THE EFFECT OF ARTIFICIAL PERCHES AND LOCAL VEGETATION ON BIRD-DISPERSED SEED DEPOSITION INTO REGENERATING SITES

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ABSTRACT

Knowledge of the role of birds in natural regeneration could be used to accelerate and reduce the costs of forest restoration. The objectives of this study were to determine: (1) whether artificial bird perches placed in sites in various stages of natural and human-assisted regeneration could be used to increase seed deposition, and (2) which local vegetation features influence input of bird-dispersed seeds. The seed rain under perches on six plots located in two different sites in northern Thailand was examined. One site contained three naturally regenerating plots, ranging from nearly treeless and grass-dominated to > 25% shrub cover. The second site contained three, one-year old experimental forest restoration plots. The species richness and density of bird-dispersed seeds were significantly higher below perches than at control points at both sites. After seven months, seed input under the perches was greatest at a restoration plot that contained two fruiting trees, *Debregeasia longifolia* and *Clerodendrum glandulosum*, which were regularly visited by at least five bird species. However, the median input of bird-dispersed seeds was significantly higher on the three naturally regenerating plots (13.5 versus 0 seeds/trap). Total species richness of birds visiting perches was also higher on the naturally regenerating plots (15 versus 8 species). Although landscape variables have not been quantified, all of the naturally regenerating plots were closer to remaining forest patches compared to the restoration plots. Our preliminary results suggest that perches offer a useful technique for potentially increasing seed deposition by birds. Our circumstantial evidence also suggests that in the absence of nearby forest, the presence and specific characteristics of fruiting trees used for restoration plantations can have a significant impact on the ability of plantations to attract seed-dispersing birds.

INTRODUCTION

In Thailand, as in most other tropical countries, large-scale deforestation is a serious problem (FAO 1997). Currently, less than 20% of Thailand remains forested, compared with an estimate of 53% from the early 1960's (LEUNGARAMSRI and RAJESH 1992). Large-scale deforestation increases soil erosion, diminishes watershed quality, destroys wildlife habitat

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and interferes with rural development (LEUNGARAMSRI and RAJESH 1992). Without restoration efforts, denuded landscapes may remain in a stage of primary succession for an indefinite period (ROBINSON et al. 1992). One challenge to ecologists is to develop a cost-efficient means of restoring the original ecological function of such degraded areas.

While it is theoretically possible to replant large, deforested areas, current methods in Thailand are labour-intensive and expensive ($600 to $4700 US per hectare [S. ELLIOTT, *unpubl. data*]). Strategies that encourage natural regeneration could reduce the need for such plantings. Manipulating plant reproduction strategies and using pre-existing seed sources may also promote vegetation succession (DALAMACIO 1987, JENSEN and PFEIFER 1989, GOOSEM and TUCKER 1995). However, insufficient seed dispersal is a constraint to succession of degraded areas. Therefore, attracting seed-dispersing animals might accelerate natural regeneration (PICKETT 1982, ROBINSON et al. 1992, ROBINSON and HANDEL 1993).

While some plant species offer seed-dispersers fruit rewards, structural complexity of the vegetation is also an attractant (MCDONNELL and STILES 1983). ROBINSON and HANDEL'S (1993) studies of experimental plantations showed a positive correlation between vegetation height and the density of new seedling recruits, suggesting that fruit-eating birds are drawn towards taller plants in early successional habitats. This supports the finding, based on a study conducted in the north-eastern United States, that frugivorous birds using early successional fields prefer perches that are taller than the surrounding vegetation (MCDONNELL 1986).

In separate studies, MCCLANAHAN and WOLFE (1993) and MCDONNELL and STILES (1983) reported that forest birds use perches placed in unplanted, primary successional landscapes. In both investigations, the number of bird-dispersed seeds was significantly higher under perches than in control seed traps (in areas without perches). Similar results were also reported for Costa Rica (HOLL 1998). MCCLANAHAN and WOLFE demonstrated that the diversity of plant genera was also higher beneath perches. Their study went on to follow seedling recruitment beneath perches, which was double that of control areas.

Although erecting perches in deforested areas is likely to increase the input of bird dispersed seeds, frequencies of perch use by birds may also depend on characteristics of the local landscape. The number and species richness of birds visiting perches might vary with distance from reproductive trees, proximity to fruit rewards, amount of forest cover, or amount of human disturbance.

The goal of this study was to assess the potential influence of birds in the regeneration of forest in areas undergoing forest regeneration, either natural or human-assisted, in northern Thailand. Birds have the potential to assist forest restoration in this region because: (1) they are important seed dispersers in tropical forests (WUNDERLE 1997), including evergreen forests in Thailand (WONG 1992) and (2) as stated above, birds use natural or artificial perches in open fields and increase seed deposition beneath perches (MCCLANAHAN and WOLFE, 1993; MCDONNELL and STILES, 1983; MCDONNELL, 1986; HOLL, 1998). Specifically, we wanted to determine whether the deposition of bird-dispersed seeds from forest tree species could be enhanced in early successional fields, through the use of artificial bird perches. Secondly, we wanted to assess which structural characteristics of the vegetation may help or hinder input of bird dispersed seeds into regenerating areas.

STUDY AREA

This study was conducted at two deforested sites to compare the effects of perches on seed deposition at (1) a site where natural regeneration was being manipulated by planting saplings of a diverse mixture of indigenous forest tree species (Ban Mae Sa Mai) and (2) a site undergoing unassisted natural regeneration (Pah Dang). Ban Mae Sa Mai (BMSM) is a Hmong hill tribe community at the north end of Doi Suthep-Pui National Park, Chiang Mai Province (18° 52' N, 94° 51' E), approximately 1,207-1,310 m in elevation. The BMSM plots (1-3) were located on 40 m x 40 m sections of three, 0.64 hectare "framework species" plantations established by the Forest Restoration Research Unit (FORRU) in June of 1998 (see FORRU 1998, ELLIOTT *et al.* 2000 for additional site description and planting methods). Most of the 29 species of planted trees were between 0.5 and 2.5 meters tall at the start of the experiment in June 1999. The ground flora of all plots was mostly herbs particularly *Pteridium aquilinum* and composites, e.g. *Eupatorium* sp. The percent composition of these species changed seasonally and as a result of weeding for plantation maintenance. Planted plots were weeded every four to six weeks in the rainy season (June - October). Our observations also suggested that weeding reduced the density and species richness of birds (R. SCOTT and S. ELLIOTT, *unpubl. data*). All BMSM plots were protected by firebreaks and surrounded by either FORRU plantations or fields dominated by *Imperata cylindrica*, *Thysanolaena latifolia*, and *Pteridium aquilinum*.

Pah Dang (PD) is a Lahu hill tribe community approximately 30-km north of BMSM of similar elevation and forest type (Maxwell 1988, 1989). The PD plots (4-6) were in deforested areas approximately 1 to 2 km from the village. These plots were closer to the surrounding forest, i.e., degraded mixed evergreen/deciduous and hill-evergreen forest, than those at BMSM (P. PATTANAKAEW, *unpubl. data*), but the formal assessment has not been completed. Plot 4 was established in November of 1999 (later than the other plots because the original plot, established in May 1999, had to be moved due to a disagreement amongst the villagers). Approximately half of this site had been planted with corn and harvested in October 1999, just prior to plot establishment (see Table 2 for vegetation characteristics). Plot 5 was established in May 1999 in a recently (1-2 years) abandoned agricultural field dominated by *Thysanolaena*, *Imperata*, and *Phragmites vallatoria*. Plot 6 was established in May 1999 in a recently cleared (< 1 year) patch of bamboo forest. Bamboo, shrubs, and young or coppicing trees were slashed and burned just before the site was claimed for research. Vegetation structure of this plot was the most complex and bamboo grew to a height of over 3m before being cut back to 1m in November of 1999 (see Table 2).

METHODOLOGY

Plot construction

Within each site, plots were placed at least 400 meters from each other to ensure some habitat variation and some spatial independence in bird usage. All plots had 12 perches spaced 10 meters apart (3 rows x 4 columns) intermixed with control points without perches, such that within a row the distance between perches and control points was 5 m. Rows were 10 m apart. The total dimensions of each plot were 35 x 20 meters. Plots were designed with 6 treatments (four of which will not be discussed here): 1) perches with weeds removed, 2) perches with weeds present, 3) perches with seed traps, 4) control sites with weeds removed, 5) control sites with weeds present, and 6) control sites with seed traps. Three perches with seed traps on each plot were used to monitor seed dispersal directly. Three control traps per plot (without perches) were used for comparison.

Perch design

Perch construction was simple and inexpensive, using locally available materials. The main part of the perch consisted of one 3-m vertical bamboo pole, approximately 7 cm in diameter. In addition, two 0.8-m pieces of bamboo had been fitted through holes cut into the vertical pole, 0.30 m and 0.25 m below the top. These two pieces were placed at right angles to form four perpendicular "branches". The base of each perch was buried 0.5 m below ground for support. After placement in the ground, the "branches" were approximately 2.25 and 2.20 m above the ground and clearly visible above the surrounding vegetation for most of the year[1]. The top "branch" was pointed in a direction parallel with the long axis of the plot.

Seed-trap construction and seed collection

Seed-traps were circular, 1 meter in diameter, and built from 1.7-mm mesh, plastic netting secured to a wire frame. Four or more, 0.3-m high bamboo legs supported each trap. The main pole of the perch was fitted vertically through a small hole cut in the centre of the trap and the netting was then sewn tightly to the shaft such that seeds could not pass through. Traps of the same design were placed at points without perches. For each plot, seeds were collected on the same day from both control and perch seed-traps once per month. Collected seeds were placed either in alcohol for later identification, while a subset was germinated in the FORRU greenhouse to confirm identification. Species thought to have been dispersed by birds (either by being enclosed in bird faeces or by showing clear signs of digestive decomposition) were described.

Bird surveys

Observers were trained by conducting preliminary bird surveys of experimental plots and surrounding areas before the perch plots were established. Once surveys were initiated, bird species on all plots were surveyed once per month. Two plots were surveyed for 1.5 hours each per day, beginning 15 minutes after sunrise. Observers recorded all bird species and the number of individuals of each species on site, and the time each spent on perches. Because weather can significantly affect bird activity (HAMEL *et al.* 1996), counting was only done under acceptable weather conditions. Furthermore, since birds tend to be most active shortly after sunrise, the survey order was changed each day and each month to avoid time-activity biases.

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[1] Vegetation was cut back on plots 5 and 6 to keep perches visible.

Vegetation measurements

We measured vegetation features around and within plots that may have influenced seed dispersal. (However, because plot 4 had to be relocated, vegetation measurements have yet to be completed for this plot). We used simple counts of woody stems > 1 m in height, and used the BRAUN-BLANQUET (1951) scale to estimate the abundance and cover of lower vegetation. Measures included: (1) number of planted trees, (2) number of naturally established woody species > 1.0 m in height, (3) abundance naturally established woody species < 1.0 m in height, (4) cover and abundance of bamboo shrubs, (5) cover, abundance, and height of herbaceous ground flora, and (6) canopy cover of woody plants.

RESULTS

Seed rain

Fifteen perches and 15 controls were monitored between June 1999 and January 2000 with three additional perches and controls monitored between November 1999 and January 2000. A combined total of 1,598 bird-dispersed seeds from 29 species were found in all 36 traps, 1563 seeds under perches and 35 in controls. Twelve seed taxa have been positively identified to genus or species (Table 1). The remainder is awaiting final identification from ongoing germination trials. *Debregeasia longifolia* was the most common species found in the traps and accounted for 49.4% of all seeds. This species and most of those identified thus far, usually grow in open (partial canopy) mixed evergreen / deciduous forest, as well as in degraded forest (Table 1).

Due to the small number of sample points on each plot we pooled the data to compare seed deposition at perches with that at control points within the two sites (BMSM and PD) and among all plots combined. A median of 28.5 seeds and 3 species were found under perches, while a median of 0 seeds and 0 species were found in controls. These differences were large both within sites and among all plots combined. (At PD, Mann-Whitney U test $W = 119.5$, $P < 0.01$ for species, $W = 123$, $P < 0.01$ for seeds; at BMSM, test not possible when all values are zero and for all plots combined, $W = 449.5$, $P < 0.001$ for species, $W = 455.0$, $P < 0.001$ for seeds). The median input of bird-dispersed seeds for all traps combined (controls and perches) was significantly higher at the three naturally regenerating plots (PD), compared with the plantation plots (BMSM) (13.5 versus 0 seeds/trap, $W = 271.0$, $P = 0.05$).

Vegetation factors

The numbers of FORRU planted trees, unplanted trees/saplings and unplanted woody species, less than 1.0-meter-tall, varied among the BMSM plots, with the latter two highly variable at PD (see Table 2). After seven months of study, seed input under perches was greatest at BMSM plot 3 (613 seeds) which had two fruiting trees (*Debregeasia longifolia* and *Clerodendrum glandulosum*) growing naturally (not planted) on the site. These trees came into fruit in November and were regularly visited by Grey Bushchats (*Saxicola ferrea*), Sooty-headed Bulbuls (*Pycnonotus aurigaster*), Red-whiskered Bulbuls (*Pycnonotus jocosus*), Flavescent Bulbuls (*Pycnonotus flavescens*), and a Dusky Thrush (*Turdus naumanni*). The plot with the second highest seed input was at the naturally regenerating site (PD plot 4, 457 seeds). Although the vegetation of plot 4 has not been quantified, the number of woody stems was clearly less than at PD plot 6. Plot 6 had the largest number of naturally occurring woody stems > 1 m tall, particularly bamboo (Table 2). In addition 362 seeds were recorded there, including 34 seeds in the control traps. Plantation plots 1 and 2 had the lowest seed input (45 and 2 seeds respectively). Plot 2 had the smallest number of woody stems on the plot and the smallest number of large trees adjacent to the plot compared to the other BMSM plots (Table 2). Furthermore, no trees were observed fruiting during the study period in plot 2 (although there was no systematic method of recording which species were or were not fruiting). Although landscape variables were not quantified, all of the naturally regenerating plots were closer to remaining forest patches compared to the plantation plots.

Bird visitation

During 129 hours of observation, 125 observations of birds visiting perches (Table 3) were recorded. A total of 17 bird species visited perches, 15 at PD and eight at BMSM. The number of visits was higher at PD (96) than at BMSM (29). The species that visited the perches were largely insectivorous (LEKAGUL and ROUND, 1991, CORLETT 1998), but many of them were observed occasionally eating fruit or have been reported to do so in the literature (Table 3, CORLETT 1998). These bird species are tolerant of disturbance and generally forage in open habitats and degraded forests (LEKAGUL and ROUND 1991).

DISCUSSION

Although not all of the seed-dispersing bird community is likely to use perches, preliminary results suggest that perches increase seed deposition in restoration sites. It is clear from this study, as well as previously cited studies, that birds do not disperse seed randomly. Approximately 45 times more seeds were deposited under perches than in the controls. Naturally regenerating sites (PD) had greater bird density and bird species richness than the plantation sites (BMSM), presumably because the remaining forest patches were closer to the plots at PD than BMSM. These patches of forest probably offer complex habitat, and therefore more food and nest resources, as well as cover for birds than are currently available in young plantations, particularly when plantation vegetation structure is simplified through weed removal.

Table 1. Species and numbers of bird-dispersed seeds found under perches and in controls at both study sites ordered by total number of seeds (see text for site descriptions). The number of unidentified species is 8 for BMSM, 7 for PD perches and 2 for PD controls.

Family	Species	Growth form[1]	Location[2]	BMSM Perch	BMSM Control	PD Perch	PD Control	Total Seeds / species
Euphorbiaceae	*Antidesma acidum* Retz.	S, T	F	26	0	52	7	85
Euphorbiaceae	*Antidesma bunius* (L.) Spreng	S, T	F, C	3	0	0	0	3
Euphorbiaceae	*Antidesma sootepense* Craib	T	F	0	0	24	10	34
Cyperaceae	*Carex baccans* Nees	H	O	10	0	0	0	10
Verbenaceae	*Clerodendrum glandulosum* Colebr. ex Lindl.	S	F, O	23	0	0	0	23
Urticaceae	*Debregeasia longifolia* (Burm. f.) Mett. ex Khun	S	F, O	520	0	270	0	790
Myrsinaceae	*Embelia sessiliflora* Kurz	V	F, O	0	0	1	0	1
Myrsinaceae	*Embelia subcoriacea* (Cl.) Mez	V	F, O	0	0	1	0	1
Moraceae	*Ficus* sp.	T	F?	1	0	39	0	40
Lauraceae	*Litsea cubeba* (Lour.) Pers.	T	F, O	6	0	0	0	6
Curcubitaceae	*Mukia maderspatana* (L.) M. J. Roem	V	O, C	0	0	393	0	393
Solanaceae	*Solanum nigrum* L.	S	O, C	50	0	107	11	168
Unidentified				21	0	16	7	44
	Total Seeds / Treatment			660	0	903	35	1598

[1] Growth form: H, herb; S, shrub, T, tree; V, vine.
[2] Location where a species is found: O, open degraded forest; F, forest; C, cultivated. (from MAXWELL 1988, 1989)

Table 2. Vegetation characteristics of 5 of the 6 study plots[1]. Estimations of naturally established woody shrubs < 1.0 m, bamboo, and herbaceous coverage are indicated by Braun-Blanquet Total Estimate Score.

	BMSM 1	BMSM 2	BMSM 3	PD 5	PD 6
No. of planted trees	183	143	159	0	0
No. of wild woody species > 1.0 m	56	17	18	10	76
Total woody species > 1.0 m	239	160	177	10	76
Naturally established woody species < 1.0 m	plentiful, but coverage small	plentiful, but coverage small	plentiful, but coverage small to 5%	scarcely present	covering 26 - 50 % of plot
Adjacent forest type	none[2]	none	none	bamboo forest bordering one edge	secondary mixed evergreen/deciduous forest bordering one edge
Bamboo shrub cover	none	none	none	none	covering 26-50% of plot
Grass cover & height	covering 6-25%, < 1.0 m high	covering 5-6%, < 1.0 m high	covering 5-6%, < 1.0 m high	76-100% coverage, 1-2 m high	scarcely present, 1-2 m high
Canopy cover (%)	6.25	0	0	0	37.5

[1] Plot PD 4 not yet surveyed.

[2] Plots 1-3 did have 5, 2, and 4 large (> 25 m in height) trees respectively, approximately 100 m from their borders. Some of these appeared to be common perching / roosting areas for birds (R. SCOTT, pers. obs.).

Table 3. Number of bird visits to perches per hour during 129 hours of observation (72 hours BMSM, 57 hours PD) listed from most to least frequent visits[1].

				Visits/ hour	
Scientific Name	Common Name	Diet	Habitat	BMSM	PD
Saxicola ferrea	Grey Bushchat	I, F	O	0.11	1.05
Prinia hodgsonii	Grey-breasted Prinia	I	O	0.14	0.14
Pycnonotus aurigaster	Sooty-headed Bulbul	F	F, O	0.01	0.14
Anthus hodgsonii	Olive-backed Pipet	I	O	0.03	0.09
Saxicola caprata	Pied Bushchat	I, F?	O	0.06	0
Pycnonotus jocosus	Red-whiskered Bulbul	F	F, O	0.03	0.02
Pomatorhinus schisticeps	White-browed Scimitar-Babbler	I, F?	F, O	0	0.05
Muscicapa dauurica	Asian Brown Flycatcher	I	O	0.01	0.02
Emberiza rutila	Chestnut Bunting	G	F, O	0	0.04
Lanius cristatus	Brown Shrike	I, F?	O	0	0.04
Cyornis banyumas	Hill Blue Flycatcher	I, F?	F, O	0	0.02
Lanius schach	Long-tailed Shrike	I, F?	O	0	0.02
Macronous gularis	Striped Tit-Babbler	I, F?	F, O	0	0.02
Phylloscopus inornatus	Inornate Warbler	I, F?	F, O	0	0.02
Timalia pileata	Chestnut-capped Babbler	I, F?	F, O	0	0.02
Chrysomma sinense	Yellow-eyed Babbler	I	O	0.01	0
Muscicapidae	Unidentified Flycatcher	?		0	0.02

[1] Dietary preferences are listed based on direct observation and CORLETT (1998). Species names and habitat preferences are based on Lekagul and ROUND (1991).

Furthermore, preliminary analyses of other bird survey data suggest that bird density and richness were lower in the planted plots compared to adjacent, unplanted (and non-weeded) areas. However, bird density, richness, and diversity of these adjacent areas of BMSM have yet to be compared with the PD plots.

In summary, these tentative results suggest that in the absence of nearby forest, the presence of fruiting trees on restoration plantations can have a significant impact on the ability of these plantations to attract seed-dispersing birds. However, the vegetation structure of the plot itself, including the density of trees, appears to have a limited influence on seed deposition compared to the presence of fruiting trees and the presence of nearby forest patches. However, greater study is needed to determine the spatial scale at which these factors operate. In addition, the reasons for the large differences among plots remains circumstantial at best until we have quantified the vegetation surrounding the plots and conducted a more complete study of the fruiting phenology of nearby trees.

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