Propagation and transplanting of manau rattan *Calamus manan* in Bukit Duabelas National Park, Sumatra, Indonesia

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SUMMMARY

As one of the most commercially valuable and commonly used rattan palms in the furniture-making industry, populations of manau rattan *Calamus manan* have severely declined throughout their Southeast Asian range due to unsustainable harvest of wild plants, exacerbated by habitat loss due to deforestation. Surveys conducted in Sumatra in forest in 2003 and 2004 highlighted how rare the species had become. In March 2006, a total of 670 nursery-grown seedlings (1.5 and 2.5 years old) were planted out in formerly occupied areas of Bukit Duabelas National Park (Sumatra). Three sites were chosen representing three habitat types: hill forest, riverside forest, and a rubber *Hevea brasiliensis* plantation within a valley. Survival after 16 months was highest in the plantation (44%), followed by the hill forest site (33%) and riverside site (22%). Seedling growth (height increase) was somewhat variable but overall, was best for those planted in the plantation (average initial height 45 cm, increasing to 100 cm at 16 months). Longer term monitoring of survival and growth is required to assess if transplanting into the wild is a viable conservation management intervention.

BACKGROUND

Rattans (Palmae or Arecaceae) are climbing palms primarily of sub-tropical and tropical Asian forests. *Calamus* is the largest genus (around 400 species) and some are especially commercially important in the furniture-making industry. One such species is manau rattan *Calamus manan* (locally known in Indonesia as rotan manau) due to its valuable large-diameter cane or stem (up to 8 cm without sheaths) which can grow to 100 m in length. The stem is durable, has great strength and is very flexible. *C. manan* grows in hill dipterocarp forest from about 50 to 1,000 m altitude (Bin Muhammad 1994), and is widespread through southern Thailand, Malaysia, Sumatra and Kalimantan (Dransfield 1979, Dransfield *et. al.* 1989). However, despite this large range, it has been collected out by rattan hunters in many areas (Bin Muhammad 1994). This has resulted in severe population depletion hence its 'Vulnerable' designation (World Conservation Monitoring Centre 1997). As well as over-exploitation, habitat destruction and degradation are considered major reasons for declines (Baillie *et al*. 2004). Therefore, conservation action for the species was considered important to implement. Bogor Botanic Garden (60 km south of Jakarta, Java) is playing a crucial role in conserving native plant species of the region, and given the plight of *C.manan*, targeted this species as the focus of trials for a potential reintroduction/restocking programme.

Surveys in Bukit Duabelas National Park in 2003 of several previously known sites for *C.manan*, located only two mature individuals plus a few immatures and seedlings. Given its apparent population decline but presence of suitable forest habitat, the National Park was selected to conduct reintroduction trials.

ACTION

Study area: Bukit Duabelas National Park (69,500 ha; 50-438 m a.s.l.) in Jambi Province was established in 2000 under the Indonesian Minister of Forestry and Plantation decree No.258/Kpts-II/1992. Administratively the park lies in three Sumatran regencies: Sarolangun, BungoTebo and Batanghari. Temperatures range from 24 to 29ºC, with humidity between 72 to 100%. Soil are slightly acidic, pH ranging from 5.5 to 6.5 at the planting sites (Anon. 2003).

Field surveys: Surveys to assess population status of *C.manan* in the National Park were conducted over approximately 15 days in May and June (2003 and 2004) using random searches in suitable forest habitat at six sites (Anon. 2003, Mujahidin *et. al*. 2004) and within a 100 m x 10 m transect at one site (Table 1). All individuals located were catergorised according to one of three age classes: i) seedling (cane length < 3 m); ii) immature (cane length 3-15 m); mature (cane length > 15 m). Each was tagged (to prevent double counting). Ripe fruits were collected for nursery propagation purposes.

Propagation: At Bogor Botanic Garden (Java), collected rattan fruits were peeled to extract the seeds. Seeds were germinated (no pretreatment) by planting in a box (6 x 1 x 0.2 m deep) containing a washed sand substrate that was kept wet. Seedlings as they emerged were transplanted into polythene planting bags (15 x 20 cm) containing a mix of soil, compost, manure and rice husk in equal proportions (this mix previously shown to be successful for growing rattan seedlings). The bags were placed in a semi-shaded nursery area (about 60% ambient light intensity) and watered every day to ensure adequate moisture. Seedlings were transplanted after 1 year into slightly larger volume bags (20 x 25 cm).

Planting: In March 2006, a total of 670 nursery grown seedlings were planted in Bukit Duabelas National Park. February to September is the rainy season, thus March was considered an appropriate time for outplanting due to high soil water availability. Three sites were chosen to cover three habitat types: i) *hill forest* in Bukit Suban (01º54′53.8″S 102º32′05.7″E; 70 m a.s.l.); ii) *riverside forest* in Sungai Senamo Kecil (01º57′05.3″S 102º35′09.0″E; 70 m a.s.l.); and iii) *a valley* rubber *Hevea brasiliensis* plantation located in Singosari (01º56′44.8″ S 102º36′25.9″ E; 100 m a.s.l.). Of the 670 seedlings, 270 were planted in the hill forest, 200 in the riverside forest and 200 in the rubber plantation. All seedlings appeared in good condition at the time of planting. In each site, the chosen planting point was alongside an existing tree (*C. manan* needs structural support from a tree up which to grow). *C. manan* seedlings were planted an average distance of 6 m apart in a planting hole of about 30 cm diameter x 30 cm deep. Each seedling and supporting tree were tagged for monitoring purposes.

Monitoring: Monitoring was conducted in August 2006 (4 months after planting), November 2006, March 2007, and July 2007 (16 months after planting). Seedling survival was estimated from a sub-sample of 353 seedlings (116 in hill forest, 117 in riverside forest, and 120 in the rubber plantation). Three measurements of growth, height (from ground to tallest growing point), leaf length and width (first leaf from the base) were recorded.

Analysis: Pairwise comparisons of seedling survival among sites were performed using a log-rank test (Krebs 1999). Growth measurements (height, leaf length and width) were analyzed using Kruskal Wallis to evaluate whether any differences in these variables was related to planting site (Pavlovic & Grundel 2009). For this purpose, 38 individuals (hill forest), 31 individuals (riverside forest) and 50 individuals (rubber plantation) were sampled randomly; not all individuals were measured due to time constraints. Statistical analysis were performed using SPSS 15.0 for Windows (SPSS Inc., 2006).

CONSEQUENCES

Survey results: Surveys suggest that the surviving population of *C.manan* in Bukit Duabelas is small (Table 1). Only two mature reproductive individuals (one fuiting and one flowering) were located (both in 2003) plus 37 immatures and eight seedlings. In 2004 the flowering individual was found to have been cut and removed by a rattan collector (Anon. 2004). *C.manan* is a single cane rattan thus cutting the main stem kills the plant. Subsequently four mature individuals and 42 seedlings were found in the Sungai Bernay dan Sungai Mumpuy area of Bukit Duabelas.

Table 1. Number of individuals and age class of *Calamus manan* plants located at the seven survey sites in Bukit Duabelas National Park, 2003-2004.

Site	Search method	Number of plants	Age class
Bukit Panggang	random searches	13	immature
Bukit Punai Banyak	random searches	2 (1 cut in 2004)	mature
Timur		8	seedling
Bukit Suban	random searches	2	immature
Bukit Punai Banyak	random searches	13	immature
Selatan			
Air Panas	random searches	0	-
Bukit Teregang	random searches	9	immature
Sungai Bernay dan	transect	4	mature
Sungai Mumpuy		42	seedling

Propagation: In May 2003, 195 mature fruits were collected from the one adult fruiting rattan (4.2 cm in diameter, climbing up a *Lansium* sp. tree) located at Bukit Punai Banyak Timur (140 m a.s.l.). Due to the low number of fruits collected, additional fruits was obtained in 2004 from Baturraden (central Java) from cultivated *C.manan* individuals originating from Sumatra. In June 2003, seeds were extracted from fruits collected in the field in May and sown. These started to germinate in September 2003. Seeds from Baturraden were sown in August 2004 and started to germinate in September 2004. There was a difference in germination success between seed sources. Seeds collected in the field had 69.7% germination success while those from Baturraden had only 21.5% germination success. The seedlings were thus grown in the nursery for 1.5 and 2.5 years (when on average about 45 cm tall; seedling derived from seeds sown in June 2003 were a little taller than those sown in August 2004) before outplanting in the National Park in March 2006.

Survival: After 16 months, highest survival was found in the rubber plantation (44%), followed by the hill forest (33%) and riverside forest (22%) sites (Figs. 1 & 2). Based on survival analysis and pairwise comparison (log-rank test) however, the three sites exhibited no significant difference in survival trends ($\sum\chi^2$= 3.951, df = 2, p = 0.139) over the monitoring period. Causes of seedling mortality appeared to be similar at each site being primarily attributed to herbivory. Feeding signs (as identified by a local guide), suggested that porcupines *Hystrix* spp. had eaten some seedlings, and that insects (indicated by damaged leaves) were probably responsible for some losses. A few also died due to branch fall from surrounding trees. Unfortunately, there is no data regards mortality attributed to each cause. Despite lower germination success, it appeared that seedlings propagated from Baturraden survived better (31.0%) than those derived form seed collected in Bukit Duabelas (16.7%). This may have been attributable to age at planting, as the older (Bukit Duabelas) seedlings seemed more susceptible to stress when transplanting into the new environment due to suppressed root growth (over capacity within planting bags); good root growth is critical to the establishment of planted seedlings (Grossnickle 2005).

Growth: Of the three growth parameters recorded, the only one for which significant differences were recorded between sites were for height at 16 months (Kruskal Wallis Test, $p < 0.05$), as well as incremental height increase (Kruskal Wallis Test, $p < 0.05$). Leaf length and leaf width parameters were similar (Fig. 3). Best growth was achieved in the rubber plantation as indicated by higher average seedling height growth at 16 months after planting (average initial height 45 cm, increasing to 100 cm). In comparison rattans in the hill forest site averaged around 75 cm tall, and those in the riverside forest 85 cm.

Discussion and conclusions: These results provide evidence that *Calamus manan* is able to tolerate a fairly broad range of forest growing conditions and does not appear to have very specific microhabitat requirements. The growth rates recorded although not that high, were considered reasonable. For example, in Malaysia a growth rate of 0.3-3.0 m/yr was recorded for *C. manan* intercropped with rubber trees (Blazkova & Jenicek 2006). A lower probability of seedling survival in the wild (as opposed to the rubber plantation situation) is apparent from this study, reasons for this are unclear. Light intensity may

be a factor as this has been shown to influence popuations of some *Calamus* species. The abundance and site preferences of *Calamus exilis* and *C.zollingeri* were studied in primary forest in Sumatra and Sulawesi, respectively (Seibert 1993). Populations of *C. exilis* (number of plants and canes) were negatively related to high light intensities, whilst those of *C. zollingeri* were positively related to high light intensities (specifically associated forest canopy gaps). This may have implications on where best to plant immature *C. manum* plants.

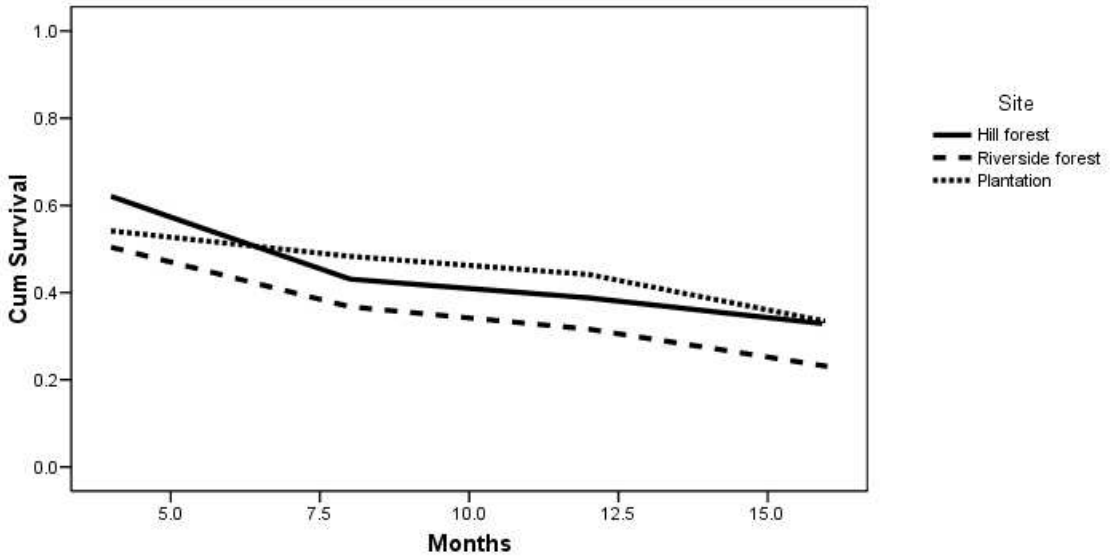

Figure 1. Survival of *Calamus manan* seedlings at each planting site in Bukit Duabelas National Park, over the 16 months monitoring period.

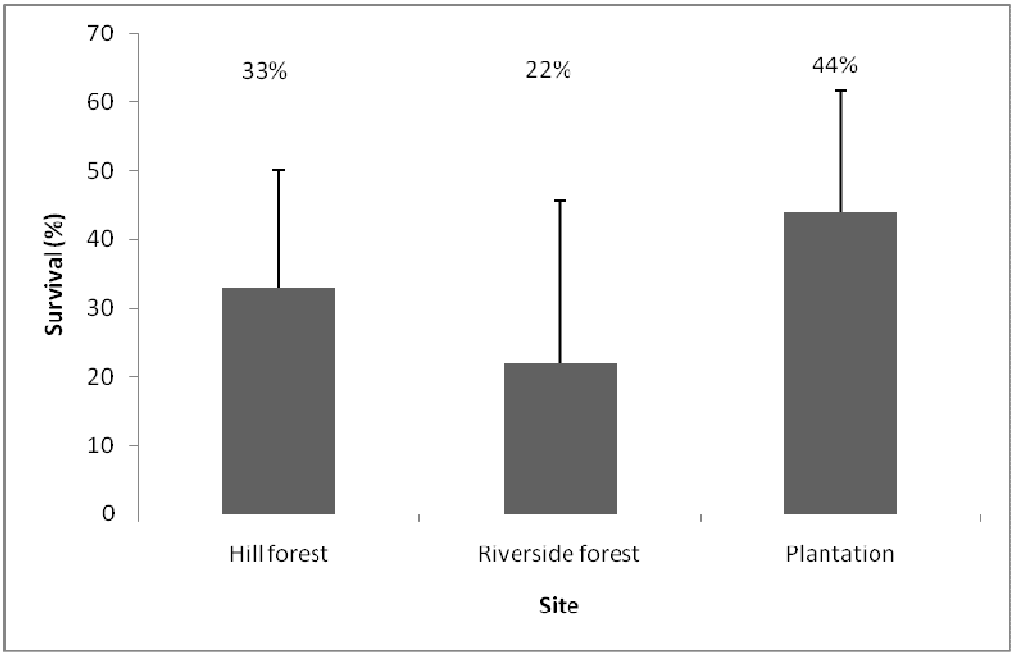

Figure 2. Percentage survival of *Calamus manan* seedlings (and SD) at each site 16 months after planting out.

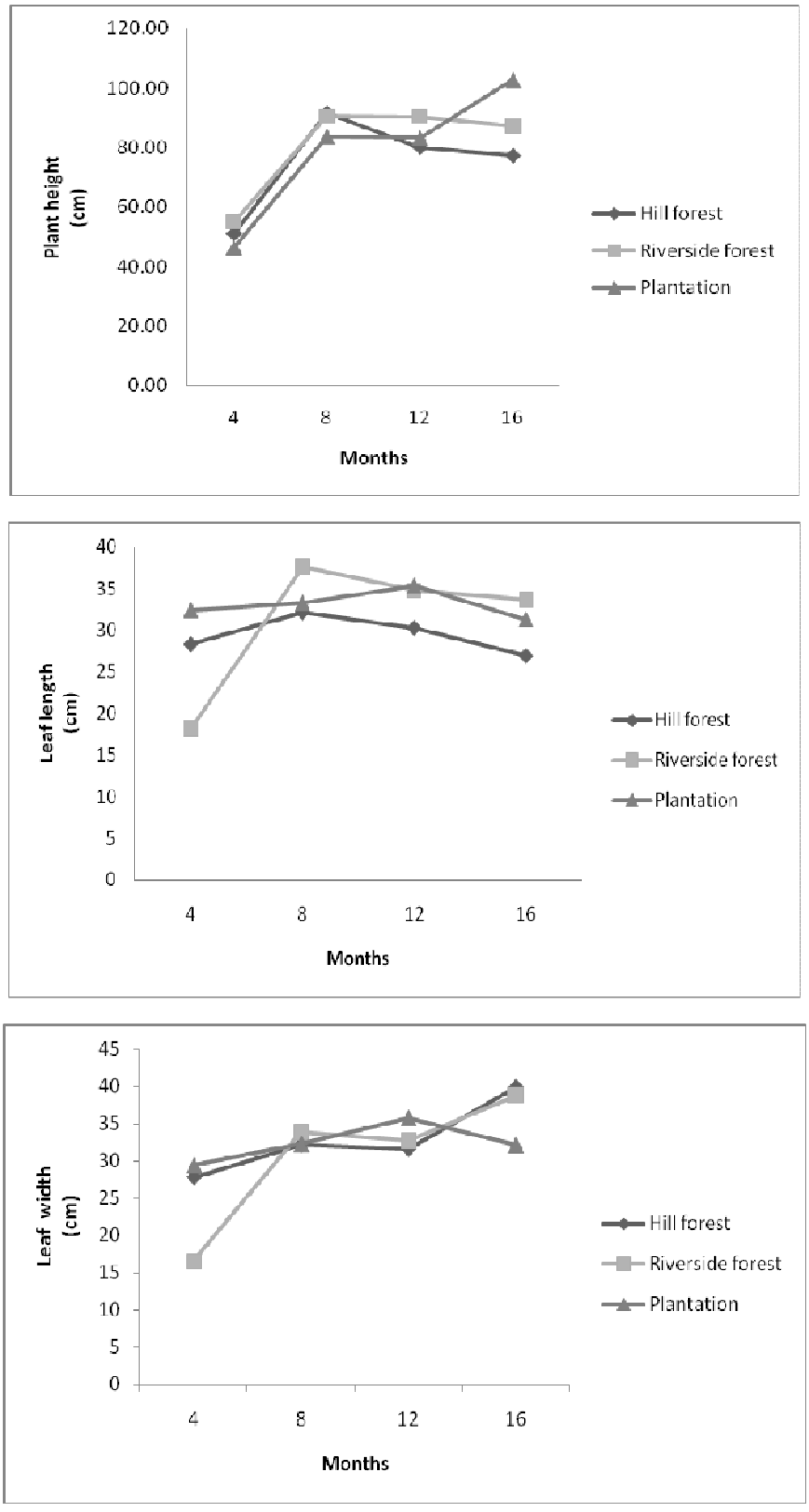

Figure 3. Mean plant height, leaf length and leaf width over 16 months observation at the three planting sites, in Bukit Dua Belas National Park, 2006-2007.

Further work is needed to determine better reintroduction/restocking techniques in order to improve survival. Maintainance of transplanted seedlings in the field during initial establishment e.g. by weeding, pruning of senescent/withered plant parts, or removing diseased parts is considered probably pertinent to enhance transplant success. The reintroduction of *C. manan* by planting of nursery grown seedlings into the wild is not easy to do (due in part to difficulty of access to remote sites) and is fairly labour intensive. However, it might represent a viable conservation option aimed at bolstering rattan populations at the local scale where the threat of unsustainable harvest is removed. Long term monitoring (of transplant survival and growth) is required to assess if transplanting into the wild is in fact, a viable conservation management intervention.

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