

Tree Population Dynamics Of *Shorea spp* in a Primary Lowland Dipterocarp Forest at Pasoh, Peninsular Malaysia

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Abstract

The analysis focused on the tree population dynamics of selected *Shorea spp* from large demography 50 ha plot of a primary lowland dipterocarp forests. Ten *Shorea spp* (*Shorea acuminata*, *S. bracteolata*, *S. guiso*, *S. leprosula*, *S. lepidota*, *S. macroptera*, *S. maxwelliana*, *S. ovalis*, *S. parvifolia* and *S. pauciflora*, with individuals more than 500 trees were selected for the analysis covering over four census period, 1st- 1987 to 1990, 2nd -1990-1995, 3rd – 1995-2000, 4th – 2000-2005. The tree population dynamic parameter response over the census periods varies among the species. *S. leprosula* exhibited the highest dbh growth rate, mortality rate and recruitment rate, while *S. parvifolia* showed highest population change rate. In general dbh growth rate is increasing in the 4th census for most *Shorea spp*, although they showed a decreasing trend in the first three census period. A general increase in mortality rate among *Shorea spp* was also observed over the four census periods. The fluctuation in the recruitment rate between census periods could be attributed to the fruiting seasonality of mass fruiting that occurs during the period of assessment. The study supports strong justification for long-term studies on population dynamics belong-term census periods to understand their response pattern and variation among the species.

Key Word: population dynamics, dipterocarps, lowland, *Shorea*

Introduction

Basic demographic information on population abundance and change, growth increment, mortality and recruitment based on sufficient data is required to understand the growth behavior of the species. In 1985, a 50 ha large demography plot was established in a lowland dipterocarp forest of Peninsular Malaysia for the purpose of among others gathering this information on dynamics and diversity of tropical forest. Since then, five more censuses have been completed in 1990, 1995, 2000, 2005 and 2010 for all trees 1 cm dbh and above measured. The plot provides substantial data base on demographic patterns for many important commercial species. This paper presents the population dynamics of *Shorea spp* from large scale demography plot of 50 ha and also a long-term ecological research sites in Peninsular Malaysia

Methodology

The study site is located at Pasoh Forest Reserve in Peninsular Malaysia. The vegetation is primary rain forest and falls within the south-central subtype of the "Red Meranti- Keruing' forest sub-type of Wyatt-Smith (1987). The upper canopy is dominated by red meranti, *Shorea* section Muticae, especially *S. leprosula*, *S.*

acuminata and *S. macroptera*. Other important canopy emergents are keruing (*Dipterocarpus cornutus*), balau (*Shorea maxwelliana*) and chengal (*Neobalanocarpus heimii*) (Manokaran et al. 1992).

All free-standing trees greater than 10 mm dbh were measured at 1.3 m above ground and identified to species level. We used five census data to describe the population dynamics. The advantage of large plots is that sufficient individual is obtainable in almost all size class. We limit the analysis to those with more than 500 individuals only. The focus of this analysis is the *Shorea* spp: *S. acuminata* (SHORAC), *S. bracteolata* (SHORBR), *S. guiso* (SHORGU), *S. leprosula* (SHORL1), *S. lepidota* (SHORL2), *S. macroptera* (SHORM1), *S. maxwelliana* (SHORM2), *S. ovalis* (SHOROV), *S. parvifolia* (SHORP1) and *S. pauciflora* (SHORP2).

We calculated the population abundance and change, growth rate, mortality rate and recruitment of *Shorea* spp in the 50 ha plot based on 5 measurements 1987, 1990, 1995, 2000 and 2005. The individual growth rates are presented as absolute value. Abundance of trees for both censuses was taken as number of all surviving trees at each census. The absolute growth rates is the difference of diameter between the two census divided by mean interval time of the quadrants. Mortality is taken as trees that died in the second census. Annual recruitment rates were calculated similar to mortality rates. It required two complete datasets, one per census with date for every individual of trees in the first and second census. Recruitments were defined as the as the trees found in the minimum dbh limits of the second census but absent in the first census. The date of census in each 20x20m quadrant of the plot was used to calculate the mean interval time between censuses. The four measurement periods considered in the analysis were 1987-1990, 1990-1995, 1995-2000 and 2000-2005. All trees above 10 mm dbh were considered.

All analysis was conducted using R open-source statistical software (R Core Team, 2013) and *CTFS R* package. The graphical visualization was created using *googelVis R* package.

Results and Discussion

Overall Performance of the Tree Population Structure and Dynamics

The mean values of the four census period of the tree population dynamic parameters are summarised in Table 1. Among the *Shorea* spp, *S. maxwelliana* exhibited the highest average number of individuals throughout the four censuses with 5830 individuals. Most of the *Shorea* spp showed negative population change rate with *S. parvifolia* exhibited the highest decreasing values. *S. leprosula* showed the highest dbh growth rate, mortality rate as well as recruitment rate as compared to other *Shorea* spp. Three *Shorea* spp namely *S. guiso*, *S. maxwelliana* and *S. pauciflora* showed lower mortality rate than the recruitment rate and they also performed poorly in term of dbh growth as compared to other *Shorea* spp.

Population Change Rate

The population change rate among the *Shorea* spp indicated increasing trend at the 4th census period, with the highest value shown by *S. leprosula*, followed by *S. lepidota* and *S. pauciflora*, although there were marked decreasing trend in the three

previous census periods. Most of the *Shorea spp* showed an increasing trend from 1st to 2nd period but decreasing in the 3rd period, but bounce again in the 4th period. *S. bracteolata*, however behaved differently, whereby a modest decreasing trend over the four census periods. In general, the trend of population change rate is not consistent for many *Shorea spp*, and may change due to circumstances such as recruitment of trees into the minimum size class or reduction in density due to anthropogenic (e.g. animal (Rain, 2001)) or natural (tree fall from windthrow) disturbances during the census period (Figure 1).

Table 1: Tree population dynamic of *Shorea spp* in Pasoh 50 ha demography plot based. All values are mean of four census period.

Species code	Average number of trees	Population change rate (% yr ⁻¹)	Dbh growth rate (mm yr ⁻¹)	Mortality rate per year	Recruitment rate per year	Mean dbh (mm)
SHORAC	1898	-0.026	1.625	0.047	0.027	67.4
SHORBR	993	-0.026	1.642	0.035	0.023	60.2
SHORGU	716	-0.003	1.036	0.019	0.027	35.0
SHORL1	2358	-0.016	3.397	0.090	0.082	85.7
SHORL2	915	-0.026	2.595	0.063	0.045	113.1
SHORM1	1467	-0.019	1.365	0.034	0.023	60.7
SHORM2	5830	0.002	0.923	0.017	0.026	50.7
SHOROV	1138	-0.026	1.765	0.042	0.025	60.4
SHORP1	1298	-0.051	2.618	0.072	0.030	85.8
SHORP2	2336	0.000	1.353	0.031	0.038	58.3

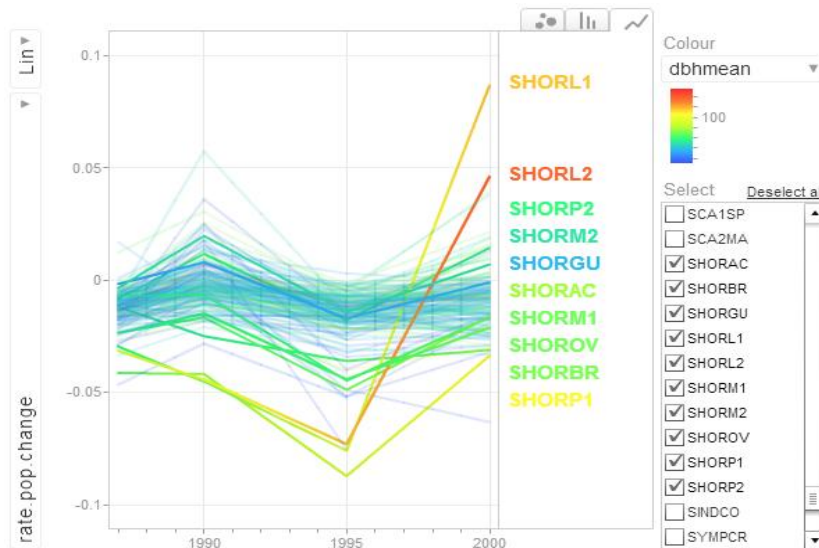


Figure 1 : Population change of *Shorea spp* in 50 ha demography plot at Pasoh Research Forest at different measurement periods. Details of species code was mentioned earlier. dbhmean: Abundance color code where red is the highest mean dbh of the tree species population

Mortality Rate

All *Shorea spp* showed an increasing mortality rate over the four census periods (Figure 2), except for *S. lepidota* which showed a slight decrease in the 4th census period. *S. leprosula* exhibited a consistently highest mortality across the census periods, followed by *S. parvifolia* and *S. lepidota*. The mortality rate range among the *Shorea spp* seemed to be increasing over the census periods. In the 1st census period the range is between 0.009 for *S. guiso* and 0.061 for *S. leprosula*, while in the 4th census period, the range widens with the lowest mortality rate at 0.024 for *S. maxwelliana* to 0.112 for *S. leprosula*.

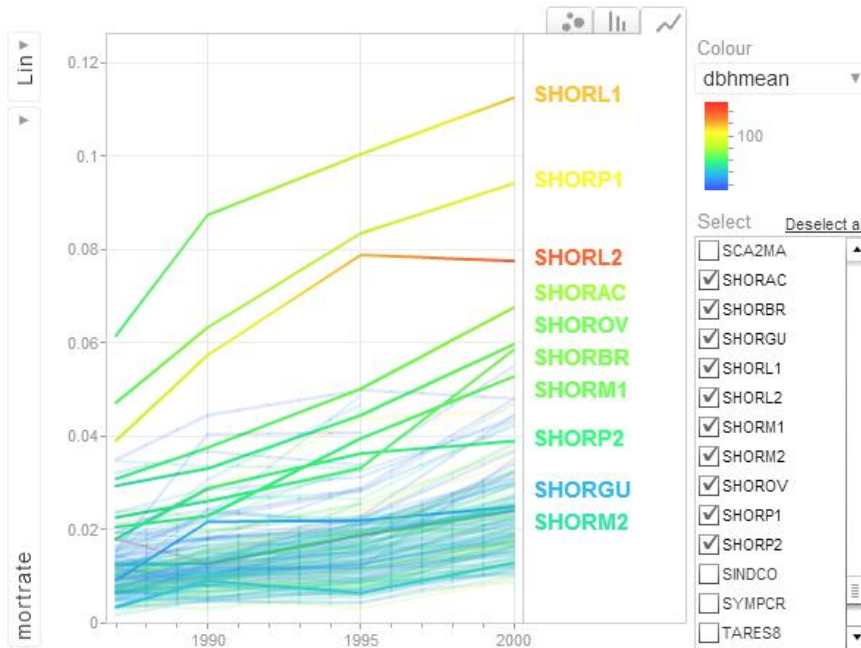


Figure 2: Mortality rate of *Shorea spp* in 50 ha demography plot at Pasoh Research Forest at different measurement periods. Details of species code was mentioned earlier. dbhmean: Abundance color code where red is the highest mean dbh of the tree species population

Dbh Growth Rate

In many cases, the dbh growth rate of the *Shorea spp* showed a decreasing trend from the 1st to the 3rd census period, but in the 4th period the the growth rate increases with the highest value showed by *S. leprosula*, *S. parvifolia* and *S. lepidota*. *S. guiso* and *S. maxwelliana* showed the lowest growth rate at 0.97 and 0.86 mm yr⁻¹ (Figure 3). The dbh growth rate of these species seemed to be associated with its higher wood specific gravity as compared to other *Shorea spp*.

Recruitment Rate

In general most of the *Shorea spp* showed an increased in the recruitment rate from the 1st to 2nd census period, but decreasing in the 3rd but subsequently increasing with greater range among species in the 4th census period (Figure 4). *S. leprosula* showed a marked increase in the recruitment rate from the 3rd to the 4th census period, followed by *S. lepidota*.

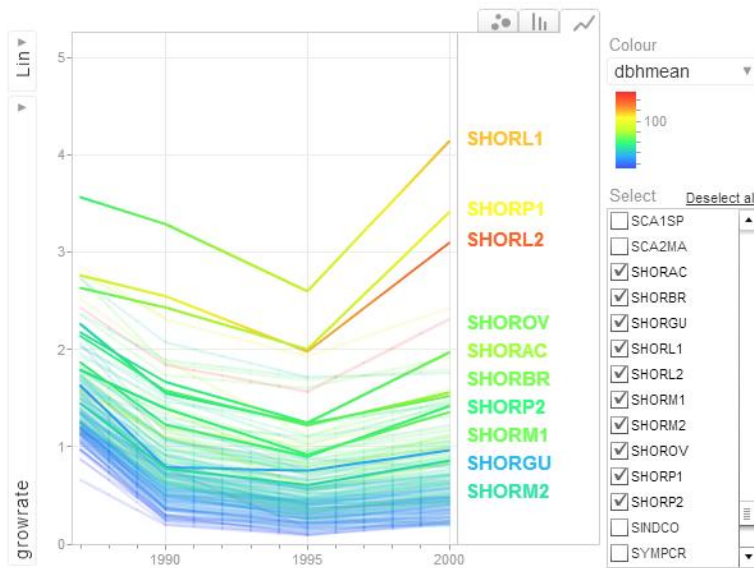


Figure 3: DBH growth rate (cm yr^{-1}) of dipterocarps in 50 ha demography plot at Pasoh Research Forest at different measurement periods. Details of species code was mentioned earlier. dbhmean: Abundance color code where red is the highest mean dbh of the tree species population

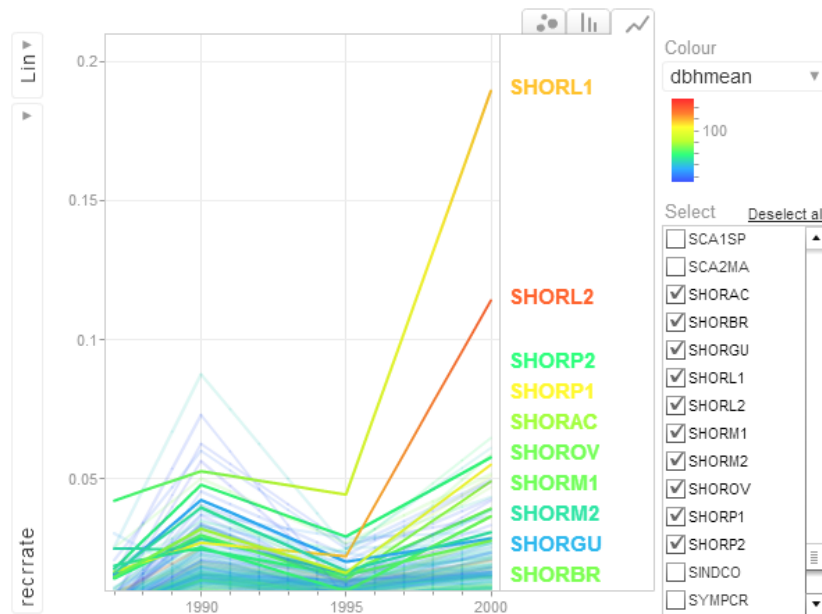


Figure 4: Recruitment rate (stem yr^{-1}) of dipterocarps trees greater than 1 cm dbh in 50 ha demography plot at Pasoh Research Forest at different measurement periods. Details of species code was mentioned earlier. dbhmean: Abundance color code where red is the highest mean dbh of the tree species population

Conclusion

Although all species assessed are from the same genus, their tree population dynamic response magnitude and trend do varies to a certain extent. A general increase in mortality rate among *Shorea spp* were observed over the four census periods. The fluctuation in the recruitment rate between census periods could be

attributed to the fruiting event that occurs during the period of assessment. The study supports strong justification for long-term studies on population dynamics to understand their response pattern and variation among the species.

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