Fellowship report

Population dynamics of commercial tree species after selective logging in Myanmar

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Marked: A forest worker demarcates an experimental plot at the study site. *Photo: R. Newin*

The moist deciduous forests in the Bago Mountains of Myanmar have the best growth rates and highest stockings of teak (*Tectona grandis*) of any forest in the country (Kermode 1964). The Bago Mountain forests, including the Kabaung Reserved Forest, comprise 11.3% of the country's total teak-bearing forests (Aung Thant Zin 2000). Natural teak-bearing forests are Myanmar's primary source of forest products, and the extraction of teak and other commercial hardwood species is a major source of foreign exchange revenue.

The recruitment of tree regeneration is a critical step in securing sustained wood production in naturally managed tropical forests. Selective logging is one of the main silvicultural practices in Myanmar, and a detailed understanding of regeneration following selective logging is therefore important for sustainability. However, there is a lack of empirical studies on the impacts of logging on forest stands and tree regeneration in the Kabaung Reserved Forest. This study, which was conducted with the assistance of an ITTO fellowship grant, was designed to help fill this gap.

Objectives and study site

The study had two objectives: to determine stand structure after selective logging; and to evaluate the effect of selective logging on tree regeneration.

The Bago Mountains are located near the townships of Taungoo and Oktwin in Taungoo District in the southern part of Myanmar's central basin at approximately 18°50'–19°09'N and 95°50'–96°12'E . Natural teak-bearing forests in the Bago Mountains have been managed under the Myanmar Selection System (MSS) since 1856 (Ko Ko Gyi and Kyaw Tint 1995), and the MSS is still the main regime used for managing natural teak-bearing forests. Under the MSS, the felling cycle is 30 years, and the minimum exploitable diameters at breast height (dbh) are 73 cm in moist forests and 63 cm in dry forests. Various tending operations are carried out to help restore the forests prior to the start of the next harvest cycle. The goal of this system is to sustainably harvest teak-bearing forests every 30 years.

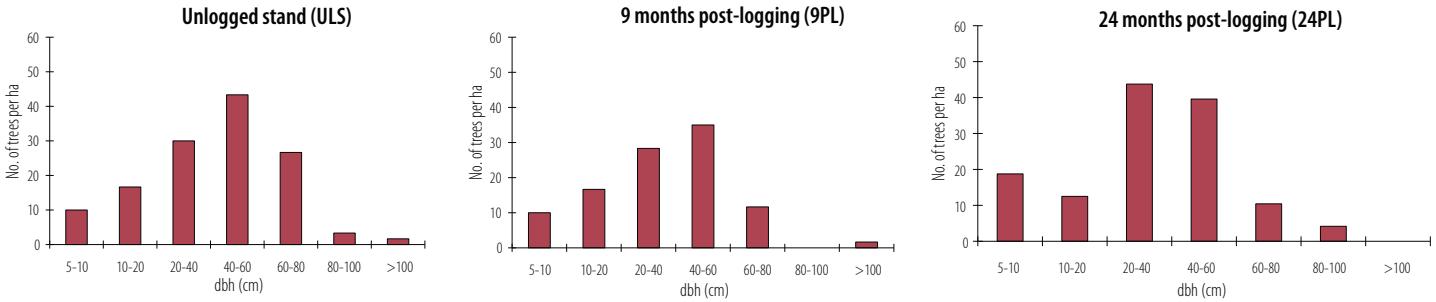
Study species

Two species were studied. Teak is Myanmar's most important species in terms of timber production and plantation development programs. It is recognized as a light-demanding species (Troup 1921), and it is resistant to fire. Pyinkado (*Xylia xylocarpa*), also known as Myanmar ironwood, is a shade-tolerant species, particularly at young stages of its lifecycle; it is a natural associate of teak but is not fire-resistant. Pyinkado is a popular commercial species because of its strength, durability and relative abundance (Thant Shin 2006). It is one of the most sought-after species in Myanmar for house and bridge construction and for railway sleepers.

Materials and methods

One sample plot (60 m x 80 m) was established in each of the following in the Kabaung Reserved Forest: an unlogged stand (ULS); a stand nine months after logging (9PL); and a stand 24 months after logging (24PL). Each of these plots was divided into twelve 20 m x 20 m subplots. In each subplot, all living trees with height ≥ 1.3 m were tagged and identified and their stem dbh was measured; shoots (<1.3 m height) were counted and tagged and their diameter and height measured. Four canopy photos using a fisheye

Figure 1: Structure of logged and unlogged stands



lens (Nikon FC-E8) were taken at a height of 1 m in interior locations in each subplot. The images were analyzed using Gap Light Analyzer (Simon Fraser University, Institute of Ecosystem Studies). The significance of differences in the density and height of shoots in subplots among disturbance types was tested by one-way ANOVA. A *post hoc* Tukey test was used to compare disturbance categories. Statistical analyses were carried out with SPSS 16.0.

Results and discussion

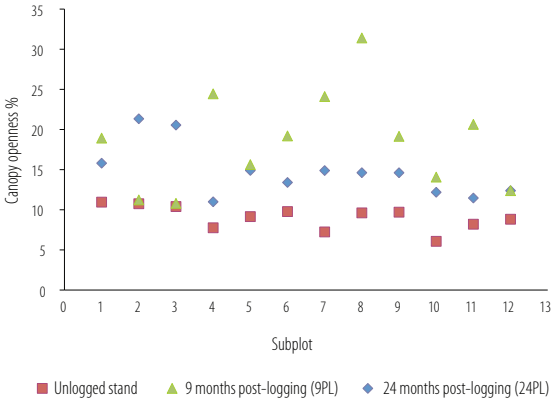
Stand structure after selective logging

Figure 1 shows the stand structure of logged and unlogged stands. The 9PL and 24PL plots contained fewer trees in the 60–80 cm diameter classes than the ULS plot, because logging had removed most trees in that diameter class (thus indicating that logging had adhered to the MSS prescription of harvesting trees with dbh ≥ 73 cm).

Canopy openness in logged and unlogged areas

Figure 2 shows that canopy openness was significantly different in the ULS plot compared with the 9PL and 24PL plots ($P < 0.05$). In most subplots, canopy openness was higher than 20% in 9PL but less than 15% in 24PL, although, overall, canopy openness in the two logged-over plots was not significantly different ($P = .082$). The lower canopy openness in 24PL compared with 9PL shows the rapid rate of canopy recovery in logged stands in Myanmar.

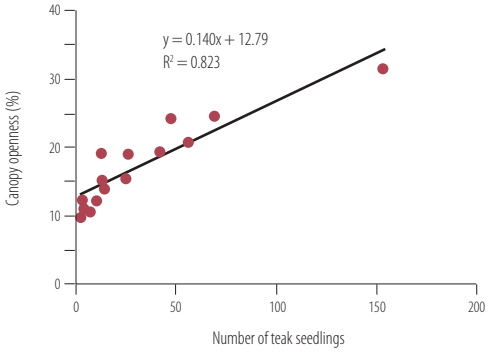
Figure 2: Canopy openness in logged and unlogged stands



Relationship between canopy openness and teak regeneration

Figure 3 shows that canopy openness is positively correlated with the number of teak seedlings, consistent with the fact that teak is a light-demanding species.

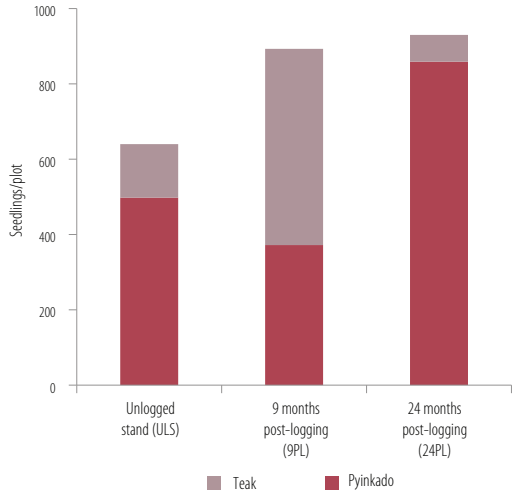
Figure 3: Canopy openness and regeneration



Density of teak and pyinkado seedlings in logged and unlogged areas

Figure 4 shows that the density of teak seedlings was highest in the 9PL plot, where canopy openness was highest. However, the density of teak seedlings was lower in the 24PL plot, and the density of pyinkado, a shade-tolerant species, was much higher.

Figure 4. Density of teak and pyinkado seedlings



Closing in: Canopy cover of moist deciduous teak forest in experimental plots, Bago Mountains, Myanmar: unlogged (left), nine months after logging (middle), and 24 months after logging. *Photos: R. Newin*

Although canopy openness was higher in the 24PL plot than the ULS plot, the density of teak seedlings at these sites was not significantly different. The density of undergrowth is highly variable in tropical moist deciduous forests, and if the canopy is opened it can become very dense, effectively preventing tree regeneration (Kermode 1964). In the study area, field observations indicated that the 24PL plot had the highest density of competing vegetation, especially bamboo seedlings, accounting for the much lower density of teak seedlings in 24PL compared with 9PL and also for the similar density of teak seedlings between ULS and 24PL.

Distribution pattern of tree seedlings in logged and unlogged areas

Figure 5 shows that the height of seedlings in the 9PL and 24PL plots was higher than in the ULS plot. This finding is consistent with the findings of Hla Maung Thein et al. (2007), who found that the combination of logging and bamboo flowering that creates high canopy openness can stimulate the recruitment of saplings into pole-sized trees. Sist and Nguyen-The' (2002) found that canopy opening from logging stimulated tree growth in the first four years after logging.

Factors affecting the future survival and growth of seedlings

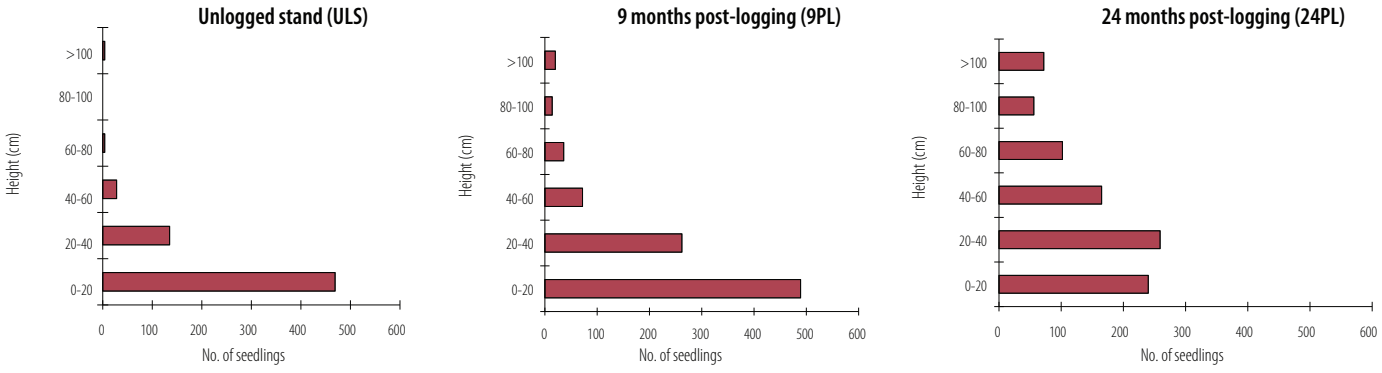
Forest fires and bamboo flowering are the two most important factors for natural forest regeneration (Ko Ko Gyi and Kyaw Tint 1995). Forest fires are normal occurrences in natural teak forests, and usually only the surface layer of litter on the forest floor burns. The fires do not cause severe damage to large, resistant trees, but they can kill small seedlings and saplings. Forest fires therefore cause reductions in the number of teak and pyinkado seedlings and consequently reduce the number of saplings and pole-sized trees (Saw Kelvin Keh 2004). However, many teak seedlings have been found to survive fire; teak is fairly resistant to the effects of fire and shows rapid recovery after fire (Troup 1921). In the early seedling stage, surface fires may destroy aboveground shoots, but the root stool produces a new shoot if rain occurs soon after the fire. If this process recurs over several years until conditions are favorable, the root will develop sufficiently to produce a vigorous shoot that can escape the damage caused by surface fires. In contrast, fires kill most pyinkado seedlings, a fire-sensitive species.

Another important factor for promoting natural regeneration in teak-bearing forests is the timing of bamboo flowering. Generally, bamboo is the main understory species in natural teak-bearing forests, and the middle layer of the study site was dominated by bamboo (according to field observations). Bamboo flowering occurs in a cycle of 30–60 years, depending on the bamboo species, after which the bamboos die. The death of a bamboo plant creates a large opening that can increase the amount of light reaching the forest floor, facilitating forest regeneration, especially of teak (Marod et al. 1999).

Conclusion

This study analyzed stand structure and tree seedling density in logged and unlogged stands. According to the stand structure analysis, the logging operations appeared to follow the standard MSS. A comparison of canopy openness in 9PL and 24PL indicated that canopy cover recovers rapidly after logging. This study provides evidence that teak had higher rates of regeneration in the 9PL plot, where light intensity was relatively high and there was a low density of competing vegetation. The number of teak seedlings was much lower in the ULS and 24PL plots compared with the

Figure 5: Structure of tree seedlings in the three plots



New fellowships

Twenty-three fellowships were awarded by the International Tropical Timber Organization in the 2013 Autumn Cycle. The newest group of fellowship recipients represents 14 different countries and includes eight female fellows. The total amount awarded to these new fellows was US$151 445. 49th Session Fellowship awardees are:

Ms. Abdullah, Azlinawati Abdullah (Malaysia) Ph.D. research on "Environmental Education for Primary School Students in Malaysia and Japan: Knowledge and Awareness of the Forest and Water" at Universiti Kebangsaan Malaysia in Selangor, Malaysia; **Mr. Akpona, Hugues Adéloui (Benin)** Preparation of Technical Document on "Integrated Analysis of the Operation of the Timber and Service in Benin: State, Projections, Prospects and Implications for Sustainable Forest Management"; **Mr. Ansah, Kingsley Bekoe (Ghana)** Manual on "Livelihoods Impact Assessment of the Ghana-EU Voluntary Partnership Agreement as a Tool to Ensure Social Safeguard of Vulnerable Group in the Timber Sector in Ghana"; **Mr. Afelu, Bareremna (Togo)** Ph.D. research on "Forest Ecosystems of Togo: Vulnerability and Adaptation to Fire" at the University of Lome in Lome, Togo; **Mr. Boakye, Mickey (Ghana)** Master's research on "Coarse Woody Debris in Post Logging Chronosequence at Bobiri Forest Reserve" at Forestry Research Institute of Ghana (FORIG)/University of Eastern Finland in Kumasi, Ghana; **Mr. Dancé, Raúl Javier (Peru)** Master's Program in Wood Science & Engineering at the Oregon State University in Corvallis, U.S.A.; **Mr. Etongo Bau, Daniel (Cameroon)** Ph.D. research on "Land Use Dynamics, Environmental Entitlements and Options for Sustainable Forest Management in Southern Burkina Faso" at Helsinki University in Helsinki, Finland; **Mr. Garcia del Aguila, Erick Robinson (Peru)** XXVI International Intensive Course on Diversified Management of Tropical Natural Forests at CATIE, Turrialba, Costa Rica; **Mr. George, Rajee (India)** Short Course in "Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA) Applying System Analysis and Spatial Decision Support Tools" at ITC in University of Twente in Enschede, the Netherlands; **Mr. Ghosh, Abhishek (India)** Master's Program in Forestry at Forest Research Institute (Deemed) University in Dehradun, India; **Ms. Gusman, Elizabeth del Carmen (Ecuador)** Ph.D. research on "Functional Diversity and Phylogenetic Diversity in the Dry Forests of Southern Ecuador" at the Polytechnic University of Madrid in Madrid, Spain; **Mr. Kouame, N'goran Reymond (Côte d'Ivoire)** Master's Program in Remote Sensing and GIS at Centre Universitaire de Recherche d'Application en Télédétection (CURAT) in Abidjan, Cote d'Ivoire; **Mr. Koudegnan, Comlan Mawussi (Togo)** Ph.D. research on "Apiculture in the Combat against Climate Change in the Ecological Zone IV of Togo" at the University of Lome in Lome, Togo; **Ms. Lazos Ruíz, Adi Estela (Mexico)** Technical training in "Nursery Management, Intensive Management of Trees and Scientific Dissemination" at Botanical Garden of Rio de Janeiro in Rio de Janeiro, Brazil; **Mr. Paricha, Sanjaya Kumar (India)** International course in "Landscape Functions and People: Strategic Approaches for Climate Smart, Sustainable and Productive Landscapes" in Bangkok, Thailand organized by Wageningen UR Centre for Development Innovation, the Netherlands; **Ms. Plata Fajardo, Ana Milena (Colombia)** Terrestrial Carbon Accounting Certificate Program at the University of California, San Diego, U.S.A.; **Ms. Ramírez Pérez, Mariana (Mexico)** Participation in the 14th World Conference on Timber Engineering and Study Visit to FPI Innovations and Laval University in Quebec, Canada; **Mr. Tahnur, Muhammad (Indonesia)** Master's research on "Marketing Strategy of Molding Product by Using Raw Materials of People Forest" at Hasanuddin University of Makassar in Makassar, Indonesia; **Ms. Tchana Nyabeu, Nadege Mariette (Cameroon)** Master's research on "Domestication, Integrated Management and Study Program of Production and Marketing of Non-Timber Forest Product Neglected for Multiple Usage: Case of *Tetracarpidium conophorum*, Euphorbiaceae (Müll. Arg) Hutch & Dalz in the Village Production Systems in Cameroon" at Higher Institute of Environmental Sciences in Yaounde, Cameroon; **Mr. Teshwar, Ankush (India)** Master's Program in Forestry at Forest Research Institute (Deemed) University in Dehradun, India; **Mr. Tieyiri, Joseph Vii-kpenibe (Ghana)** Master's Program in Bio-Economy and Natural Resources & Executive Master's Program in Business Administration at Forestry Research Institute of Ghana (FORIG)/ University of Eastern Finland in Kumasi, Ghana; **Ms. Xicay Franco, Onelia Rosa María (Guatemala)** Master's Program in Integrated Management of Watershed at CATIE in Turiallba, Costa Rica; **Mr. Zung, Ting (Myanmar)** Master's research on "A Study of the Impacts of Shifting Cultivation on the Environment and Local people in Kachin State, Myanmar" at Nagoya University in Nagoya, Japan

ITTO Fellowship Program

ITTO offers fellowships through the Freezailah Fellowship Fund to promote human resource development and to strengthen professional tropical forestry and related expertise in member countries. The goal is to promote the sustainable management of tropical forests, the efficient use and processing of tropical timber, and better economic information about the international trade in tropical timber.

The next deadline for fellowship applications is August 2014 for proposed activities starting in early 2015 (exact dates will be posted on www.itto.int).

To apply or for further details, visit www.itto.int or contact Dr Chisato Aoki, ITTO Fellowship Officer; fellowship@itto.int; Fax 81 45 223 1111 (see page 2 for ITTO's postal address).

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9PL plot; therefore, activities designed to increase light and control competing vegetation may be necessary in the ULS and 24PL plots to promote satisfactory teak regeneration.

Acknowledgements

The author thanks the ITTO Fellowship Programme for its financial support and the local people in the village of Kayinmathe for their kind support and collaboration during field work.

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