	x	x	x
49	*Dillenia parviflora* Griff. var. *kerri* i (Craib) Hoogl.	Dilleniaceae	t		x		
50	*Dillenia pentagyna* Roxb.	Dilleniaceae	t	x			
51	*Dioscorea alata* L.	Dioscoreaceae	v		x		x
52	*Dioscorea glabra* Roxb. var. *glabra*	Dioscoreaceae	v	x	x		
53	*Dioscorea prazeri* Prain & Burk.	Dioscoreaceae	v		x		
54	*Diospyros glandulosa* Lace	Ebenaceae	t	x			
55	*Drymaria diandra* Bl.	Caryophyllaceae	h	x		x	x
56	*Eleusine indica* (L.) Gaertn.	Gramineae	h	x			
57	*Embelia sessiliflora* Kurz	Myrsinaceae	wc		x		
58	*Embelia subcoriacea* (Cl.) Mez	Myrsinaceae	h	x			
59	*Entada rheedii* Spreng. ssp. *rheedii*	Leguminosae, Mimosoideae	wc		x		
60	*Erythrina suberosa* Roxb.	Leguminosae	t	x	x		
61	*Eugenia albiflora* Duth. *ex* Kurz	Myrtaceae	t	x	x		
62	*Eupatorium adenophorum* Spreng.	Compositae	h	x	x	x	x
63	*Eupatorium odoratum* L.	Compositae	h	x	x	x	x
64	*Fernandoa adenophylla* (Wall. *ex* G. Don) Steen.	Bignoniaceae	t	x			
65	*Ficus hispida* L.f. var. *hispida*	Moraceae	l		x		
66	*Firmiana colorata* (Roxb.) R. Br.	Sterculiaceae	t	x	x		
67	*Galinsoga parviflora* Cav.	Compositae	h	x		x	x
68	*Garuga pinnata* Roxb.	Burseraceae	t	x			
69	*Glochidion eriocarpum* Champ.	Euphorbiaceae	t	x			
70	*Glochidion sphaerogynum* (M.-A.) Kurz	Euphorbiaceae	t	x	x		
71	*Gmelina arborea* Roxb.	Verbenaceae	t		x		x
72	*Helicia nilagirica* Bedd.	Proteaceae	t	x			
73	*Helicteres elongata* Wall. *ex* Boj.	Sterculiaceae	s		x		

74	*Imperata cylindrica* (L.) P. Beauv. var. *major* (Nees) C.E. Hubb. *ex* Hubb. & Vaugh.	Gramineae	h	x	x		x
75	*Ixora cibdela* Craib var. *cibdela*	Rubiaceae	l	x			
76	*Kuniwatsukia cuspidata* (Bedd.) Pic.-Ser.	Athyriaceae	h	x			
77	*Lagerstroemia speciosa* (L.) Pers. var . *speciosa*	Lythraceae	t			x	
78	*Laggera pterodonta* (DC.) Sch. Bip. *ex* Oliv.	Compositae	h	x			
79	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	t,l	x	x		
80	*Maesa montana* A. DC.	Myrsinaceae	l		x		
81	*Markhamia stipulata* (Wall.) Seem. *ex* K. Sch. var. *kerrii* Sprague	Bignoniaceae	t		x		
82	*Michelia baillonii* Pierre	Magnoliaceae	l		x		
83	*Melastoma normale* D. Don. var. *normale*	Melastomataceae	t	x	x		
84	*Melia toosendan* Sieb. & Zucc.	Meliaceae	v	x	x		
85	*Merremia vitifolia* (Burm. f.) Hall. f.	Magnoliaceae	t				x
86	*Microstegium vagans* (Nees *ex* Steud.) A. Camus	Gramineae	h	x	x		
87	*Millettia pachycarpa* Bth.	Leguminosae, Papilionoideae	wc				x
88	*Mimosa diplotricha* C. Wright *ex* Sauv. var. *diplotricha*	Leguminosae, Mimosoideae	s				x
89	*Mitracarpus villosus* (Sw.) DC.	Rubiaceae	h	x	x	x	
90	*Mucuna bracteata* A. DC.	Leguminosae, Papilionoideae	v	x	x	x	x
91	*Murdannia scapiflora* (Roxb.) Roy.	Commelinaceae	h	x			
92	*Mussaenda parva* Wall. *ex* G. Don	Rubiaceae	v,sc	x	x		
93	*Neyraudia reynaudiana* (Kunth) Keng *ex* Hitch.	Gramineae	h	x			
94	*Oroxylum indicum* (L.) Kurz	Bignoniaceae	t	x			x
95	*Oxalis corniculata* L.	Oxalidaceae	h	x		x	
96	*Paederia wallichii* Hk. f.	Rubiaceae	v	x			
97	*Panicum notatum* Retz.	Gramineae	h	x	x		x

98	*Paris polyphylla* J.E. Smith	Liliaceae	h		x		
99	*Paspalum conjugatum* Berg.	Gramineae	h	x	x	x	
100	*Pennisetum polystachyon* (L.) Schult.	Gramineae	h	x		x	x
101	*Phoebe lanceolata* (Nees) Nees	Lauraceae	t	x			
102	*Phoebe* sp.	Lauraceae	t				x
103	*Phragmitus vallatoria* (Pluk. *ex* L.) Veldk.	Gramineae	h	x	x		
104	*Phyllanthus emblica* L.	Euphorbiaceae	t	x	x		
105	*Phyllanthus urinaria* L.	Euphorbiaceae	h	x			
106	*Polygonum chinense* L.	Polygonaceae	h	x		x	x
107	*Prunus persica* (L.) Bat.	Rosaceae	t	x		x	x
108	*Pteridium aquilinum* (L.) Kuhn ssp. *aquilinum* var. *wightianum* (Ag.) Try	Dennstaedtiaceae	h		x	x	x
109	*Pteris biaurita* L.	Pteridaceae	h	x			
110	*Pterocarpus macrocarpus* Kurz	Apocynaceae	l	x			
111	*Rauvolfia verticillata* (Lour.) Baill.	Anacardiaceae	l				x
112	*Rhynchelytrum repens* (Willd.) C.E. Hubb.	Gramineae	h	x	x	x	x
113	*Saccolepis indica* (L.) A. Chase	Gramineae	h	x			
114	*Schima wallichii* (DC.) Korth.	Theaceae	t	x	x		
115	*Securinega virosa* (Roxb. *ex* Willd.) Baill.	Euphorbiaceae	t		x		
116	*Seteria palmifolia* (Koen.) Stapf var. *palmifolia*	Gramineae	h	x	x		
117	*Seteria parviflora* (Poir.) Kerg.	Gramineae	h	x	x	x	x
118	*Seteria verticillata* (L.) P. Beauv.	Gramineae	h		x		
119	*Sida rhombifolia* L. ssp. *rhomifolia*	Malvaceae	h			x	x
120	*Smilax perfoliata* Lour.	Smilacaceae	v	x			
121	*Solanum nigrum* L.	Solanaceae	h	x			x
122	*Solanum torvum* Swz.	Solanaceae	h	x	x	x	x
123	*Sonchus oleraceus* L.	Compositae	h	x			

124	*Spilanthes paniculata* Wall. *ex* DC.	Compositae	h	x		x	x
125	*Sporobolus diander* (Retz.) P. Beauv.	Gramineae	h	x		x	
126	*Sterculia villosa* Roxb.	Sterculiaceae	t		x		
127	*Stereospermum colais* (B. -H. *ex* Dillw.) Mabb.	Bignoniaceae	t	x			
128	*Thysanolaena latifolia* (Roxb. *ex* Horn.) Honda	Gramineae	h	x	x		
129	*Trichosanthes tricuspidata* Lour.	Cucurbitaceae	v				x
130	*Triumfetta pilosa* Roth	Tiliaceae	h	x			
131	*Triumfetta rhomboidea* Jacq.	Tiliaceae	h			x	x
132	*Turpinia pomifera* (Roxb.) Wall. *ex* DC.	Staphyleaceae	t		x		
133	*Urena lobata* L. ssp. *lobata* var. *lobata*	Malvaceae	h	x	x	x	
134	*Vernonia divergens* (DC.) Edgew.	Compositae	h	x			
135	*Wendlandia scabra* Kurz var. *scabra*	Rubiaceae	t	x			
136	*Wendlandia tinctoria* (Roxb.) DC. ssp. *floribunda* (Craib) Cowan	Rubiaceae	t	x	x		
		Total number of species		95	71	33	41

Remarks:

Habit:

h = herb

l = treelet

s = shurb

t = tree

v = vine

wc = woody climber

X = found

Appendix 4. List of total ground flora species recorded in all surveys.

No.	Botanical Name	Family	Habit	P98	C98	P97	C97
1	*Abrus pulchellus* Wall. *ex* Thw. ssp. *pulchellus*	Leguminosae, Papilionoideae	v		x		
2	*Acacia megaladena* Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	x	x		
3	*Ageratum conzoides* L.	Compositae	h	x	x	x	x
4	*Alectra avensis* (Bth.) Merr.	Scrophulariaceae	h	x			
5	*Alpinia malaccensis* (Burm. f.) Rosc.	Zingiberceae	h	x	x		
6	*Anaphalis margaritacea* (L.) Bth. & Hk. f.	Compositae	h	x	x		
7	*Aneilema sinicum* Lindl.	Commelinaceae	h	x			
8	*Aporusa villosa* (Lindl.) Baill.	Euphorbiaceae	t	x			
9	*Argyreia aggregata* Roxb.	Convolvulaceae	wc		x		
10	*Argyreia obtecta* (Choisy) Cl.	Convolvulaceae	v	x			
11	*Artemisia indica* Willd.	Compositae	h	x	x	x	
12	*Arthraxon castratus* (Griff.) Nara. *ex* Bor	Gramineae	h	x			
13	*Asparagus filicinus* Ham. *ex* D. Don	Liliaceae	h	x			
14	*Bidens pilosa* L. var. *minor* (Bl.) Sherff	Compositae	h	x	x	x	x
15	*Blumea balsamifera* (L.) DC.	Compositae	h	x			
16	*Boehmeria chiangmaiensis* Yaha.	Urticaceae	l		x		x
17	*Boehmeria diffusa* Wedd.	Urticaceae	h				x
18	*Borreria laevis* (Lmk.) Griseb.	Rubiaceae	h	x			
19	*Buddleja asiatica* Lour.	Loganiaceae	l	x			
20	*Capillipedium parviflorum* (R.Br.) Stapf	Gramineae	h	x		x	
21	*Carex baccans* Nees	Cyperaceae	h	x			x
22	*Castanopsis argyrophylla* King *ex* Hk. f.	Fagaceae	t		x		
23	*Centella asiatica* (L.) Urb.	Umbelliterae	h	x	x		
24	*Chamaecrista leschenaultiana* (DC.) Degener	Leguminosae, Caesalpinoideae	h	x			

25	*Cissampelos hispida* For.	Menispermaceae	v				x
26	*Clerodendrum glandulosum* Colebr. *ex* Lindl.	Verbenaceae	h/l	x	x	x	x
27	*Codonopsis javanica* (Bl.) Hk. f.	Companulaceae	v		x		
28	*Commelina benghalensis* L.	Commelinaceae	h				x
29	*Conyza sumatrensis* (Retz.) Walk.	Compositae	h	x	x	x	x
30	*Crassocephalum crepidiodes* (Bth.) S. Moore	Compositae	h	x	x	x	x
31	*Crotalaria dubia* Grah. *ex* Bth.	Leguminosae, Papilionoideae	h	x			
32	*Cyperus cyperoides* (L.) O.K.	Cyperaceae	h	x	x	x	x
33	*Cyrtococcum accrescens* (Trin.) Stapf	Gramineae	h	x			
34	*Dalbergia stipulacea* Roxb.	Leguminosae, Papilionoideae	wc	x			
35	*Desmodium heterocarpon* (L.) DC. ssp. *heterocarpon* var. *heterocarpon*	Leguminosae, Papilionoideae	h	x	x		
36	*Desmodium velutinum* (Willd.) DC. ssp. *velutinum* var. *velutinum*	Leguminosae, Papilionoideae	h		x		x
37	*Digitaria setigera* Roth *ex* Roem. & Shult.var.	Gramineae	h	x	x	x	x
38	*Dioscorea alata* L.	Dioscoreaceae	v		x		x
39	*Dioscorea glabra* Roxb. var. *glabra*	Dioscoreaceae	v	x	x		
40	*Dioscorea prazeri* Prain & Burk.	Dioscoreaceae	v		x		
41	*Drymaria diandra* Bl.	Caryophyllaceae	h	x		x	x
42	*Eleusine indica* (L.) Gaertn.	Gramineae	h	x			
43	*Embelia sessiliflora* Kurz	Myrsinaceae	wc		x		
44	*Embelia subcoriacea* (Cl.) Mez	Myrsinaceae	h	x			
45	*Entada rheedii* Spreng. ssp. *rbeedii*	Leguminosae, Mimosoideae	wc		x		
46	*Erythrina suberosa* Roxb.	Leguminosae, Papilionoideae	t	x			
47	*Eugenia albiflora* Duth. *ex* Kurz	Myrtaceae	t	x	x		
48	*Eupatorium adenophorum* Spreng.	Compositae	h	x	x	x	x
49	*Eupatorium odoratum* L.	Compositae	h	x	x	x	x

50	*Firmiana colorata* (Roxb.) R. Br.	Sterculiaceae	t		x		
51	*Galinsoga parviflora* Cav.	Compositae	h	x		x	x
52	*Gmelina arborea* Roxb.	Verbenaceae	t		x		
53	*Helicteres elongata* Wall. ex Boj.	Sterculiaceae	s		x		
54	*Imperata cylindrica* (L.) P. Beauv. var. *major* (Nees) C.E. Hubb. *ex* Hubb & Vaugh.	Gramineae	h	x	x		x
55	*Ixora cibdela* Craib var. *cibdela*	Rubiaceae	l	x			
56	*Kuniwatsukia cuspidata* (Bedd.) Pic.-Ser	Athyriaceae	h	x			
57	*Laggera pterodonta* (DC.) Sch. Bip. *ex* Oliv.	Compositae	h	x			
58	*Maesa montana* A. DC.	Myrsinaceae	l		x		
59	*Melastoma normale* D. Don. var. *normale*	Melastomataceae	l	x	x		
60	*Merremia vitifolia* (Burm. f.) Hall. f.	Convolvulaceae	v				x
61	*Microstegium vagans* (Nees *ex* Steud.) A. Camus	Gramineae	h	x	x		
62	*Millettia pachycarpa* Bth.	Leguminosae, Papilionoideae	wc				x
63	*Mimosa diplotricha* C. Wright *ex* Sauv. var.	Leguminosae, Mimosoideae	s				x
64	*Mitracapus villosus* (Sw.) DC.	Rubiaceae	h	x	x	x	
65	*Mucuna bracteata* A. DC.	Leguminosae, Papilionoideae	v	x	x	x	x
66	*Murdannia scapiflora* (Roxb.) Roy.	Commelinaceae	h	x			
67	*Mussaenda parva* Wall. *ex* G. Don	Rubiaceae	v				
68	*Neyraudia reynaudiana* (Kunth) Keng *ex* Hitch.	Gramineae	h	x			
69	*Oroxylum indicum* (L.) Kurz	Bignoniaceae	t	x			x
70	*Oxalis corniculata* L.	Oxalidaceae	h	x		x	
71	*Paederia wallichii* Hk. f.	Rubiaceae	v	x			
72	*Panicum notatum* Retz.	Gramineae	h	x	x		x
73	*Paris polyphylla* J.E. Smith	Liliaceae	h		x		
74	*Paspalum conjugatum* Berg.	Gramineae	h	x	x	x	
75	*Pennisetum polystachyon* (L.) Schult.	Gramineae	h	x		x	x

76	*Phragmitus vallatoria* (Pluk. *ex* L.) Veldk.	Gramineae	h	x	x		
77	*Phyllanthus urinaria* L.	Euphorbiaceae	h	x			
78	*Polygonum chinense* L.	Polygonaceae	h	x		x	x
79	*Pteridium aquilinum* (L.) Kuhn ssp. *aquilinum* var. *wightianum* (Ag.) Try.	Dennstaedtiaceae	h	x	x	x	x
80	*Pteris biaurita* L.	Pteridaceae	h	x			
81	*Pterocarpus macrocarpus* Kurz	Leguminosae, Papilionoideae	t	x			
82	*Rauvolfia verticillata* (Lour.) Baill.	Apocynaceae	l				x
83	*Rhynchelytrum repens* (Willd.) C.E. Hubb.	Gramineae	h	x	x	x	x
84	*Saccolepis indica* (L.) A. Chase	Gramineae	h	x			
85	*Schima wallichii* (DC.) Korth.	Theaceae	t		x		
86	*Seteria palmifolia* (Koen.) Stapf var. *palmifolia*	Gramineae	h	x	x		
87	*Seteria parviflora* (Poir) Kerg.	Gramineae	h	x	x	x	x
88	*Seteria verticillata* (L.) P. Beauv.	Gramineae	h		x		
89	*Sida rhombifolia* L. ssp. *rhomifolia*	Malvaceae	h			x	x
90	*Smilax perfoliata* Lour.	Smilacaceae	v	x			
91	*Solanum nigrum* L.	Solonaceae	h	x		x	x
92	*Solanum torvum* Swz.	Solanaceae	h	x	x		x
93	*Sonchus oleraceus* L.	Compositae	h	x		x	
94	*Spilanthes paniculata* Wall. *ex* DC.	Compositae	h	x		x	x
95	*Sporobolus diander* (Retz.) P. Beauv.	Gramineae	h	x		x	
96	*Sterculia villosa* Roxb.	Sterculiaceae	t		x		
97	*Thysanolaena latifoia* (Roxb. *ex* Horn.) Honda	Gramineae	h	x	x		
98	*Trichosanthes tricuspidata* Lour.	Cucurbitaceae	v				x
99	*Triumfetta pilosa* Roth	Tiliaceae	h	x	x	x	
100	*Triumfetta rhomboidea* Jacq.	Tiliaceae	h	x		x	x
101	*Urena lobata* L. ssp. *lobata* var. *lobata*	Malvaceae	h	x	x	x	

102	*Vernonia divergens* (DC.) Edgew.	Compositae	h	x			
103	*Wendlandia scabra* Kurz var. *scabra*	Rubiaceae	t	x			
		Total number of species		75	51	28	37

Remarks:

X = found

Habit:

h = herb

l = treelet

s = shurb

t = tree

v = vine

wc = woody climber

Appendix 5. Ground flora in plot P98 for all 3 surveys.

A. Percent Cover of Ground Flora Found in 10 Subplots in Plot P98 in April (1st Survey).

Botanical Name	Family	Habit	SP1	SP2	SP3	SP4	SP5	SP6	SP7	SP8	SP9	SP10	Total	X1
Ageratum conzoides L.	Compositae	h	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5	0.5
Alpinia malaccensis (Burm. f.) Rosc.	Zingiberceae	h	0	0.5	0.5	0	0	0	0	0	0.5	0	1.5	0.15
Artemisia indica Willd.	Compositae	h	0.5	0.5	0.5	0	0.5	0.5	0.5	0	0.5	0.5	4	0.4
Asparagus filicinus Ham. *ex* D. Don	Liliaceae	h	0	0	0	0	0.5	0	0	0	0.5	0	1	0.1
Bidens pilosa L. var. *minor* (Bl.) Sherff	Compositae	h	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5.5	0.55
Blumea balsamifera (L.) DC.	Compositae	h	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0	4.5	0.45
Borreria laevis (Lmk.) Griseb.	Rubiaceae	h	0.5	0	0	0	0	0	0	0	0	0	0.5	0.05
Buddleja asiatica Lour.	Loganiaceae	l	0.5	0	0.5	0.5	0.5	0	0	0	0.5	0.5	3	0.3
Centella asiatica (L.) Urb.	Umbelliterae	h	1	0.5	0	0	0.5	0.5	0.5	0.5	0.5	0.5	4.5	0.45
Clerodendrum glandulosum Colebr. *ex* Lindl.	Verbenaceae	h/l	0	0	0.5	0	0	0	0	0	0	0	0.5	0.05
Conyza sumatrensis (Retz.) Walk.	Compositae	h	3	2	3	2	2	2	2	3	2	2	23	2.3
Crassocephalum crepidiodes (Bth.) S. Moore	Compositae	h	0.5	0.5	0.5	0	0	0	0	0	0	0	1.5	0.15
Cyperus cyperoides (L.) O.K.	Cyperaceae	h	0.5	0	0.5	0	0.5	0.5	0.5	0.5	1	0	4	0.4
Desmodium heterocarpon (L.) DC. ssp. *heterocarpon* var. *heterocarpon*	Leguminosae, Papilionoideae	h	0.5	0	0	0.5	0	0	0	0	0	0	1	0.1
Digitaria setigera Roth *ex* Roem. & Shult.var. *setigera*	Gramineae	h	0	0	0.5	0	0	0	0	0.5	0	0	1	0.1
Dioscorea glabra Roxb. var. *glabra*	Dioscoreaceae	v	0	0	0	0	0	0	0	0	0	0.5	0.5	0.05
Drymaria diandra Bl.	Caryophyllaceae	h	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Embelia subcoriacea (Cl.) Mez	Myrsinaceae	h	0	0	0	0	0	0	0	0.5	0	0	0.5	0.05
Eupatorium adenophorum Spreng.	Compositae	h	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	5.5	0.55
Eupatorium odoratum L.	Compositae	h	0.5	0.5	0.5	1	0.5	0	0.5	0.5	0.5	0.5	5	0.5
Galinsoga parviflora Cav.	Compositae	h	0.5	0	0	0.5	0	0	0	0	0.5	0	1.5	0.15
Imperata cylindrica (L.) P. Beauv. var. *major* (Nees) C.E. Hubb. *ex* Hubb & Vaugh.	Gramineae	h	0.5	0	0.5	0	0.5	0	0.5	0.5	0.5	1	4	0.4

Kuniwatsukia cuspidata (Bedd.) Pic.-Ser.	Athyriaceae	h	0	0	0	0	0	0	0	0	0.5	0	0.5	0.05
Laggera pterodonta (DC.) Sch. Bip. *ex* Oliv.	Compositae	h	0.5	0.5	0	0	0	0	0	0	0	0	1	0.1
Mitracapus villosus (Sw.) DC.	Rubiaceae	h	0.5	0.5	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	4.5	0.45
Murdannia scapiflora (Roxb.) Roy.	Commelinaceae	h	0	0	0	0.5	0	0.5	0	0.5	0	0	1.5	0.15
Neyraudia reynaudiana (Kunth) Keng *ex* Hitch.	Gramineae	h	0	0	0	0.5	0.5	0.5	1	0.5	0.5	0	3.5	0.35
Oroxylum indicum (L.) Kurz	Bignoniaceae	t	0	0	0.5	0	0	0	0	0.5	0	0	1	0.1
Oxalis corniculata L.	Oxalidaceae	h	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Paspalum conjugatum Berg.	Gramineae	h	0.5	0	0	0.5	0.5	0.5	0	0	0.5	0	2.5	0.25
Phragmitus vallatoria (Pluk. *ex* L.) Veldk.	Gramineae	h	1	0	0	0	0	25	1	0	0	0	27	2.7
Polygonum chinense L.	Polygonaceae	h	0.5	0	0	0	0	0	0	0	0	0	0.5	0.05
Pteridium aquilinum (L.) Kuhn ssp. *aquilinum* var. *wightianum* (Ag.) Try.	Dennstaedtiaceae	h	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	6	0.6
Pterocarpus macrocarpus Kurz	Leguminosae, Papilionoideae	t	0	0	0	0	0	0	0.5	0	0.5	0	1	0.1
Rhynchelytrum repens (Willd.) C.E. Hubb.	Gramineae	h	0.5	0.5	0.5	0.5	0.5	0.5	0..5	0.5	0.5	0.5	5	0.5
Saccolepis indica (L.) A. Chase	Gramineae	h	0	0	0	0	0	0	0	0.5	0	0	0.5	0.05
Seteria palmifolia (Koen.) Stapf var. *palmifolia*	Gramineae	h	0.5	0	0	0	0	0.5	0	0	0.5	0.5	2	0.2
Seteria parviflora (Poir.) Kerg.	Gramineae	h	0	0.5	0	0.5	0	0.5	0	0.5	0.5	0.5	3	0.3
Smilax perfoliata Lour.	Smilacaceae	v	0	0	0	0	0	0	0	0.5	0	0	0.5	0.05
Solanum nigrum L.	Solonaceae	h	0	0	0	0	0	0.5	0	0	0.5	0.5	1.5	0.15
Solanum torvum Swz.	Solanaceae	h	0.5	0	0	0	0	0	0	0.5	0	0	1	0.1
Spilanthes paniculata Wall. *ex* DC.	Compositae	h	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5	0.5
Thysanolaena latifolia (Roxb. *ex* Horn.) Honda	Gramineae	h	0	0.5	0	0	0.5	1	0.5	0.5	0	0	3	0.3
Triumfetta pilosa Roth	Tiliaceae	h	0	0	0.5	0	0	0	0.5	0	0.5	0	1.5	0.15

B. Percent Cover of Ground Flora Found in 10 Subplots in Plot P98 in July (2nd Survey).

Botanical Name	Family	Habit	SP1	SP2	SP3	SP4	SP5	SP6	SP7	SP8	SP9	SP10	Total	X2
Ageratum conzoides L.	Compositae	h	2	2	3	3	2	3	1	3	2	2	23	2.3
Alectra avensis (Bth.) Merr.	Scrophulariaceae	h	0.5	1	0	0.5	0	0.5	0	0.5	0.5	0.5	4	0.4
Alpinia malaccensis (Burm. f.) Rosc.	Zingiberceae	h	0	0.5	0.5	0	0	0	0	0	0	0	1	0.1
Anaphalis margaritacea (L.) Bth. & Hk. f.	Compositae	h	0.5	0	0	0	0	0	0	0	0.5	0	1	0.1
Aneilema sinicum Lindl.	Commelinaceae	h	0.5	0	0	0	0	0	0	0	0	0	0.5	0.05
Artemisia indica Willd.	Compositae	h	0.5	0	0.5	0.5	0.5	0.5	0	0	0	0	2.5	0.25
Asparagus filicinus Ham. *ex* D. Don	Liliaceae	h	0	0	0	0	0.5	0	0	0	0.5	0	1	0.1
Bidens pilosa L. var. *minor* (Bl.) Sherff	Compositae	h	0.5	1	0.5	0.5	1	0.5	1	0.5	0.5	0.5	6.5	0.65
Blumea balsamifera (L.) DC.	Compositae	h	0.5	0.5	0.5	0	0	0	0.5	0.5	0.5	0.5	3.5	0.35
Borreria laevis (Lmk.) Griseb.	Rubiaceae	h	0.5	0	0	0	0	0	0	0	0	0	0.5	0.05
Buddleja asiatica Lour.	Loganiaceae	l	0.5	0	0.5	0.5	0	0	0	0	0.5	0	2	0.2
Centella asiatica (L.) Urb.	Umbelliterae	h	1	0.5	1	0.5	0.5	0.5	0.5	0	0.5	0	5	0.5
Clerodendrum glandulosum Colebr. *ex* Lindl.	Verbenaceae	h/l	0	0	0.5	0	0	0	0	0	0	0	0.5	0.05
Conyza sumatrensis (Retz.) Walk.	Compositae	h	2	1	1	1	1	1	1	0.5	0	0.5	10.5	1.05
Crassocephalum crepidiodes (Bth.) S. Moore	Compositae	h	0.5	0	0.5	0.5	0	0.5	0	0.5	0	0.5	3	0.3
Cyperus cyperoides (L.) O.K.	Cyperaceae	h	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5.5	0.55
Dalbergia stipulacea Roxb.	Leguminosae, Papilionoideae	wc	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Desmodium heterocarpon (L.) DC. ssp. *heterocarpon* var. *heterocarpon*	Leguminosae, Papilionoideae	h	0	0	0	0.5	0	0	0	0	0	0	0.5	0.05
Digitaria setigera Roth *ex* Roem. & Shult.var. *setigera*	Gramineae	h	0.5	0.5	0	0	0.5	0.5	0	0	0.5	0.5	3	0.3
Dioscorea glabra Roxb. var. *glabra*	Dioscoreaceae	v	0	0	0	0	0	0.5	0	0	0	0.5	1	0.1
Drymaria diandra Bl.	Caryophyllaceae	h	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Eupatorium adenophorum Spreng.	Compositae	h	0.5	1	0.5	0.5	0.5	2	0.5	3	0.5	1	10	1
Eupatorium odoratum L.	Compositae	h	0.5	0.5	0.5	0.5	1	0.5	0.5	1	0.5	0.5	6	0.6
Galinsoga parviflora Cav.	Compositae	h	0	0	0.5	0	0.5	0	0	0	0.5	0.5	2	0.2

Imperata cylindrica (L.) P. Beauv. var. *major* (Nees) C.E. Hubb. *ex* Hubb & Vaugh.	Gramineae	h	0.5	0.5	0	0	0	0	0	0.5	0	0.5	2	0.2
Ixora *cibdela* Craib var. *cibdela*	Rubiaceae	l	0	0.5	0	0	0	0	0	0	0	0	0.5	0.05
Kuniwatsukia cuspidata (Bedd.) Pic.-Ser.	Athyriaceae	h	0	0	0	0	0	0	0	0	0.5	0	0.5	0.05
Mitracapus villosus (Sw.) DC.	Rubiaceae	h	1	1	0.5	2	0.5	2	1	0.5	0.5	2	11	1.1
Neyraudia reynaudiana (Kunth) Keng *ex* Hitch.	Gramineae	h	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Oroxylum indicum (L.) Kurz	Bignoniaceae	t	0	0	0.5	0	0	0	0	0.5	0	0	1	0.1
Oxalis corniculata L.	Oxalidaceae	h	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Panicum notatum Retz.	Gramineae	h	0.5	0.5	0	0	0.5	0	0	0	0.5	0	2	0.2
Phragmitus vallatoria (Pluk. *ex* L.) Veldk.	Gramineae	h	0.5	0	0	0	0	1	0	0	0	0	1.5	0.15
Polygonum chinense L.	Polygonaceae	h	0.5	0	0	0	0	0	0	0	0	0	0.5	0.05
Pteridium aquilinum (L.) Kuhn ssp. *aquilinum* var. *wightianum* (Ag.) Try	Dennstaedtiaceae	h	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	6	0.6
Pteris biauria L.	Pteridaceae	h	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Pterocarpus macrocarpus Kurz	Leguminosae, Papilionoideae	t	0	0	0	0	0	0	0.5	0	0.5	0	1	0.1
Rhynchelytrum repens (Willd.) C.E. Hubb.	Gramineae	h	0	0.5	0	0.5	0	0	0	0	0	0.5	1.5	0.15
Saccolepis indica (L.) A. Chase	Gramineae	h	0	0.5	0	0	0	0	0	0	0	0	0.5	0.05
Seteria palmifolia (Koen.) Stapf var. *palmifolia*	Gramineae	h	0.5	0	0	0	0	0	0.5	0.5	0	0	1.5	0.15
Seteria parviflora (Poir.) Kerg.	Gramineae	h	0.5	0.5	0	3	0	0.5	0	0.5	0.5	1	6.5	0.65
Smilax perfoliata Lour.	Smilacaceae	v	0	0	0	0	0	0	0	0.5	0	0	0.5	0.05
Solanum nigrum L.	Solonaceae	h	0	0	0	0	0	0.5	0	0	0.5	0.5	1.5	0.15
Sonchus oleraceus L.	Compositae	h	0	0.5	0	0.5	0.5	0.5	0	0.5	0	0.5	3	0.3
Spilanthes paniculata Wall. *ex* DC.	Compositae	h	0.5	0	0.5	0.5	0	0.5	0.5	0	0	0	2.5	0.25
Thysanolaena latifolia (Roxb. *ex* Horn.) Honda	Gramineae	h	0	0.5	0	0	0.5	0.5	0.5	0.5	0	0	2.5	0.25
Triumfetta pilosa Roth	Tiliaceae	h	0	0	0.5	0	0	0	0.5	0	0.5	0	1.5	0.15

C. Percent Cover of Ground Flora Found in 10 Subplots in Plot P98 in November (3rd Survey).

Botanical Name	Family	Habit	SP1	SP2	SP3	SP4	SP5	SP6	SP7	SP8	SP9	SP10	Total	X3
Acacia megaladena Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	0	0	0	0	0	0	0	0	0.5	0	0.5	0.05
Ageratum conzoides L.	Compositae	h	4	4	5	0.5	2	4	4	5	5	1	34.5	3.45
Alectra avensis (Bth.) Merr.	Scrophulariaceae	h	0	5	0	2	0.5	1	0	0.5	0.5	1	10.5	1.05
Alpinia malaccensis (Burm. f.) Rosc.	Zingiberceae	h	0	0.5	0.5	0	0	0	0	0	0.5	0	1.5	0.15
Anaphalis margaritacea (L.) Bth. & Hk. f.	Compositae	h	0.5	0	0	0.5	0.5	0	0	0.5	0	0.5	2.5	0.25
Aneilema sinicum Lindl.	Commelinaceae	h	0.5	0	0	0	0	0.5	0	0	0.5	0	1.5	0.15
Aporusa villosa (Lindl.) Baill.	Euphorbiaceae	t	0	0	0	0	0	0.5	0	0	0	0	0.5	0.05
Argyreia obtecta (Choisy) Cl.	Convolvulaceae	v	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Artemisia indica Willd.	Compositae	h	0.5	0.5	0	0.5	0.5	0.5	0.5	0	0.5	0.5	4	0.4
Arthraxon castratus (Griff.) Nara. *ex* Bor	Gramineae	h	0	0	0	0	2	0	0	0	0	0	2	0.2
Asparagus filicinus Ham. *ex* D. Don	Liliaceae	h	0	0	0	0	0.5	0	0	0	0.5	0	1	0.1
Bidens pilosa L. var. *minor* (Bl.) Sherff	Compositae	h	0.5	0	0.5	0.5	0.5	1	0	1	0	0.5	4.5	0.45
Blumea balsamifera (L.) DC.	Compositae	h	0	0.5	0.5	0	0	0	0.5	0.5	0.5	0.5	3	0.3
Borreria laevis (Lmk.) Griseb.	Rubiaceae	h	0	0	0	0.5	0.5	0	0	0	0	0	1	0.1
Buddleja asiatica Lour.	Loganiaceae	l	0.5	0	0.5	0.5	0	0	0	0	0.5	0.5	2.5	0.25
Capillipedium parviflorum (R.Br.) Stapf	Gramineae	h	0	0.5	0	0	0	0	0	0	0.5	0	1	0.1
Carex baccans Nees	Cyperaceae	h	0	0	0	0	0	0	0	0	0.5	0	0.5	0.05
Centella asiatica (L.) Urb.	Umbelliterae	h	0	0.5	0.5	0	0.5	0.5	0.5	0.5	0	0.5	3.5	0.35
Chamaecrista leschenaultiana (DC.) Degener	Leguminosae, Caesalpinoideae	h	0	0	0	0	0	0.5	0	0	0	0	0.5	0.05
Clerodendrum glandulosum Colebr. *ex* Lindl.	Verbenaceae	h/l	0	0	0.5	0	0	0	0	0	0	0	0.5	0.05
Conyza sumatrensis (Retz.) Walk.	Compositae	h	0.5	0.5	0	0.5	0.5	0.5	0	0	0	0.5	3	0.3
Crassocephalum crepidiodes (Bth.) S. Moore	Compositae	h	0.5	0.5	0.5	0.5	0.5	0	0.5	0.5	3	0.5	7	0.7
Crotalaria dubia Grah. *ex* Bth.	Leguminosae, Papilionoideae	h	0	0	0	0	0	0.5	0	0	0	0	0.5	0.05
Cyperus cyperoides (L.) O.K.	Cyperaceae	h	0.5	0	0.5	0	0	0	0.5	0.5	0.5	0.5	3	0.3

Cyrtococcum accrescens (Trin.) Stapf	Gramineae	h	0	0	0	0	0	0.5	0	0	0	0	0.5	0.05
Dalbergia stipulacea Roxb.	Leguminosae, Papilionoideae	wc	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Digitaria setigera Roth *ex* Roem. & Shult.var. *setigera*	Gramineae	h	0.5	0.5	0.5	0	0.5	0.5	0	0	0.5	0.5	3.5	0.35
Dioscorea glabra Roxb. var. *glabra*	Dioscoreaceae	v	0	0	0	0	0	0	0	0	0	0.5	0.5	0.05
Drymaria diandra Bl.	Caryophyllaceae	h	0	0	0	0	0	0	1	0	0	0	1	0.1
Eleusine indica (L.) Gaertn.	Gramineae	h	0.5	0	0	0	0	0	0	0	0	0	0.5	0.05
Erythrina suberosa Roxb.	Leguminosae, Papilionoideae	t	0	0	0	0	0	0	0	0	0	0.5	0.5	0.05
Eugenia albiflora Duth. *ex* Kurz	Myrtaceae	t	0	1	0	0	0	0	0	0.5	0	0.5	2	0.2
Eupatorium adenophorum Spreng.	Compositae	h	0.5	2	0.5	0.5	2	3	1	5	1	2	17.5	1.75
Eupatorium odoratum L.	Compositae	h	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0	4.5	0.45
Galinsoga parviflora Cav.	Compositae	h	0	0	0.5	0	0	0	0	0	0.5	0.5	1.5	0.15
Imperata cylindrica (L.) P. Beauv. var. *major* (Nees) C.E. Hubb. *ex* Hubb & Vaugh.	Gramineae	h	0.5	0.5	0.5	0.5	0	0.5	0.5	0.5	0	0.5	4	0.4
Ixora *cibdela* Craib var. *cibdela*	Rubiaceae	l	0	0.5	0	0	0	0	0	0	0	0.5	1	0.1
Kuniwatsukia cuspidata (Bedd.) Pic.-Ser.	Athyriaceae	h	0	0	0	0	0	0	0	0	0.5	0	0.5	0.05
Melastoma normale D. Don. var. *normale*	Melastomataceae	l	0	0	0	0	0.5	0	0	0	0	0	0.5	0.05
Microstegium vagans (Nees *ex* Steud.) A. Camus	Gramineae	h	0	0.5	0	0	0	0.5	0.5	0	0.5	0.5	2.5	0.25
Mitracapus villosus (Sw.) DC.	Rubiaceae	h	4	4	5	2	0.5	4	3	2	0	5	29.5	2.95
Mucuna bracteata A. DC.	Leguminosae, Papilionoideae	v	0	0	0	0	0	0	0	0.5	0	0	0.5	0.05
Murdannia scapiflora (Roxb.) Roy.	Commelinaceae	h												0
Mussaenda parva Wall. *ex* G. Don	Rubiaceae	v,sc	0	0	0.5	0	0	0	0	0	0	0.5	1	0.1
Paederia wallichii Hk. f.	Rubiaceae	v	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Pennisetum polystachyon (L.) Schult.	Gramineae	h	0.5	0.5	0.5	0.5	0	0.5	0	0.5	0	0	3	0.3
Phragmitus vallatoria (Pluk. *ex* L.) Veldk.	Gramineae	h	1	0.5	0	0	0	0.5	0.5	0.5	0	0.5	3.5	0.35
Phyllanthus urinaria L.	Euphorbiaceae	h	0	0.5	0	0	0	0	0	0	0	0	0.5	0.05
Polygonum chinense L.	Polygonaceae	h	0.5	0	0	0	0	0	0	0	0.5	0	1	0.1

Pteridium aquilinum (L.) Kuhn ssp. *aquilinum* var. *wightianum* (Ag.) Try	Dennstaedtiaceae	h	0	0	0.5	0	0	0	0	0	0	4	4.5	0.45
Pteris biauria L.	Pteridaceae	h	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Pterocarpus macrocarpus Kurz	Leguminosae, Papilionoideae	t	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Rhynchelytrum repens (Willd.) C.E. Hubb.	Gramineae	h	0	0.5	0	0.5	0	0	0	0	0	0.5	1.5	0.15
Saccolepis indica (L.) A. Chase	Gramineae	h	0	0.5	0	0	0	0	0	0	0	0	0.5	0.05
Seteria palmifolia (Koen.) Stapf var. *palmifolia*	Gramineae	h	0.5	0	0	0	0	0	0.5	0.5	0	0	1.5	0.15
Seteria parviflora (Poir.) Kerg.	Gramineae	h	0.5	0.5	0	4	0.5	1	0	0.5	0.5	2	9.5	0.95
Smilax perfoliata Lour.	Smilacaceae	v	0	0	0	0	0	0	0	0.5	0	0	0.5	0.05
Solanum nigrum L.	Solonaceae	h	0	0	0	0	0	0	0	0	0.5	0	0.5	0.05
Sonchus oleraceus L.	Compositae	h	0	0	0	0.5	0.5	0	0	0	0	0	1	0.1
Spilanthes paniculata Wall. *ex* DC.	Compositae	h	0.5	0.5	0.5	3	0.5	0.5	0.5	0	0	0.5	6.5	0.65
Sporobolus diander (Retz.) P. Beauv.	Gramineae	h	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	0.5	4	0.4
Thysanolaena latifolia (Roxb. *ex* Horn.) Honda	Gramineae	h	0	0.5	0	0	0.5	0.5	0.5	0.5	0	0	2.5	0.25
Triumfetta pilosa Roth	Tiliaceae	h	0	0	0	0	0	0	0	0	0	0.5	0.5	0.05
Urena lobata L. ssp. *lobata* var. *lobata*	Malvaceae	h	0	0	0	0.5	0	0	0	0	0	0	0.5	0.05
Vernonia divergens (DC.) var. Edgew.	Compositae	h	0	0	0	0.5	0	0.5	0	0	0	0	1	0.1
Wendlandia scabra Kurz	Rubiaceae	t	0	0	0	0	0	0	0	0	0	0.5	0.5	0.05

Remarks:

Habit

h = Herb

l = Treelet

t = Tree

v = Vine

wc = Woody Climber

Appendix 6. Ground flora in plot C98 for all 3 surveys.

A. Percent Cover of Ground Flora Found in 10 Subplots in Plot C98 in April (1st Survey).

Botanical Name	Family	Habit	SP1	SP2	SP3	SP4	SP5	SP6	SP7	SP8	SP9	SP10	Total	X1
Acacia megaladena Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	0	0	0	0	0	0	0.5	0	0	0.5	1	0.1
Ageratum conzoides L.	Compositae	h	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Anaphalis margaritacea (L.) Bth. & Hk. f.	Compositae	h	0	0	0	0	0.5	0	0	0	0	0	0.5	0.05
Argyreia aggregata Roxb.	Convolvulaceae	wc	0	0	0	0	0.5	0	0	0	0	0	0.5	0.05
Artemisia indica Willd.	Compositae	h	0.5	0	0.5	0	0.5	0.5	0.5	0	0	0.5	3	0.3
Bidens pilosa L. var. *minor* (Bl.) Sherff	Compositae	h	0.5	0	0	0	0	0	0	0	0	0.5	1	0.1
Castanopsis argyrophylla King *ex* Hk. f.	Fagaceae	t	0	0	0	0	0	0	0	0	0.5	0	0.5	0.05
Centella asiatica (L.) Urb.	Umbelliterae	h	0.5	0	0	0	0	0	0	0	0	0	0.5	0.05
Clerodendrum glandulosum Colebr. *ex* Lindl.	Verbenaceae	h/l	0	0.5	0.5	0	0	0	0.5	0	0.5	0.5	2.5	0.25
Conyza sumatrensis (Retz.) Walk.	Compositae	h	0	0.5	0	0	0.5	0.5	0.5	0	0	0	2	0.2
Crassocephalum crepidiodes (Bth.) S. Moore	Compositae	h	0	0	0	0	0	0	0	0.5	0.5	0.5	1.5	0.15
Cyperus cyperoides (L.) O.K.	Cyperaceae	h	0.5	0.5	0.5	0	0	0	0.5	0	0	0.5	2.5	0.25
Cyrtococcum accrescens (Trin.) Stapf	Gramineae	h												0
Desmodium heterocarpon (L.) DC. ssp. *heterocarpon* var. *heterocarpon*	Leguminosae, Papilionoideae	h	0	0	0.5	0	0.5	0.5	0	0	0	0	1.5	0.15
Desmodium velutinum (Willd.) DC. ssp. *velutinum* var. *velutinum*	Leguminosae, Papilionoideae	h	0	0	0	0	0.5	0	0	0	0	0	0.5	0.05
Digitaria setigera Roth *ex* Roem. & Shult.var. *setigera*	Gramineae	h	0	0	0	0	0	0	0	0	0	0.5	0.5	0.05
Dioscorea alata L.	Dioscoreaceae	v	0	0.5	0	0	0	0	0	0.5	0	0	1	0.1
Dioscorea glabra Roxb. var. *glabra*	Dioscoreaceae	v	0	0.5	0	0	0.5	0	0	0.5	0.5	0.5	2.5	0.25
Dioscorea prazeri Prain & Burk.	Dioscoreaceae	v	0	0	0	0	0.5	0	0	0	0.5	0	1	0.1
Embelia sessiliflora Kurz	Myrsinaceae	wc	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Entada rheedii Spreng. ssp. *rheedii*	Leguminosae, Mimosoideae	wc	0	0	0	0	0.5	0	0	0	0	0	0.5	0.05

Eugenia albiflora Duth. *ex* Kurz	Myrtaceae	t	0	0	0.5	0	0	0	0	0	0	0	0.5	0.05
Eupatorium adenophorum Spreng.	Compositae	h	0.5	0	0	0	0	0.5	0	0	0	0.5	1.5	0.15
Eupatorium odoratum L.	Compositae	h	0.5	0.5	0	0.5	0	0.5	0	2	0.5	0.5	5	0.5
Gmelina arborea Roxb.	Verbenaceae	t	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Helicteres elongata Wall. *ex* Boj.	Sterculiaceae	s	0	0	0	0	0.5	0	0	0	0	0	0.5	0.05
Imperata cylindrica (L.) P. Beauv. var. *major* (Nees) C.E. Hubb. *ex* Hubb & Vaugh.	Gramineae	h	2	1	1	0	1	3	0.5	1	0.5	0	10	1
Maesa montana A. DC.	Myrsinaceae	l	0	0	0	0	0.5	0	0	0	0	0	0.5	0.05
Microstegium vagans (Nees *ex* Steud.) A. Camus	Gramineae	h	0	0	0	0	0.5	0.5	0	3	0.5	1	5.5	0.55
Mitracapus villosus (Sw.) DC.	Rubiaceae	h	0	0.5	0	0	0	0.5	0	0	0	0.5	1.5	0.15
Mucuna bracteata A. DC.	Leguminosae, Papilionoideae	v	0.5	0	0.5	0	0.5	0.5	0	0	0	0.5	2.5	0.25
Panicum notatum Retz.	Gramineae	h	0	0	0	0	0.5	0	0	0.5	0	0.5	1.5	0.15
Paris polyphylla J.E. Smith	Liliaceae	h	0	0	0	0	0	0	0	0	0.5	0	0.5	0.05
Phragmitus vallatoria (Pluk. *ex* L.) Veldk.	Gramineae	h	1	1	1	1	0	0.5	1	0	0.5	0	6	0.6
Pteridium aquilinum (L.) Kuhn ssp. *aquilinum* var. *wightianum* (Ag.) Try	Dennstaedtiaceae	h	0	3	1	3	3	1	1	3	2	4	21	2.1
Rhynchelytrum repens (Willd.) C.E. Hubb.	Gramineae	h	0	0	0	0	0	0	0	0	0	2	2	0.2
Seteria palmifolia (Koen.) Stapf var. *palmifolia*	Gramineae	h	0	0.5	0	0	0	0	0	0	0.5	0	1	0.1
Seteria parviflora (Poir.) Kerg.	Gramineae	h	0	0	0	0.5	0	0	0	0	0	0.5	1	0.1
Seteria verticillata (L.) P. Beauv.	Gramineae	h	0	0	0	0	0.5	0	0	1	0	0.5	2	0.2
Solanum torvum Swz.	Solanaceae	h	0	0	0	0	0	0	0	0	0	0.5	0.5	0.05
Sterculia villosa Roxb.	Sterculiaceae	t	0	0	0	0.5	0	0	0	0	0	0	0.5	0.05
Thysanolaena latifolia (Roxb. *ex* Horn.) Honda	Gramineae	h	3	0	2	1	0	0	2	0	1	0	9	0.9
Triumfetta pilosa Roth	Tiliaceae	h	0	0.5	0.5	0.5	0	0	0.5	0	0.5	0.5	3	0.3
Urena lobata L. ssp. *lobata* var. *lobata*	Malvaceae	h	0	0	0	0.5	0	0	0	0	0	0	0.5	0.05

B. Percent Cover of Ground Flora Found in 10 Subplots in Plot C98 in July (2nd Survey).

Botanical Name	Family	Habit	SP1	SP2	SP3	SP4	SP5	SP6	SP7	SP8	SP9	SP10	Total	X2
Abrus pulchellus Wall. *ex* Thw. ssp. *pulchellus*	Leguminosae, Papilionoideae	v	0	0	0	0	0	0.5	0	0	0	0	0.5	0.05
Acacia megaladena Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	0	0	0	0	0	0	0.5	0	0	0.5	1	0.1
Ageratum conzoides L.	Compositae	h	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Alpinia malaccensis (Burm. f.) Rosc.	Zingiberceae	h	0	0	0	0	0	0	0	0.5	0	0	0.5	0.05
Anaphalis margaritacea (L.) Bth. & Hk. f.	Compositae	h	0	0	0	0	1	0	0	0	0	0	1	0.1
Argyreia aggregata Roxb.	Convolvulaceae	wc	0	0	0	0	0.5	0	0	0	0	0	0.5	0.05
Artemisia indica Willd.	Compositae	h	0.5	0	1	0	0	0.5	0.5	0	0.5	0.5	3.5	0.35
Bidens pilosa L. var. *minor* (Bl.) Sherff	Compositae	h	0.5	0	0.5	0	0	0	0	0	0.5	0.5	2	0.2
Boehmeria chiangmaiensis Yaha.	Urticaceae	l	0	0	0	0	0.5	0	0	0	0.5	0	1	0.1
Castanopsis argyrophylla King *ex* Hk. f.	Fagaceae	t	0	0	0	0	0	0	0	0	0.5	0	0.5	0.05
Centella asiatica (L.) Urb.	Umbelliterae	h	0	0.5	0	0.5	0	0	0.5	0	0	0	1.5	0.15
Clerodendrum glandulosum Colebr. *ex* Lindl.	Verbenaceae	h/l	0	0.5	0	0.5	0	0	0.5	0.5	0.5	0.5	3	0.3
Codonopsis javanica (Bl.) Hk. f.	Companulaceae	v	0	0	0	0	0	0	0	0	0	0.5	0.5	0.05
Conyza sumatrensis (Retz.) Walk.	Compositae	h	0	0	0	0	0	0.5	0.5	0	0	0	1	0.1
Crassocephalum crepidiodes (Bth.) S. Moore	Compositae	h	0	0.5	0	0.5	0	0	0.5	0	0.5	0.5	2.5	0.25
Cyperus cyperoides (L.) O.K.	Cyperaceae	h	0	0	0	0	0	0	0.5	0	0	0.5	1	0.1
Desmodium heterocarpon (L.) DC. ssp. *heterocarpon* var. *heterocarpon*	Leguminosae, Papilionoideae	h	0	0	0.5	0	0.5	0.5	0	0	0	0	1.5	0.15
Desmodium velutinum (Willd.) DC. ssp. *velutinum* var. *velutinum*	Leguminosae, Papilionoideae	h	0	0	0	0	0.5	0	0	0	0	0	0.5	0.05
Digitaria setigera Roth *ex* Roem. & Shult.var. *setigera*	Gramineae	h	0	0	0	0	0	0	0	0	0	0.5	0.5	0.05
Dioscorea alata L.	Dioscoreaceae	v	0	0.5	0	0	0	0	0	0.5	0	0	1	0.1
Dioscorea glabra Roxb. var. *glabra*	Dioscoreaceae	v	0	0.5	0	0.5	0.5	0	0.5	0.5	0.5	0.5	3.5	0.35
Dioscorea prazeri Prain & Burk.	Dioscoreaceae	v	0	0	0	0	0.5	0	0	0	0.5	0	1	0.1
Embelia sessiliflora Kurz	Myrsinaceae	wc	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05

Entada rheedii Spreng. ssp. *rheedii*	Leguminosae, Mimosoideae	wc	0	0	0	0	0.5	0	0	0	0	0	0.5	0.05
Eugenia albiflora Duth. *ex* Kurz	Myrtaceae	t	0	0	0.5	0	0	0	0	0	0	0	0.5	0.05
Eupatorium adenophorum Spreng.	Compositae	h	0	0	0.5	0.5	0	0.5	0	0.5	0.5	0.5	3	0.3
Eupatorium odoratum L.	Compositae	h	0.5	0.5	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	4.5	0.45
Firmiana colorata (Roxb.) R. Br.	Sterculiaceae	t	0	0	0.5	0	0	0	0	0	0	0	0.5	0.05
Gmelina arborea Roxb.	Verbenaceae	t	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Helicteres elongata Wall. *ex* Boj.	Sterculiaceae	s	0	0	0	0	0.5	0	0	0	0	0	0.5	0.05
Imperata cylindrica (L.) P. Beauv. var. *major* (Nees) C.E. Hubb. *ex* Hubb & Vaugh.	Gramineae	h	4	3	4	0	1	5	0.5	1	0.5	0	19	1.9
Maesa montana A. DC.	Myrsinaceae	l	0	0	0	0	0.5	0	0	0	0	0	0.5	0.05
Melastoma normale D. Don. var. *normale*	Melastomataceae	l	0	0	0	0.5	0	0	0	0	0	0	0.5	0.05
Microstegium vagans (Nees *ex* Steud.) A. Camus	Gramineae	h	0	0	0	0	0.5	0.5	0	4	1	1	7	0.7
Mitracapus villosus (Sw.) DC.	Rubiaceae	h	0.5	0	0	0	0	0.5	0.5	0	0.5	0.5	2.5	0.25
Mucuna bracteata A. DC.	Leguminosae, Papilionoideae	v	0.5	0	0.5	0	0.5	0.5	0	0	0	0.5	2.5	0.25
Panicum notatum Retz.	Gramineae	h	0	0	0	0	0.5	0	0	0.5	0.5	0.5	2	0.2
Paris polyphylla J.E. Smith	Liliaceae	h	0	0	0	0	0	0	0	0	0.5	0	0.5	0.05
Paspalum conjugatum Berg.	Gramineae	h	0.5	0	0	0	0	0	0	0	0	0.5	1	0.1
Phragmitus vallatoria (Pluk. *ex* L.) Veldk.	Gramineae	h	1	2	2	2	0	1	1	0	0.5	0	9.5	0.95
Pteridium aquilinum (L.) Kuhn ssp. *aquilinum* var. *wightianum* (Ag.) Try	Dennstaedtiaceae	h	0	3	1	4	4	1	4	4	2	2	25	2.5
Rhynchelytrum repens (Willd.) C.E. Hubb.	Gramineae	h	0	0	0	0	0	0	0	0	0	1	1	0.1
Schina wallichii (DC.) Korth.	Theaceae	t	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Seteria palmifolia (Koen.) Stapf var. *palmifolia*	Gramineae	h	0	0.5	0	0	0	0	0	0	0.5	0	1	0.1
Seteria parviflora (Poir.) Kerg.	Gramineae	h	0	0	0	0.5	0	0	0	0	0	0.5	1	0.1
Seteria verticillata (L.) P. Beauv.	Gramineae	h	0	0	0	0	0.5	0	0	0.5	0	0.5	1.5	0.15
Solanum torvum Swz.	Solanaceae	h	0	0	0	0	0	0	0	0	0	0.5	0.5	0.05
Sterculia villosa Roxb.	Sterculiaceae	t	0	0	0	0.5	0	0	0	0	0	0	0.5	0.05
Thysanolaena latifolia (Roxb. *ex* Horn.)	Gramineae	h	3	0	2	1	0	0	3	0	1	0	10	1

Honda														
Triumfetta pilosa Roth	Tiliaceae	h	0	0.5	0.5	0.5	0	0	0.5	0	0.5	0.5	3	0.3
Urena lobata L. ssp. *lobata* var. *lobata*	Malvaceae	h	0	0	0	0.5	0	0	0	0	0	0	0.5	0.05

C. Percent Cover of Ground Flora Found in 10 Subplots in Plot C98 in November (3rd Survey).

Botanical Name	Family	Habit	SP1	SP2	SP3	SP4	SP5	SP6	SP7	SP8	SP9	SP10	Total	X3
Abrus pulchellus Wall. *ex* Thw. ssp. *pulchellus*	Leguminosae, Papilionoideae	v	0	0	0	0	0	0.5	0	0	0	0	0.5	0.05
Acacia megaladena Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	0	0	0	0	0	0	0.5	0	0	0.5	1	0.1
Ageratum conzoides L.	Compositae	h	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Alpinia malaccensis (Burm. f.) Rosc.	Zingiberceae	h	0	0	0	0	0	0	0	0.5	0	0	0.5	0.05
Anaphalis margaritacea (L.) Bth. & Hk. f.	Compositae	h	0	0	0	0	1	0	0	0	0	0	1	0.1
Argyreia aggregata Roxb.	Convolvulaceae	wc	0	0	0	0	0.5	0	0	0	0	0	0.5	0.05
Artemisia indica Willd.	Compositae	h	0.5	0	1	0	0	0.5	0.5	0	0.5	0.5	1.5	0.15
Bidens pilosa L. var. *minor* (Bl.) Sherff	Compositae	h	0.5	0	0	0	0	0	0	0	0.5	0.5	1.5	0.15
Centella asiatica (L.) Urb.	Umbelliterae	h	0	0	0	0.5	0	0	0.5	0	0	0	1	0.1
Clerodendrum glandulosum Colebr. *ex* Lindl.	Verbenaceae	h/l	0	0.5	0	0.5	0	0	0.5	0.5	0.5	0.5	3	0.3
Codonopsis javanica (Bl.) Hk. f.	Companulaceae	v	0	0	0	0	0	0	0	0	0	0.5	0.5	0.05
Conyza sumatrensis (Retz.) Walk.	Compositae	h	0	0	0	0	0	0.5	0.5	0	0	0	1	0.1
Crassocephalum crepidiodes (Bth.) S. Moore	Compositae	h	0	0.5	0	0.5	0	0	0.5	0	0.5	0.5	2.5	0.25
Cyperus cyperoides (L.) O.K.	Cyperaceae	h	0	0	0	0	0	0	0.5	0	0	0.5	1	0.1
Desmodium heterocarpon (L.) DC. ssp. *heterocarpon* var. *heterocarpon*	Leguminosae, Papilionoideae	h	0	0	0.5	0	0.5	0.5	0	0	0	0	1.5	0.15
Desmodium velutinum (Willd.) DC. ssp. *velutinum* var. *velutinum*	Leguminosae, Papilionoideae	h	0	0	0	0	0.5	0	0	0	0	0	0.5	0.05
Digitaria setigera Roth *ex* Roem. & Shult.var. *setigera*	Gramineae	h	0	0	0	0	0	0	0	0	0	0.5	0.5	0.05
Dioscorea alata L.	Dioscoreaceae	v	0	0.5	0	0	0	0	0	0.5	0	0	1	0.1
Dioscorea glabra Roxb. var. *glabra*	Dioscoreaceae	v	0	0.5	0	0.5	0.5	0	0.5	0.5	0.5	0.5	3.5	0.35

Dioscorea prazeri Prain & Burk.	Dioscoreaceae	v	0	0	0	0	0.5	0	0	0	0.5	0	1	0.1
Embelia sessiliflora Kurz	Myrsinaceae	wc	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Entada rheedii Spreng. ssp. *rheedii*	Leguminosae, Mimosoideae	wc	0	0	0	0	0.5	0	0	0	0	0	0.5	0.05
Eugenia albiflora Duth. *ex* Kurz	Myrtaceae	t	0	0	0.5	0	0	0	0	0	0	0	0.5	0.05
Eupatorium adenophorum Spreng.	Compositae	h	0	0	0.5	0.5	0	0.5	0	0.5	0.5	0.5	3	0.3
Eupatorium odoratum L.	Compositae	h	0.5	0.5	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	4.5	0.45
Firmiana colorata (Roxb.) R. Br.	Sterculiaceae	t	0	0	0.5	0	0	0	0	0	0	0	0.5	0.05
Gmelina arborea Roxb.	Verbenaceae	t	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Helicteres elongata Wall. *ex* Boj.	Sterculiaceae	s	0	0	0	0	0.5	0	0	0	0	0	0.5	0.05
Imperata cylindrica (L.) P. Beauv. var. *major* (Nees) C.E. Hubb. *ex* Hubb & Vaugh.	Gramineae	h	5	3	3	0	1	3	0.5	0.5	0	0	16	1.6
Maesa montana A. DC.	Myrsinaceae	l	0	0	0	0	0.5	0	0	0	0	0	0.5	0.05
Melastoma normale D. Don. var. *normale*	Melastomataceae	l	0	0	0	0.5	0	0	0	0	0	0	0.5	0.05
Microstegium vagans (Nees *ex* Steud.) A. Camus	Gramineae	h	0	0	0	0	0.5	1	0	5	2	1	9.5	0.95
Mitracapus villosus (Sw.) DC.	Rubiaceae	h	0.5	0	0	0	0	0.5	0.5	0	0.5	0.5	2.5	0.25
Mucuna bracteata A. DC.	Leguminosae, Papilionoideae	v	0.5	0	0.5	0	0.5	0.5	0	0	0	0.5	2.5	0.25
Panicum notatum Retz.	Gramineae	h	0	0	0	0	0.5	0	0	0.5	0	0.5	1.5	0.15
Paris polyphylla J.E. Smith	Liliaceae	h	0	0	0	0	0	0	0	0	0.5	0	0.5	0.05
Phragmitus vallatoria (Pluk. *ex* L.) Veldk.	Gramineae	h	2	2	2	2	0	1	2	0	0.5	0	11.5	1.15
Pteridium aquilinum (L.) Kuhn ssp. *aquilinum* var. *wightianum* (Ag.) Try	Dennstaedtiaceae	h	0	2	2	5	5	2	1	5	5	5	32	3.2
Rhynchelytrum repens (Willd.) C.E. Hubb.	Gramineae	h	0	0	0	0	0	0	0	0	0	0.5	0.5	0.05
Schima wallichii (DC.) Korth.	Theaceae	t	0	0	0	0	0	0	0.5	0	0	0	0.5	0.05
Seteria palmifolia (Koen.) Stapf var. *palmifolia*	Gramineae	h	0	0.5	0	0	0	0	0	0	0.5	0	1	0.1
Seteria parviflora (Poir.) Kerg.	Gramineae	h	0	0	0	0.5	0	0	0	0	0	0.5	1	0.1
Seteria verticillata (L.) P. Beauv.	Gramineae	h	0	0	0	0	0.5	0	0	0.5	0	0.5	1.5	0.15
Solanum torvum Swz.	Solanaceae	h	0	0	0	0	0	0	0	0	0	1	1	0.1
Sterculia villosa Roxb.	Sterculiaceae	t	0	0	0	0.5	0	0	0	0	0	0	0.5	0.05

Thysanolaena latifolia (Roxb. *ex* Horn.) Honda	Gramineae	h	3	0	2	1	0	0	4	0	1	0	11	1.1
Triumfetta pilosa Roth	Tiliaceae	h	0	0.5	0.5	0.5	0	0	0.5	0	0.5	0.5	3	0.3
Urena lobata L. ssp. *lobata* var. *lobata*	Malvaceae	h	0	0	0	0.5	0	0	0	0	0	0	0.5	0.05

Remarks:

Habit

h = Herb

l = Treelet

t = Tree

v = Vine

wc = Woody Climber

Appendix 7. Ground flora in plot P97 for all 3 surveys.

A. Percent Cover of Ground Flora Found in 5 Subplots in Plot P97 in April (1st Survey).

Botanical Name	Family	Habit	SP1	SP2	SP3	SP4	SP5	Total	X1
Ageratum conzoides L.	Compositae	h	0.5	0.5	1	0.5	0.5	3	0.6
Artemisia indica Willd.	Compositae	h	0	0	0	0	0.5	0.5	0.1
Bidens pilosa L. var. *minor* (Bl.) Sherff	Compositae	h	1	1	1	0.5	2	5.5	1.1
Clerodendrum glandulosum Colebr. *ex* Lindl.	Verbenaceae	h/l	0.5	0	0	0	0	0.5	0.1
Conyza sumatrensis (Retz.) Walk.	Compositae	h	0.5	0	1	0.5	0.5	2.5	0.5
Crassocephalum crepidiodes (Bth.) S. Moore	Compositae	h	0	0.5	0	0.5	0.5	1.5	0.3
Cyperus cyperoides (L.) O.K.	Cyperaceae	h	0.5	0	0.5	0.5	0	1.5	0.3
Digitaria setigera Roth *ex* Roem. & Shult.var. *setigera*	Gramineae	h	0	0.5	0	0	0.5	1	0.2
Drymaria diandra Bl.	Caryophyllaceae	h	0	0	0	1	0	1	0.2
Eupatorium adenophorum Spreng.	Compositae	h	0.5	0	0	0.5	0.5	1.5	0.3
Galinsoga parviflora Cav.	Compositae	h	0.5	0	0	0	0	0.5	0.1
Mitracapus villosus (Sw.) DC.	Rubiaceae	h	0.5	0.5	0	0.5	0.5	2	0.4
Mucuna bracteata A. DC.	Leguminosae, Papilionoideae	v	0.5	0	0	0.5	0	1	0.2
Oxalis corniculata L.	Oxalidaceae	h	0	0.5	0	0.5	0	1	0.2
Paspalum conjugatum Berg.	Gramineae	h	0	0.5	0	0	0.5	1	0.2
Pennisetum polystachyon (L.) Schult.	Gramineae	h	0.5	0.5	0.5	0.5	0.5	2.5	0.5
Polygonum chinense L.	Polygonaceae	h	0.5	0	0	0	0	0.5	0.1
Rhynchelytrum repens (Willd.) C.E. Hubb.	Gramineae	h	0.5	1	0	1	1	3.5	0.7
Solanum nigrum L.	Solonaceae	h	0.5	0.5	0	0.5	0	1.5	0.3

Sonchus oleraceus L.	Compositae	h	0	0	0	0	0.5	0.5	0.1
Triumfetta rhomboidea Jacq.	Tiliaceae	h	0	0	0.5	0	0	0.5	0.1

B. Percent Cover of Ground Flora Found in 5 Subplots in Plot P97 in July (2nd Survey).

Botanical Name	Family	Habit	SP1	SP2	SP3	SP4	SP5	Total	X2
Ageratum conzoides L.	Compositae	h	0	0.5	0.5	0.5	1	2.5	0.5
Artemisia indica Willd.	Compositae	h	0	0.5	0	0	0.5	1	0.2
Bidens pilosa L. var. *minor* (Bl.) Sherff	Compositae	h	0.5	0.5	0.5	0.5	2	4	0.8
Conyza sumatrensis (Retz.) Walk.	Compositae	h	0	0.5	1	0.5	0.5	2.5	0.5
Crassocephalum crepidiodes (Bth.) S. Moore	Compositae	h	1	0.5	0.5	0.5	0.5	3	0.6
Cyperus cyperoides (L.) O.K.	Cyperaceae	h	2	0.5	1	1	0	4.5	0.9
Digitaria setigera Roth *ex* Roem. & Shult.var. *setigera*	Gramineae	h	0	0.5	0.5	0	0.5	1.5	0.3
Drymaria diandra Bl.	Caryophyllaceae	h	0	0.5	0	1	0	1.5	0.3
Eupatorium adenophorum Spreng.	Compositae	h	1	0.5	0	0.5	0.5	2.5	0.5
Eupatorium odoratum L.	Compositae	h	0	0	0	0	0.5	0.5	0.1
Galinsoga parviflora Cav.	Compositae	h	0	0.5	0	0	0	0.5	0.1
Mitracapus villosus (Sw.) DC.	Rubiaceae	h	1	0.5	0	0.5	0.5	2.5	0.5
Mucuna bracteata A. DC.	Leguminosae, Papilionoideae	v	0	0	0	0.5	0	0.5	0.1
Oxalis corniculata L.	Oxalidaceae	h	0	0.5	0	0.5	0.5	1.5	0.3
Paspalum conjugatum Berg.	Gramineae	h	0	0	0	0.5	0	0.5	0.1
Pennisetum polystachyon (L.) Schult.	Gramineae	h	0.5	0.5	0.5	0.5	0.5	2.5	0.5
Polygonum chinense L.	Polygonaceae	h	0.5	0	0	0	0	0.5	0.1
Rhynchelytrum repens (Willd.) C.E. Hubb.	Gramineae	h	0.5	0.5	0	0.5	0	1.5	0.3
Solanum nigrum L.	Solonaceae	h	0.5	0.5	0	0.5	0	1.5	0.3

Spilanthes paniculata Wall. *ex* DC.	Compositae	h	0	0	0	0.5	0	0.5	0.1
Triumfetta rhomboidea Jacq.	Tiliaceae	h	0	0	0.5	0	0	0.5	0.1

C. Percent Cover of Ground Flora Found in 5 Subplots in Plot P97 in November (3rd Survey).

Botanical Name	Family	Habit	SP1	SP2	SP3	SP4	SP5	Total	X3
Ageratum conzoides L.	Compositae	h	0	1	2	1	0.5	4.5	0.9
Bidens pilosa L. var. *minor* (Bl.) Sherff	Compositae	h	0.5	1	0.5	0.5	1	3.5	0.7
Capillipedium parviflorum (R.Br.) Stapf	Gramineae	h	0	0	0	0	0.5	0.5	0.1
Conyza sumatrensis (Retz.) Walk.	Compositae	h	0.5	0	2	0.5	1	4	0.8
Crassocephalum crepidiodes (Bth.) S. Moore	Compositae	h	0	0.5	0	0.5	0.5	1.5	0.3
Cyperus cyperoides (L.) O.K.	Cyperaceae	h	0	0	0.5	0.5	0	1	0.2
Digitaria setigera Roth *ex* Roem. & Shult.var. *sètigera*	Gramineae	h	0	0.5	0	0	0.5	1	0.2
Drymaria diandra Bl.	Caryophyllaceae	h	0	0.5	0	2	0	2.5	0.5
Eupatorium adenophorum Spreng.	Compositae	h	0.5	0	0	0	0.5	1	0.2
Galinsoga parviflora Cav.	Compositae	h	0	0.5	0	0	0	0.5	0.1
Mitracapus villosus (Sw.) DC.	Rubiaceae	h	1	0	0	0.5	1	2.5	0.5
Mucuna bracteata A. DC.	Leguminosae, Papilionoideae	v	0.5	0	0.5	0.5	0.5	2	0.4
Oxalis corniculata L.	Oxalidaceae	h	0	0	0	0.5	0	0.5	0.1
Paspalum conjugatum Berg.	Gramineae	h	0	0.5	0	0	0	0.5	0.1
Pennisetum polystachyon (L.) Schult.	Gramineae	h	5	5	4	5	5	24	4.8
Polygonum chinense L.	Polygonaceae	h	0	0	0	0	1	1	0.2
Pteridium aquilinum (L.) Kuhn ssp. *aquilinum* var. *wightianum* (Ag.) Try	Dennstaedtiaceae	h	1	0	0	0	0	1	0.2
Rhynchelytrum repens (Willd.) C.E. Hubb.	Gramineae	h	0	1	0	0	1	2	0.4

Seteria parviflora (Poir.) Kerg.	Gramineae	h	0	0	0	0	0.5	0.5	0.1
Sida rhombifolia L. ssp. *rhomifolia*	Malvaceae	h	0	0	0.5	0	0	0.5	0.1
Spilanthes paniculata Wall. *ex* DC.	Compositae	h	0	0	0	0	0.5	0.5	0.1
Sporobolus diander (Retz.) P. Beauv.	Gramineae	h	0	0	0	0	0.5	0.5	0.1
Triumfetta rhomboidea Jacq.	Tiliaceae	h	0.5	0	0	0.5	0	1	0.2
Urena lobata L. ssp. *lobata* var. *lobata*	Malvaceae	h	0.5	0	0	0	0	0.5	0.1

Remarks:

Habit

h = Herb

l = Treelet

t = Tree

v = Vine

wc = Woody Climber

Appendix 8. Ground flora in plot C97 for all 3 surveys.

A. Percent Cover of Ground Flora Found in 5 Subplots in Plot C97 in April (1st Survey).

Botanical Name	Family	Habit	SP1	SP2	SP3	SP4	SP5	Total	X1
Ageratum conzoides L.	Compositae	h	0	0	0.5	0	0.5	1	0.2
Bidens pilosa L. var. *minor* (Bl.) Sherff	Compositae	h	0	0.5	0.5	0.5	1	2.5	0.5
Boehmeria chiangmaiensis Yaha.	Urticaceae	l	0.5	0	0	0	0	0.5	0.1
Carex baccans Nees	Cyperaceae	h	0.5	0	0	0	0	0.5	0.1
Cissampelos hispida For.	Menispermaceae	v	0	0	0	0.5	0	0.5	0.1
Clerodendrum glandulosum Colebr. *ex* Lindl.	Verbenaceae	h/l	0	0	0	0	0.5	0.5	0.1
Commelina benghalensis L.	Commelinaceae	h	0	0	0	0.5	0	0.5	0.1
Conyza sumatrensis (Retz.) Walk.	Compositae	h	0	0	0	0.5	0.5	1	0.2
Crassocephalum crepidiodes (Bth.) S. Moore	Compositae	h	0	0	0.5	0.5	0	1	0.2
Cyperus cyperoides (L.) O.K.	Cyperaceae	h	0	0.5	0.5	1	0	2	0.4
Digitaria setigera Roth *ex* Roem. & Shult.var. *setigera*	Gramineae	h	0	0	0.5	0.5	0	1	0.2
Dioscorea alata L.	Dioscoreaceae	v	0	0	0	0.5	0	0.5	0.1
Drymaria diandra Bl.	Caryophyllaceae	h	0	0	0	0.5	0	0.5	0.1
Eupatorium adenophorum Spreng.	Compositae	h	0	1	2	0.5	0.5	4	0.8
Eupatorium odoratum L.	Compositae	h	0	0	0	0.5	0.5	1	0.2
Imperata cylindrica (L.) P. Beauv. var. *major* (Nees) C.E. Hubb. *ex* Hubb & Vaugh.	Gramineae	h	0	0.5	0	0	0	0.5	0.1
Merremia vitifolia (Burm. f.) Hall. f.	Convolvulaceae	v	0	0	0	0	0.5	0.5	0.1
Millettia pachycarpa Bth.	Leguminosae, Papilionoideae	wc	0.5	0	0.5	0	0	1	0.2

Mimosa diplotricha C. Wright *ex* Sauv. var. *diplotricha*	Leguminosae, Mimosoideae	s	0	1	0	0	0.5	1.5	0.3
Mucuna bracteata A. DC.	Leguminosae, Papilionoideae	v	3	4	1	1	0.5	9.5	1.9
Oroxylum indicum (L.) Kurz	Bignoniaceae	t	0.5	0	0	0	0	0.5	0.1
Pennisetum polystachyon (L.) Schult.	Gramineae	h	0	0	0.5	0.5	0.5	1.5	0.3
Polygonum chinense L.	Polygonaceae	h	0	0	0.5	0.5	0.5	1.5	0.3
Pteridium aquilinum (L.) Kuhn ssp. *aquilinum* var. *wightianum* (Ag.) Try	Dennstaedtiaceae	h	0.5	0	0	4	1	5.5	1.1
Rhynchelytrum repens (Willd.) C.E. Hubb.	Gramineae	h	0	0.5	0	0	0	0.5	0.1
Sida rhombifolia L. ssp. *rhomifolia*	Malvaceae	h	0	0	0.5	0	0	0.5	0.1
Solanum torvum Swz.	Solanaceae	h	0.5	0.5	0	0	0.5	1.5	0.3
Spilanthes paniculata Wall. *ex* DC.	Compositae	h	0.5	0	0	0	0	0.5	0.1
Trichosanthes tricuspidata Lour.	Cucurbitaceae	v	0	0.5	0.5	0	0.5	1.5	0.3
Triumfetta rhomboidea Jacq.	Tiliaceae	h	0	0.5	0	0	0.5	1	0.2

B. Percent Cover of Ground Flora Found in 5 Subplots in Plot C97 in July (2nd Survey).

Botanical Name	Family	Habit	SP1	SP2	SP3	SP4	SP5	Total	X2
Ageratum conzoides L.	Compositae	h	0	0	0	0	0.5	0.5	0.1
Bidens pilosa L. var. *minor* (Bl.) Sherff	Compositae	h	0	0.5	0.5	0.5	1	2.5	0.5
Boehmeria chiangmaiensis Yaha.	Urticaceae	l	0	0	0	0	0.5	0.5	0.1
Boehmeria diffusa Wedd.	Urticaceae	h	0	0	0	0	0.5	0.5	0.1
Carex baccans Nees	Cyperaceae	h	0.5	0	0	0	0	0.5	0.1
Cissampelos hispida For.	Menispermaceae	v	0	0	0	0.5	0	0.5	0.1
Clerodendrum glandulosum Colebr. *ex* Lindl.	Verbenaceae	h/l	1.5	0.5	0	0	0.5	1.5	0.3
Commelina benghalensis L.	Commelinaceae	h	0	0	0	0.5	0	0.5	0.1

Conyza sumatrensis (Retz.) Walk.	Compositae	h	0	0	0	0.5	0	0.5	0.1
Crassocephalum crepidiodes (Bth.) S. Moore	Compositae	h	0	0	0.5	0.5	0	1	0.2
Cyperus cyperoides (L.) O.K.	Cyperaceae	h	0.5	0.5	1	1	0	5	1
Digitaria setigera Roth *ex* Roem. & Shult.var. *setigera*	Gramineae	h	0	0	0.5	0.5	0	1	0.2
Dioscorea alata L.	Dioscoreaceae	v	0	0	0	0.5	0	0.5	0.1
Drymaria diandra Bl.	Caryophyllaceae	h	0	0	0	0.5	0	0.5	0.1
Eupatorium adenophorum Spreng.	Compositae	h	0.5	0.5	2	1	0.5	4.5	0.9
Galinsoga parviflora Cav.	Compositae	h	0	0	0.5	0	0	0.5	0.1
Merremia vitifolia (Burm. f.) Hall. f.	Convolvulaceae	v	0	0	0	0	0.5	0.5	0.1
Millettia pachycarpa Bth.	Leguminosae, Papilionoideae	wc	0.5	0.5	0.5	0	0	1.5	0.3
Mimosa diplotricha C. Wright *ex* Sauv. var. *diplotricha*	Leguminosae, Mimosoideae	s	0.5	2	0	0	0.5	3	0.6
Mucuna bracteata A. DC.	Leguminosae, Papilionoideae	v	4	4	2	1	1	12	2.4
Oroxylum indicum (L.) Kurz	Bignoniaceae	t	0	0.5	0	0	0	0.5	0.1
Panicum notatum Retz.	Gramineae	h	0	0	0	0	0.5	0.5	0.1
Pennisetum polystachyon (L.) Schult.	Gramineae	h	0	0	0.5	1	0	1.5	0.3
Polygonum chinense L.	Polygonaceae	h	0.5	0	0.5	0.5	0.5	2	0.4
Pteridium aquilinum (L.) Kuhn ssp. *aquilinum* var. *wightianum* (Ag.) Try	Dennstaedtiaceae	h	2	0.5	0	3	2	7.5	1.5
Rauvolfia verticillata (Lour.) Baill.	Apocynaceae	l	0	0	0	0	0.5	0.5	0.1
Seteria parviflora (Poir.) Kerg.	Gramineae	h	1	0.5	0	0	0	1.5	0.3
Sida rhombifolia L. ssp. *rhomifolia*	Malvaceae	h	0	0	0.5	0	0	0.5	0.1
Solanum nigrum L.	Solonaceae	h	0.5	0.5	0	0	0	1	0.2
Trichosanthes tricuspidata Lour.	Cucurbitaceae	v	0	0	0.5	0	0.5	1	0.2

Triumfetta rhomboidea Jacq.	Tiliaceae	h	1	0.5	0	0	0.5	2	0.4

C. Percent Cover of Ground Flora Found in 5 Subplots in Plot C97 in November (3rd Survey).

Botanical Name	Family	Habit	SP1	SP2	SP3	SP4	SP5	Total	X3
Ageratum conzoides L.	Compositae	h	0	0	0.5	0	0	0.5	0.1
Bidens pilosa L. var. *minor* (Bl.) Sherff	Compositae	h	0	0	0.5	0.5	0.5	1.5	0.3
Boehmeria chiangmaiensis Yaha.	Urticaceae	l	0	0	0	0	0.5	0.5	0.1
Boehmeria diffusa Wedd.	Urticaceae	h	0	0	0	0	0.5	0.5	0.1
Carex baccans Nees	Cyperaceae	h	0.5	0	0	0	0	0.5	0.1
Cissampelos hispida For.	Menispermaceae	v	0	0	0	0.5	0	0.5	0.1
Clerodendrum glandulosum Colebr. *ex* Lindl.	Verbenaceae	h/l	0.5	0	0	0	0.5	1	0.2
Commelina benghalensis L.	Commelinaceae	h	0	0	0	0.5	0	0.5	0.1
Conyza sumatrensis (Retz.) Walk.	Compositae	h	0.5	0	0	0.5	0	1	0.2
Crassocephalum crepidiodes (Bth.) S. Moore	Compositae	h	0	0	0.5	0.5	0	1	0.2
Cyperus cyperoides (L.) O.K.	Cyperaceae	h	0.5	0	0.5	0.5	0	1.5	0.3
Desmodium velutinum (Willd.) DC. ssp. *velutinum* var. *velutinum*	Leguminosae, Papilionoideae	h	0	0.5	0	0	0	0.5	0.1
Digitaria setigera Roth *ex* Roem. & Shult.var. *setigera*	Gramineae	h	0	0	0.5	0.5	0	1	0.2
Dioscorea alata L.	Dioscoreaceae	v	0	0	0	0.5	0	0.5	0.1
Drymaria diandra Bl.	Caryophyllaceae	h	0	0	0	0.5	0	0.5	0.1
Eupatorium adenophorum Spreng.	Compositae	h	1	2	3	0.5	0.5	7	1.4
Eupatorium odoratum L.	Compositae	h	0.5	0	0	0	1	1.5	0.3
Galinsoga parviflora Cav.	Compositae	h	0	0	0.5	0.5	0	1	0.2
Imperata cylindrica (L.) P. Beauv. var. *major* (Nees) C.E. Hubb. *ex* Hubb & Vaugh	Gramineae	h	0	0.5	0	0	0	0.5	0.1

Merremia vitifolia (Burm. f.) Hall. f.	Convolvulaceae	v	0	0	0	0	0.5	0.5	0.1
Millettia pachycarpa Bth.	Leguminosae, Papilionoideae	wc	0.5	0	0.5	0	0	1	0.2
Mimosa diplotricha C. Wright *ex* Sauv. var. *diplotricha*	Leguminosae, Mimosoideae	s	0.5	2	0	0	0.5	3	0.6
Mucuna bracteata A. DC.	Leguminosae, Papilionoideae	v	4	4	2	1	0.5	11.5	2.3
Oroxylum indicum (L.) Kurz	Bignoniaceae	t	0.5	0.5	0.5	0	0	1.5	0.3
Panicum notatum Retz.	Gramineae	h	0	0	0	0	0.5	0.5	0.1
Pennisetum polystachyon (L.) Schult.	Gramineae	h	0	0	1	1	0	2	0.4
Polygonum chinense L.	Polygonaceae	h	0.5	0	1	0.5	0.5	2.5	0.5
Pteridium aquilinum (L.) Kuhn ssp. *aquilinum* var. *wightianum* (Ag.) Try	Dennstaedtiaceae	h	2	0	0	5	5	12	2.4
Rauvolfia verticillata (Lour.) Baill.	Apocynaceae	l	0	0	0	0	0.5	0.5	0.1
Seteria parviflora (Poir.) Kerg.	Gramineae	h	1	0	0	0	0	1	0.2
Sida rhombifolia L. ssp. *rhomifolia*	Malvaceae	h	0	0	0.5	0	0	0.5	0.1
Trichosanthes tricuspidata Lour.	Cucurbitaceae	v	0	1	0.5	0	1	2.5	0.5
Triumfetta rhomboidea Jacq.	Tiliaceae	h	1	0.5	0	0	0.5	2	0.4

Remarks:

Habit

h = Herb

l = Treelet

t = Tree

v = Vine

wc = Woody Climber

Appendix 9. List of all naturally established tree species (including seedlings, saplings, and mature trees) found in all surveys.

No.	Botanical Name	Family	Habit	P98	C98	P97	C97
1	*Acacia megaladena* Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	x	x		
2	*Albizia chinensis* (Osb.) Merr	Leguminosae, Mimosoideae	t	x	x		
3	*Albizia odoratissima* (L. f.) Bth.	Leguminosae, Mimosoideae	t		x	x	x
4	*Antidesma acidum* Retz.	Euphorbiaceae	l	x	x		
5	*Aporusa dioica* (Roxb.) M.-A.	Euphorbiaceae	t	x			
6	*Aporusa villosa* (Lindl.) Baill.	Euphorbiaceae	t	x			
7	*Artocarpus gomexianus* Wall. *ex* Trec.	Moraceae	t	x			
8	*Berrya mollis* Wall. *ex* Kurz	Tiliaceae	t	x			
9	*Boehmeria chiangmaiensis* Yaha.	Urticaceae	l		x		
10	*Bridelia glauca* Bl.	Euphorbiaceae	t			x	
11	*Buddleja asiatica* Lour.	Loganiaceae	l	x		x	
12	*Callicarpa arborea* Roxb. var. *arborea*	Verbenaceae	t		x		
13	*Castanopsis armata* (Roxb.) Spach	Fagaceae	t		x		
14	*Clerodendrum glandulosum* Colebr. *ex* Lindl.	Verbenaceae	l/t	x			
15	*Cratoxylum formosum* (Jack) Dyer ssp. *pruniflorum* (Kurz) Gog.	Guttiferae	t		x		
16	*Dalbergia discolor* Bl. *ex* Miq.	Leguminosae, Papilionoideae	t	x			
17	*Dalbergia stipulacea* Roxb.	Leguminosae, Papilionoideae	wc		x		
18	*Dillenia parviflora* Griff. var. *kerrii* (Craib) Hoogl.	Dilleniaceae	t		x		
19	*Dillenia pentagyna* Roxb.	Dilleniaceae	t	x			
20	*Diospyros glandulosa* Lace	Ebenaceae	t	x			
21	*Erythrina suberosa* Roxb.	Leguminosae	t	x	x		
22	*Eugenia albiflora* Duth. *ex* Kurz	Myrtaceae	t	x	x		

23	*Fernandoa adenophylla* (Wall. *ex* G. Don) Steen.	Bignoniaceae	t	x			
24	*Ficus hispida* L.f. var. *hispida*	Moraceae	l		x		
25	*Firmiana colorata* (Roxb.) R. Br.	Sterculiaceae	t	x			
26	*Garuga pinnata* Roxb.	Burseraceae	t	x			
27	*Glochidion eriocarpum* Champ.	Euphorbiaceae	t	x			
28	*Glochidion sphaerogynum* (M.-A.) Kurz	Euphorbiaceae	t	x	x		
29	*Gmelina arborea* Roxb.	Verbenaceae	t		x		x
30	*Helicia nilagirica* Bedd.	Proteaceae	t	x			
31	*Ixora cibdela* Craib var. *cibdela*	Rubiaceae	l	x	x		
32	*Lagerstroemia speciosa* (L.) Pers. var . *speciosa*	Lythraceae	t			x	
33	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	t,l	x			
34	*Markhamia stipulata* (Wall.) Seem. *ex* K. Sch. var. *kerrii* Sprague	Bignoniaceae	t		x		
35	*Maesa montana* A. DC.	Myrsinaceae	l		x		
36	*Michelia baillonii* Pierre	Magnoliaceae	t		x		
37	*Melia toosendan* Sieb. & Zucc.	Miliaceae	t	x	x		
38	*Mussaenda parva* Wall. *ex* G. Don	Rubiaceae	v		x		
39	*Phoebe lanceolata* (Nees) Nees	Lauraceae	t	x			
40	*Phoebe* sp.	Lauraceae	l				x
41	*Phylanthus emblica* L.	Rubiaceae	v	x	x		
42	*Prunus persica* (L.) Bat.*	Rosaceae	t			x	x
43	*Pterocarpus macrocarpus* Kurz	Leguminosae, Papilionoideae	t	x			
44	*Schima wallichii* (DC.) Korth.	Theaceae	t	x	x		
45	*Securinega virosa* (Roxb. *ex* Willd.) Baill.	Euphorbiaceae	t		x		
46	*Sterculia villosa* Roxb.	Sterculiaceae	t		x		
47	*Stereospermum colais* (B. -H. *ex* Dillw.) Mabb.	Bignoniaceae	t	x			
48	*Turpinia pomifera* (Rosb.) Wall. *ex* DC.	Tiliaceae	t		x		

49	*Wendlandia tinctoria* (Roxb.) DC. ssp. *floribunda* (Craib) Cowan	Rubiaceae	t	x	x		
			Total number of species	29	27	5	4

Remarks:

Habit:
h = herb
l = treelet
s = shurb
t = tree
v = vine
wc = woody climber

X = found
* = an introduced fruit tree species planted by villagers

Appendix 10. Natural seedlings, saplings, and trees found in circle subplots and walking surveys in plot P98 in all 3 surveys.

A. Natural seedlings, saplings, and trees found in circle subplots in plot P98 in all 3 surveys.

No. of Circle	No. of Label	Note	Scientific Name	Family	Habit	1st Survey		2nd Survey		3rd Survey	
						Height (cm)	Health Score (0-3)	Height (cm)	Health Score (0-3)	Height (cm)	Health Score (0-3)
1	99-40SE	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	t,l	-	-	-	-	197	3
2	99-1-39	nsa	*Ixora cibdela* Craib var. *cibdela*	Rubiaceae	l	113	3	114	3	135	3
3	99-1-119	nse	*Clerodendrum glandulosum* Colebr. *ex* Lindl.	Verbenaceae	l	-	-	-	-	100	3
4	99-1-92	nse	*Fernandoa adenophylla* (Wall. *ex* G. Don) Steen.	Bignoniaceae	t	-	-	-	-	105	2.5
5	-	-	-	-	-	-	-	-	-	-	-
6	99-1-35/c	nsa	*Diospyros glandulosa* Lace	Ebenaceae	t	108	3	156	3	226	3
	99-1-36	nsa	*Pterocarpus macrocarpus* Kurz	Leguminosae, Papilionoideae	t	-	-	130	3	160	3
7	99-1-30	nsa	*Berrya mollis* Wall. *ex* Kurz	Tiliaceae	t	109	3	212	3	295	2.5
	99-1-49	T	*Berrya mollis* Wall. *ex* Kurz	Tiliaceae	t	480	3	500	3	550	2.5
	99-1-52	T	*Albizia chinensis* (Osb.) Merr.	Leguminosae, Mimosoideae	t	385	3	410	3	425	2.5
8	99-1-55	T	*Albizia chinensis* (Osb.) Merr	Leguminosae, Mimosoideae	t	400	3	425	3	460	3
	57-2	nse	*Stereospermum colais* (B. -H. *ex* Dillw.) Mabb.	Bignoniaceae	t	109	2	NF	NF	NF	NF
9	99-1-29	nse	*Pterocarpus macrocarpus* Kurz	Leguminosae, Papilionoideae	t	101	3	*	*	102	3
10	52SE	nsa	*Stereospermum colais* (B. -H. *ex* Dillw.) Mabb.	Bignoniaceae	t	-	-	175	3	182	3

B. Natural seedlings, saplings, and trees found in walking surveys in plot P98 in all 3 surveys.

No. of Label	Note /No. Stem	Scientific Name	Family	Habit	1st Survey		2nd Survey		3rd Survey	
					Height (cm)	Health Score (0-3)	Height (cm)	Health Score (0-3)	Height (cm)	Health Score (0-3)
53SE	T	*Acacia megaladena* Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	NF	NF	NF	NF	272	3
99-1-58	T	*Acacia megaladena* Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	220	3	255	3	310	3
99-1-50	T	*Acacia megaladena* Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	230	3	270	3	320	3
NLa /Near 99-1-61	T	*Acacia megaladena* Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	250	3	285	3	330	3
99-1-160	T	*Acacia megaladena* Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	345	3	385	3	450	3
99-1-47	T	*Acacia megaladena* Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	350	3	390	3	455	3
99-1-46	T	*Acacia megaladena* Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	490	3	560	3	625	3
99-1-54	T	*Acacia megaladena* Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	275	3	300	3	350	3
99-1-51	T	*Acacia megaladena* Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	270	3	300	3	335	3
99-1-159	T	*Albizia chiensis* (Osb.) Merr.	Leguminosae, Mimosoideae	t	260	3	310	3	350	3
NLa/Near 99-1-59	T	*Albizia chiensis* (Osb.) Merr.	Leguminosae, Mimosoideae	t	330	3	370	3	420	3
99-1-56	T	*Albizia chiensis* (Osb.) Merr.	Leguminosae, Mimosoideae	t	400	3	450	3	500	3
99-1-234	T	*Albizia chiensis* (Osb.) Merr.	Leguminosae, Mimosoideae	t	375	3	415	3	450	3

99-1-156	T	*Albizia chiensis* (Osb.) Merr.	Leguminosae, Mimosoideae	t	278	3	300	3	330	3
99-1-55	T	*Albizia chiensis* (Osb.) Merr.	Leguminosae, Mimosoideae	t	450	3	480	3	510	3
99-1-154	T	*Albizia chiensis* (Osb.) Merr.	Leguminosae, Mimosoideae	t	480	3	500	3	520	3
99-1-105	nsa	*Antidesma acidum* Retz.	Euphorbiaceae	l	-	-	-	-	152	3
99-1-164	nse	*Antidesma acidum* Retz.	Euphorbiaceae	l	125	3	175	3	225	3
99-1-44	nsa	*Antidesma acidum* Retz.	Euphorbiaceae	l	130	3	175	3	220	3
99-42SE	nsa	*Aporusa dioica* (Roxb.) M.-A.	Euphorbiaceae	t	-	-	-	-	151	2
50SE	T	*Aporusa villosa* (Lindl.) Baill.	Euphorbiaceae	t	250	3	280	3	160	3
51SE /99-34	nsa	*Artocarpus gomezianus* Wall. *ex* Trec.	Moraceae	t	-	-	-	-	133	3
99-1-144	T	*Artocarpus gomezianus* Wall. *ex* Trec.	Moraceae	t	380	3	400	3	430	3
99-1-115	nsa	*Buddleja asiatica* Lour.	Loganiaceae	l	225	3	285	3	325	3
99-1-114	T	*Dalbergia discolor* Bl. *ex* Miq.	Leguminosae, Papilionoideae	t	305	3	345	3	405	3
46SE	T	*Dillenia pentagyna* Roxb.	Leguminosae, Papilionoideae	wc	377	3	427	3	492	3
36SE /99-1-163	T	*Erythrina suberosa* Roxb.	Leguminosae, Papilionoideae	t	240	3	325	3	415	3
99-36SE	nsa	*Eugenia albiflora* Duth. *ex* Kurz	Myrtaceae	t	-	-	-	-	173	3
Nla	nsa	*Firmiana colorata* (Roxb.) R. Br.	Sterculiaceae	t	-	-	-	-	132	2
49SE	T	*Garuga pinnata* Roxb.	Burseraceae	t	190		280	3	371	3
32SE	T	*Glochidion eriocarpum* Champ.	Euphorbiaceae	t	263	3	308	3	368	3
99-1-76	nse	*Glochidion sphaerogynum* (M.-A.) Kurz	Euphorbiaceae	t	-	-	-	-	110	3
99-41SE	nsa	*Glochidion sphaerogynum* (M.-A.) Kurz	Euphorbiaceae	t	-	-	-	-	226	3
99-1-235	T	*Helicia nilagirica* Bedd.	Proteaceae	t	215	3	265	3	310	3
99-40SE	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	l	-	-	-	-	298	3
99-1-172	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	l	195	3	265	3	330	3

99-1-151	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	l	295	3	370	3	440	3
99-1-146	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	l	370	3	468	3	535	3
99-1-150	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	l	300	3	360	3	420	3
30SE	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	l	390	3	475	3	544	3
99-1-61	T	*Melia toosendon* Sieb. & Zucc.	Meliaceae	t	540	3	720	3	900	3
99-1-157	T	*Melia toosendon* Sieb. & Zucc.	Meliaceae	t	550	3	720	3	840	
NLa /Near 99-1-59	T	*Phoebe lanceolata* (Nees) Nees	Lauraceae	t	-	-	-	-	230	3
NLa /Near 99-1-59	nsa	*Phoebe lanceolata* (Nees) Nees	Lauraceae	t	-	-	-	-	195	3
37SE	nsa	*Phylanthus emblica* L.	Euphorbiaceae	t	155	3	190	3	253	3
99-1-61	T	*Schima wallichii* (DC.) Korth.	Theaceae	t	265	3	325	3	405	3
99-1-80	nsa	*Wendlandia tinctoria* (Roxb.) DC. ssp. *floribunda* (Craib) Cowan	Rubiaceae	t	152	3	187	3	227	2.5

Remarks:

nsa = natural sapling
nse = natural seedling
T and t = tree
NF = Not found
NLa = No label

* = shoot broken
l = treelet
c = coppicing
SE = Stephen's number
v = vine

Appendix 11. Natural seedlings, saplings, and trees found in circle subplots and walking surveys in plot C98 in all 3 surveys.

A. Natural seedlings, saplings, and trees found in circle subplots in plot C98 in all 3 surveys.

No. of Circle	No. of Label	Note	Scientific Name	Family	Habit	1st Survey		2nd Survey		3rd Survey	
						Height (cm)	Health Score (0-3)	Height (cm)	Health Score (0-3)	Height (cm)	Health Score (0-3)
1	99-1-137	T	*Glochidion sphaerogynum* (M. -A.) Kurz	Euphorbiaceae	t	250	3	280	3	305	2.5
	99-1-170	nsa	*Eugenia albiflora* Duth. *ex* Kurz	Myrtaceae	t	140	3	185	3	210	3
	99-1-171	T	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	t	450	3	495	3	540	3
2	-	-	-	-	-	-	-	-	-	-	-
3	99-1-178	T	*Gmelina arborea* Roxb.	Verbenaceae	t	286	3	364	3	407	3
3	99-1-179	nsa	*Markhamia stipulata* (Wall.) Seem. *ex* K. Sch. var. *kerrii*	Bignoniaceae	t	144	3	179	3	200	3
4	99-1-180	T	*Sterculia villosa* Roxb.	Sterculiaceae	t	410	5	450	3	500	3
5	99-1-181	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	t	235	3	285	3	330	3
	99-1-182	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	t	240	3	298	3	330	3
6	99-1-183	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	t	350	3	400	3	420	2.5
7	-	-	-	-	-	-	-	-	-	-	-
8	99-1-185	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	t	375	3	420	3	480	3
	99-1-140	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	t	370	3	410	3	480	3
9	99-1-186	nsa	*Boehmeria chiangmaiensis* Yaha.	Urticaceae	t	180	3	240	3	295	2.5
	99-1-187	nsa	*Castanopsis armata* (Roxb.) Spach	Fagaceae	t	-	-	115	3	140	2
	NLa	nse	*Castanopsis armata* (Roxb.) Spach	Fagaceae	t	-	-	-	-	110	3
10	-	-	-	-		-	-	-	-	-	-

B. Natural seedlings, saplings, and trees found in walking surveys in plot C98 in all 3 surveys.

No. of Label	Note /No. Stem	Scientific Name	Family	Habit	1st Survey		2nd Survey		3rd Survey	
					Height (cm)	Health Score (0-3)	Height (cm)	Health Score (0-3)	Height (cm)	Health Score (0-3)
99-1-38	T	*Acacia megaladena* Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	195	3	230	3	260	3
99-1-134	T	*Acacia megaladena* Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	300	3	350	3	390	3
99-1-121	T	*Acacia megaladena* Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	310	3	350	3	390	3
99-1-129	T	*Acacia megaladena* Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	420	3	470	3	520	3
99-1-211	T	*Acacia megaladena* Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	450	3	485	3	525	3
99-1-206	T	*Acacia megaladena* Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	500	3	530	3	575	3
99-1-202	T	*Acacia megaladena* Desv. var. *megaladena*	Leguminosae, Mimosoideae	wc	375	3	410	3	470	3
99-1-128	T	*Albizia chiensis* (Osb.) Merr.	Leguminosae, Mimosoideae	t	250	3	310	3	360	3
99-1-209	T	*Albizia chiensis* (Osb.) Merr.	Leguminosae, Mimosoideae	t	230	3	260	3	310	3
99-1-208	T	*Albizia chiensis* (Osb.) Merr.	Leguminosae, Mimosoideae	t	410	3	450	3	510	3
99-1-130	T	*Albizia chiensis* (Osb.) Merr.	Leguminosae, Mimosoideae	t	280	3	310	3	330	3
99-1-133	T	*Albizia chiensis* (Osb.) Merr.	Leguminosae, Mimosoideae	t	400	3	420	3	460	3
22SE	T	*Albizia odoratissima* (L. f.) Bth.	Leguminosae, Mimosoideae	t	160	3	194	3	244	3
29SE	T	*Antidesma acidum* Retz.	Euphorbiaceae	l	295	3	345	3	405	3

99-1-219	T	*Callicarpa arborea* Roxb. var. *arborea*	Verbenaceae	t	610	3	680	3	800	3
99-45SE	nsa	*Cratoxylum formosum* (Jack) Dyer ssp. *Pruniflorum* (Kurz) Gog.	Guttiferae	t	-	-	-	-	175	3
99-1-210	nsa	*Dalbergia stipulacea* Roxb.	Leguminosae, Papilionoideae	wc	160	3	225	3	285	3
56SE	nsa	*Dillenia parviflora* Griff. Var. *kerrii* (Craib) Hoogl.	Dilleniaceae	t	NF	NF	NF	NF	198	3
99-1-225	T	*Dillenia parviflora* Griff. Var. *kerrii* (Craib) Hoogl.	Dilleniaceae	t	250	3	320	3	380	3
99-1-149	T	*Dillenia parviflora* Griff. Var. *kerrii* (Craib) Hoogl.	Dilleniaceae	t	350	3	410	3	480	3
99-1-142 /99-49SE	T	*Erythrina suberosa* Roxb.	Leguminosae	t	315	3	405	3	514	3
99-1-234	nsa	*Eugenia albiflora* Duth. *ex* Kurz	Myrtaceae	t	-	-	-	-	195	3
99-46SE	nsa	*Ficus hispida* L.f. var. *hispida*	Moraceae	l	-	-	-	-	174	3
99-1-235	nsa	*Glochidion sphaerogynum* (M.-A.) Kurz	Euphorbiaceae	t	-	-	-	-	165	3
99-52SE	nsa	*Glochidion sphaerogynum* (M.-A.) Kurz	Euphorbiaceae	t	-	-	-	-	159	3
99-1-213	nsa	*Glochidion sphaerogynum* (M.-A.) Kurz	Euphorbiaceae	t	290	3	347	3	407	3
99-1-133	nsa	*Glochidion sphaerogynum* (M.-A.) Kurz	Euphorbiaceae	t	220	3	250	3	290	3
99-50SE	nsa	*Gmelina arborea* Roxb.	Verbenaceae	t	-	-	-	-	112	2
99-1-122	nsa	*Gmelina arborea* Roxb.	Verbenaceae	t	190	3	240	3	310	3
99-1-120	T	*Gmelina arborea* Roxb.	Verbenaceae	t	320	3	395	3	465	3
99-1-204	T	*Gmelina arborea* Roxb.	Verbenaceae	t	370	3	445	3	510	3
99-47SE	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	l	-	-	-	-	241	3
28SE	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	l	170	3	244	3	354	3
21SE	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	l	130	3	180	3	246	3
61SE	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	l	210	3	290	3	391	3
99-1-141	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	l	220	3	295	3	380	3

26SE	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	l	260	3	352	3	438	3
17SE	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	l	300	3	395	3	492	3
20SE	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	l	280	3	364	3	459	3
99-1-162	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	l	220	3	285	3	360	2.5
60SE	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	l	380	3	490	3	620	3
23SE	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	l	287	3	360	3	452	3
15SE	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	l	310	3	400	3	482	3
25SE	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	l	350	3	435	3	540	3
99-1-131	nsa	*Litsea cubeba* (Lour.) Pers. var. *cubeba*	Lauraceae	l	375	3	440	3	530	3
99-57SE	nsa	*Markhamia stipulata* (Wall.) Seem. *ex* K. Sch. var. *kerrii*	Bignoniaceae	t	-	-	-	-	190	2
99-1-212	nsa	*Markhamia stipulata* (Wall.) Seem. *ex* K. Sch. var. *kerrii*	Bignoniaceae	t	205	3	255	3	320	3
99-1-203	nsa	*Markhamia stipulata* (Wall.) Seem. *ex* K. Sch. var. *kerrii*	Bignoniaceae	t	260	3	310	3	370	3
99-1-215	nsa	*Markhamia stipulata* (Wall.) Seem. *ex* K. Sch. var. *kerrii*	Bignoniaceae	t	295	3	330	3	395	3
99-1-235	nsa	*Maesa montana* A. DC.	Myrsinaceae	l	-	-	-	-	110	3
54SE	T	*Michelia baillonii* (Pireer) Hu	Magnoliaceae	t	340	3	385	3	448	3
99-48SE	nse	*Melia toosendan* Sieb. & Zucc.	Meliaceae	t	-	-	-	-	101	3
99-1-226	nsa	*Mussaenda parva* Wall. *ex* G. Don	Rubiaceae	v	220	3	250	3	300	3
14SE	nsa	*Phylanthus emblica* L.	Euphorbiaceae	t	195	3	250	3	297	3
99-1-205	T	*Schima wallichii* (DC.) Korth.	Theaceae	t	500	3	560	3	630	3
18SE	nsa	*Securinega virosa*(Roxb. *ex* Willd.) Baill.	Euphorbiaceae	t	165	3	235	3	293	3
99-1-218	nsa	*Turpinia pomifera* (Rosb.) Wall. *ex* DC.	Stachyleaceae	t	145	3	180	3	220	3
99-1-127	T	*Wendlandia tinctoria* (Roxb.) DC. ssp. *floribunda* (Craib) Cowan	Rubiaceae	t	290	3	345	3	405	3

Remarks:

* = shoot broken
L = treelet
C = coppicing
NF = not found
nsa = natural saplings
nse = natural seedlings
SE = Stephen's number
T and t = tree
v = vine

Appendix 12. Natural seedlings, saplings, and trees found in circle subplots and walking surveys in plot P97 in all 3 surveys.

A. Natural seedlings, saplings, and trees found in circle subplots in plot P97 in all 3 surveys.

No. of Circle	No. of Label	Note	Scientific Name	Family	Habit	1st Survey		2nd Survey		3rd Survey	
						Height (cm)	Health Score (0-3)	Height (cm)	Health Score (0-3)	Height (cm)	Health Score (0-3)
1	97-1-2/ P/V	T	*Prunus persica* (L.) Bat.	Rosaceae	t	262	3	280	3	310	2.5
	99-1-109	nsa	*Lagerstroemia speciosa* (L.) Pers. var . *speciosa*	Lythraceae	t	153	3	168	3	178	3
2	99-1-234	nse	*Albizia odoratissima* (L. f.) Bth.	Leguminosae, Mimosoideae	t	-	-	-	-	114	3
3	-	-	-	-	-	-	-	-	-	-	-
4	99-1-69	nsa	*Bridelia glauca* Bl.	Euphorbiaceae	t	-	-	190	3	230	3
5	-	-	-	-	-	-	-	-	-	-	-

B. Natural seedlings, saplings, and trees found in walking surveys in plot P97 in all 3 surveys.

No. of Label	Note /No. Stem	Scientific Name	Family	Habit	1st Survey		2nd Survey		3rd Survey	
					Height (cm)	Health Score (0-3)	Height (cm)	Health Score (0-3)	Height (cm)	Health Score (0-3)
99-1-238	T	*Buddleja asiatica* Lour.	Loganiaceae	l	190	2.5	265	3	327	3
99-1-239	P/V	*Prunus persica* (L.) Bat.	Rosaceae	t	350	2.5	380	3	410	2.5

Remarks:

c = coppicing
l = treelet
nsa = natural sapling
nse = natural seedling
P/V = planted by villagers
T and t = tree

Appendix 13. Natural seedlings, saplings, and trees found in circle subplots and walking surveys in plot C97 in all 3 surveys.

A. Natural seedlings, saplings, and trees found in circle subplots in plot C97 in 3 surveys.

No. of Circle	No. of Label	Note	Scientific Name	Family	Habit	1st Survey		2nd Survey		3rd Survey	
						Height (cm)	Health Score (0-3)	Height (cm)	Health Score (0-3)	Height (cm)	Health Score (0-3)
1	-	-	-	-	-	-	-	-	-	-	-
2	99-1-85	nsa	*Albizia odoratissima* (L. f.) Bth.	Leguminosae, Mimosoideae	t	107	3	130	3	160	3
3	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-

B. Natural seedlings, saplings, and trees found in walking surveys in plot C97 in all 3 surveys.

No. of Label	Note /No. Stem	Scientific Name	Family	Habit	1st Survey		2nd Survey		3rd Survey	
					Height (cm)	Health Score (0-3)	Height (cm)	Health Score (0-3)	Height (cm)	Health Score (0-3)
99-1-232	nsa	*Gmelina arborea* Roxb.	Verbenaceae	t	-	-	-	-	280	3
99-1-233	nsa	*Phoebe* sp.	Lauraceae	t	-	-	-	-	150	3
99-1-230	P/V	*Prunus persica* (L.) Bat.	Rosaceae	t	330	2.5	NF	NF	NF	NF
99-1-231	P/V	*Prunus persica* (L.) Bat.	Rosaceae	t	430	2.5	NF	NF	NF	NF

Remarks:

c = coppicing
l = treelet
nsa = natural sapling
nse = natural seedling

P/V = planted by villagers
T and t = tree

Appendix 14. List of planted tree species found in both plots P97 and P98 in all surveys.

No.	Botanical Name	Family
1	*Aphanamixis polystachya* (Wall.) R. Parker	Meliaceae
2	*Bischofia javanica* Bl.	Euphorbiaceae
3	*Bridelia glauca* Bl.	Euphorbiaceae
4	*Castanopsis acumminatissima* (Bl.) A. DC.	Fagaceae
5	*Cinnamomum iners* Reinw. *ex* Bl.	Lauraceae
6	*Diospyros glandulosa* Lace	Ebenaceae
7	*Erythrina subumbrans* (Hassk.) Merr.	Leguminosae, Papilionoideae
8	*Ficus altissima* Bl.	Moraceae
9	*Ficus benjamina* L. var. *benjamina*	Moraceae
10	*Ficus subulata* Bl. var. *subulata*	Moraceae
11	*Garcinia mckeaniana* Craib	Guttiferae
12	*Glochidion kerrii* Craib	Euphorbiaceae
13	*Gmelina arborea* Roxb.	Verbenaceae
14	*Helicia nilagirica* Bedd.	Proteaceae
15	*Heynea trijuga* Roxb. *ex* Sims	Meliaceae
16	*Horsfieldia amygdalina* Warb. var. *amygdalina*	Myristicaceae
17	*Horsfieldia thorelii* Lec.	Myristicaeae
18	*Hovenia dulcis* Thunb.	Rhamnaceae
19	*Manglietia garrettii* Craib	Magnoliaceae
20	*Markhamia stipulata* (Wall.) Seem. *ex* K. Sch. var. *kerrii* Sprague	Bignoniaceae
21	*Melia toosendan* Sieb. & Zucc.	Meliaceae
22	*Nyssa javanica* (Bl.) Wang.	Nyssaceae
23	*Phoebe lanceolata* (Nees) Nees	Lauraceae
24	*Prunus cerasoides* D. Don	Rosaceae
25	*Quercus kerrii* Craib var. *kerrii*	Fagaceae
26	*Quercus semiserrata* Roxb.	Fagaceae
27	*Sapindus rarak* DC.	Sapindaceae
28	*Sarcosperma arboreum* Bth.	Sapotaceae
29	*Spondias axillaris* Roxb.	Anacardiaceae

Appendix 15. List of planted tree species found in the plot P97.

No.	Species No.	Botanical Name	Family
1	12	*Ficus microcarpa* L.f. var. *microcarpa* forma *microcarpa*	Moraceae
2	13	*Sapindus rarak* DC.	Sapindaceae
3	18	*Hovenia dulcis* Thunb.	Rhamnaceae
4	39	*Ficus subulata* Bl. var. *subulata*	Moraceae
5	62	*Quercus semiserrata* Roxb.	Fagaceae
6	71	*Prunus cerasoides* D. Don	Rosaceae
7	78	*Gmelina arborea* Roxb.	Verbenaceae
8	101	*Phoebe lanceolata* (Nees) Nees	Lauraceae
9	157	*Heynea trijuga* Roxb. *ex* Sims	Meliaceae
10	179	*Glochidion kerrii* Craib	Euphorbiaceae
11	187	*Bridelia glauca* Bl.	Euphorbiaceae
12	204	*Markhamia stipulata* (Wall.) Seem. *ex* K. Sch. var. *kerrii* Sprague	Bignoniaceae
13	216	*Eriobtrya bengalensis* (Roxb.) Hk. f. forma *bengalensis*	Rosaceae
14	218	*Cinnamomum iners* Reinw. *ex* Bl.	Lauraceae

Appendix 16. List of planted tree species found in plot P98.

No.	Species No.	Botanical Name	Family
1	4	*Bischofia javanica* Bl.	Euphorbiaceae
2	5	*Melia toosendan* Sieb. & Zucc.	Meliaceae
3	7	*Manglietia garrettii* Craib	Magnonliaceae
4	12	*Diospyros glandulosa* Lace	Ebenaceae
5	13	*Sapindus rarak* DC.	Sapindaceae
6	18	*Hovenia dulcis* Thunb.	Rhamnaceae
7	60	*Aphanamixis polystachya* (Wall.) R. Parker	Meliaceae
8	62	*Quercus semiserrata* Roxb.	Fagaceae
9	66	*Spondias axillaris* Roxb.	Anacardiaceae
10	71	*Prunus cerasoides* D. Don	Rosaceae
11	72	*Ficus altissima* Bl.	Moraceae
12	78	*Gmelina arborea* Roxb.	Verbenaceae
13	101	*Phoebe lanceolata* (Nees) Nees	Lauraceae
14	104	*Helicia nilagirica* Bedd.	Proteaceae
15	105	*Sarcosperma arboreum* Bth.	Lauraceae
16	119	*Horsfieldia amygdalina* Warb. var. *amygdalina*	Myristicaceae
17	128	*Garcinia mckeaniana* Craib	Guttiferae
18	146	*Nyssa javanica* (Bl.) Wang.	Nyssaceae
19	157	*Heynea trijuga* Roxb. *ex* Sims	Meliaceae
20	236	*Horsfieldia thorelii* Lec.	Myristicaceae
21	309	*Quercus kerrii* Craib var. *kerrii*	Fagaceae
22	317	*Erythrina subumbrans* (Hassk.) Merr.	Leguminosae, Papilionoideae

Appendix 17. Planted tree species found in 5 subplots in plot P97 in all 3 surveys.

No. of Circle	No. of Label /Note	Scientific Name	Family	1st Survey		2nd Survey		3rd Survey	
				Height (cm)	Health Score (0-3)	Height (cm)	Health Score (0-3)	Height (cm)	Health Score (0-3)
1	97-71	*Prunus cerasoides* D. Don	Rosaceae	185	3	250	3	293	2.5
	97-179-X	*Glochidion kerrii* Craib	Euphorbiaceae	36	3	60	3	73	3
	97-187-110	*Bridelia glauca* Bl.	Euphorbiaceae	179	2.5	202	3	230	3
2	97-18-7	*Hovenia dulcis* Thunb.	Rhamnaceae	85	3	149	3	258	3
	97-18-X	*Hovenia dulcis* Thunb.	Rhamnaceae	165	3	235	3	293	3
	97-39-3	*Ficus subulata* Bl. var. *subulata*	Moraceae	160	3	209	3	220	3
	97-157-12	*Heynea trijuga* Roxb. *ex* Sims	Meliaceae	86	3	116	3	192	3
	97-157-14	*Heynea trijuga* Roxb. *ex* Sims	Meliaceae	106	3	139	3	207	3
	97-157-X	*Heynea trijuga* Roxb. *ex* Sims	Meliaceae	57	3	98	3	117	3
3	97-179-14 /99-1-89	*Glochidion kerrii* Craib	Euphorbiaceae	77	3	125	3	145	3
	97-204-12	*Markhamia stipulata* (Wall.) Seem. *ex* K. Sch. var. *kerrii* Sprague	Bignoniaceae	138	3	198	3	257	3
	99-1-125 /97-218-X	*Cinnamomum iners* Reinw. *ex* Bl.	Lauraceae	62	3	96	3	136	3
	97-62-1	*Quercus semiserrata* Roxb.	Fagaceae	43	3	51	3	NF	NF
4	97-78-X	*Gmelina arborea* Roxb.	Verbenaceae	236	3	360	3	410	3
	97-204-5	*Markhamia stipulata* (Wall.) Seem. *ex* K. Sch. var. *kerrii*	Bignoniaceae	-	-	169	3	315	3
	97-101-9	*Phoebe lanceolata* (Nees) Nees	Lauraceae	150	3	207	3	260	3
	97-101-7/D	*Phoebe lanceolata* (Nees) Nees	Lauraceae	-	-	-	-	-	-
	97-71-113	*Prunus cerasoides* D. Don	Rosaceae	437	3	480	3	510	3
5	97-216-19	*Castanopsis acumminatissima* (Bl.) A. DC.	Fagaceae	209	3	291	3	370	3
	97-13-11	*Sapindus rarak* DC.	Sapindaceae	270	3	326	3	393	3
	97-29-17	*Ficus benjamina* L. var. *benjamina*	Moraceae	239	3	292	3	220	2.5
	99-1-90	*Phoebe lanceolata* (Nees) Nees	Lauraceae	53	3	78	3	112	3

Remarks: D = died, NF = not found

Appendix 18. Planted tree species found in 10 subplots in plot P98 in all 3 surveys.

No. of Circle	No. of Label /Note	Scientific Name	Family	1st Survey		2nd Survey		3rd Survey	
				Height (cm)	Health Score (0-3)	Height (cm)	Health Score (0-3)	Height (cm)	Health Score (0-3)
1	62-9	*Quercus semiserrata* Roxb.	Fagaceae	83	2.5	137	2	157	1.5
	104-9	*Helicia nilagirica* Bedd.	Proteaceae	42	3	45	2.5	46	2
	13-9.	*Sapindus rarak* DC.	Sapindaceae	107	3	65	1	78	3
	71-17	*Prunus cerasoides* D. Don	Rosaceae	171	3	305	3	390	3
	123-12	*Aphanamixis polystachya* (Wall.) R. Parker	Meliaceae	50	3	55	2	64	3
2	7-X	*Manglietia garrettii* Craib	Magnoliaceae	NF	NF	NF	NF	147	3
	146-4	*Nyssa javanica* (Bl.) Wang.	Nyssaceae	74	3	100	3	NF	NF
	317-5	*Erythrina suberosa* Roxb.	Leguminosae, Papilionoideae	132	3	189	3	282	3
	13-X	*Sapindus rarak* DC.	Sapindaceae	37	3	40	3	65	3
	236-7	*Horsfieldia thorelii* Lec.	Myristicaeae	NF	NF	68	3	77	3
3	4-7.	*Bischofia javanica* Bl.	Euphorbiaceae	66	2.5	85	3	108	2.5
	12-29.	*Diospyros glandulosa* Lace	Ebenaceae	64	3	110	3	169	3
	128-16/D	*Garcinia mckeaniana* Craib	Guttiferae	-	-	-	-	-	-
4	4-25.	*Bischofia javanica* Bl.	Euphorbiaceae	83	3	115	3	150	3
	5-19.	*Melia toosendan* Sieb. & Zucc.	Meliaceae	210	3	610	3	920	3
	71-X	*Prunus cerasoides* D. Don	Rosaceae	123	1	185	3	204	1
	5-6.	*Melia toosendan* Sieb. & Zucc.	Meliaceae	250	3	560	3	740	3
	60-11/P	*Aphanamixis polystachya* (Wall.) R. Parker	Meliaceae	NF	NF	NF	NF	61	3
	60-4/D	*Aphanamixis polystachya* (Wall.) R. Parker	Meliaceae	-	-	-	-	-	-
	309-1	*Quercus kerrii* Craib var. *kerrii*	Fagaceae	74	3	NF	NF	NF	NF
5	101-6	*Phoebe lanceolata* (Nees) Nees	Lauraceae	43	3	52	3	88	3
	72-8	*Ficus altissima* Bl.	Moraceae	91	3	NF	NF	NF	NF
	157-8	*Heynea trijuga* Roxb. *ex* Sims	Meliaceae	82	3	96	3	90	3
	18-4.	*Hovenia dulcis* Thunb.	Rhamnaceae	161	3	198	3	236	2.5
	5-17.	*Melia toosendan* Sieb. & Zucc.	Meliaceae	480	3	530	3	760	3
	7-28.	*Manglietia garrettii* Craib	Magnoliaceae	82	3	156	3	242	3
	123-X	*Aphanamixis polystachya* (Wall.) R. Parker	Meliaceae	NF	NF	49	2.5	73	2
	105-X	*Sarcosperma arboreum* Bth.	Lauraceae	55	3	67	3	100	3

	236-X	*Horsfieldia thorelii* Lec.	Myristicaeae	61	3	66	3	78	3
6	123-10	*Aphanamixis polystachya* (Wall.) R. Parker	Meliaceae	31	3	34	2	37	3
	4-22.	*Bischofia javanica* Bl.	Euphorbiaceae	60	3	80	2.5	58	3
	105-27	*Sarcosperma arboreum* Bth.	Lauraceae	74	3	75	3	103	3
	123-3	*Aphanamixis polystachya* (Wall.) R. Parker	Meliaceae	34	3	43	2.5	48	3
	104-8	*Helicia nilagirica* Bedd.	Proteaceae	64	3	95	3	104	2.5
	104-16	*Helicia nilagirica* Bedd.	Proteaceae	59	3	75	3	85	2.5
	13-24	*Sapindus rarak* DC.	Sapindaceae	37	3	112	3	170	3
	4-11.	*Bischofia javanica* Bl.	Euphorbiaceae	NF	NF	82	2.5	122	2.5
7	104-30	*Helicia nilagirica* Bedd.	Proteaceae	46	3	50	3	52	2.5
	18-1.	*Hovenia dulcis* Thunb.	Rhamnaceae	126	3	245	3	252	2
	66-25	*Spondias axillaris* Roxb.	Anacardiaceae	124	3	247	3	345	2.5
	128-2/D	*Garcinia mckeaniana* Craib	Guttiferae	-	-	-	-	-	-
	18-2.	*Hovenia dulcis* Thunb.	Rhamnaceae	137	3	183	3	198	2.5
8	66-32	*Spondias axillaris* Roxb.	Anacardiaceae	129	3	215	3	340	3
	268-8	*Phoebe lanceolata* (Nees) Nees	Lauraceae	57	3	69	3	80	2
	18-14	*Hovenia dulcis* Thunb.	Rhamnaceae	142	3	188	3	252	3
	78-7	*Gmelina arborea* Roxb.	Verbenaceae	NF	NF	112	3	104	2.5
	62-19	*Quercus semiserrata* Roxb.	Fagaceae	59	3	91	3	127	3
9	119-4	*Horsfieldia amygdalina* Warb. var. *amygdalina*	Myristicaeae	40	3	47	3	52	3
	7-30.	*Manglietia garrettii* Craib	Magnoliaceae	79	2	136	3	188	3
	71-4	*Prunus cerasoides* D. Don	Rosaceae	148	2.5	133	3	260	3
	317-4	*Erythrina suberosa* Roxb.	Leguminosae, Papilionoideae	200	3	402	3	345	2
	12-19.	*Diospyros glandulosa* Lace	Ebenaceae	38	3	54	3	80	2.5
	72-9	*Ficus altissima* Bl.	Moraceae	27	3	51	3	73	3
	146-2/D	*Nyssa javanica* (Bl.) Wang.	Nyssaceae	-	-	-	-	-	-
10	128-15	*Garcinia mckeaniana* Craib	Guttiferae	27	3	30	3	36	3
	105-12	*Sarcosperma arboreum* Bth.	Sapotaceae	NF	NF	80	3	107	3
	78-15	*Gmelina arborea* Roxb.	Verbenaceae	NF	NF	NF	NF	148	3

Remarks: D = died, NF = not found

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