

Sustainable forestry in Trinidad? Natural forest management in the south-east

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Summary

In international policy, Trinidad has acquired a reputation for sustainable natural forest management. Definitions, criteria and indicators of sustainability are premised on ecological and social predictability; that forests and people will respond to rational management in rational, predictable and known ways. These premises are incorporated within the Periodic Block System; a 'blueprint' system for selective logging in particular blocks every 25-30 years in the 'Mora excelsa' forests of the south and east.

Yet uncertainties have continually beset the system over the last 80 years, both ecological (e.g. failure of expected regeneration, fire events) and socio-economic (e.g. changes in timber markets and felling practices; conflicts between loggers). While some *mora* stands are of high quality after two felling cycles, others are highly degraded, swept by fire. Corrective silviculture to 'stabilise' and shape the forest have been costly, placing greater strain on budgets (capital investment loans) and poor, small-scale artisanal loggers (for whom improvement felling is less profitable). Moreover, the changing social configuration of the logging sector, in which artisans increasingly lose out to larger, well connected enterprises threatens the viability of corrective measures. Socio-political instabilities and possible unrecognised non-equilibrium dynamics of the forest may thus interact to undermine sustainability.

National-level Forest department officials nevertheless represent the system as stable, sustainable and productive. First, it iconises a form of scientific professionalism in forestry which has long been central to the department's image and claims to institutional ground, and is increasingly so as multiplying conservation-focused institutions compete for national and international funds and attention. Second, the system is a means to justify the continued use of state forest reserves for timber production against critical NGOs and others who would prefer them devoted to biodiversity protection. Third, the relationship with artisanal loggers can be cast as a form of 'community forestry' – useful to the department's image with NGOs and international donors – without implying loss of state resource control, and simultaneously preventing timber sales to large concessionaries.

Sustaining this image has depended on several processes less openly acknowledged by national foresters. The dependence of the artisanal community means they absorb much of the work resulting from 'unforeseen' 'externalities' of the system. The system has also received – and may owe its economic viability to – heavy state subsidisation from the oil and gas-rich revenue base. That forestry has not had to be financially autonomous has enabled its science and practice to continue in particular ways, such as intensive PBS management over a relatively small area, and has allowed Trinidad to maintain a culture of scientific forestry as opposed to economic forestry..

In contrast both foresters working in the conservancy ('field level bureaucrats'), and artisanal loggers, acknowledge the ecological and social unpredictabilities of the system. They make flexible adaptations to felling practices and agreements that continually subvert the system's 'rules', yet are necessary for it to

work. These practices of adaptive management remain unformalised and unacknowledged within the larger forestry bureaucracy, as the latter's required image of scientific professionalism intersects with its strongly hierarchical authority structures which tend to discourage and discount initiative-taking by local staff.

Introduction¹

This paper examines the relationship between science, policy and the practice of forestry in the development of what has come to be considered by some as 'sustainable production' in Trinidad, especially in its natural forest. Trinidad has acquired an international reputation for sustainable timber production. When reviewing tropical forest management in South America and the Caribbean, for example, Synnott (1989) wrote that 'From the viewpoint of professional forestry, this author has not identified any case of operational tropical moist forest management for sustainable timber production in any [ITTO] member country except Trinidad and Tobago'.² (Synnott 1989: 75).³ 'It is the only country in which government foresters are carrying out natural forest management, on an operational scale, for timber production, over a substantial proportion of the national forest land' (Synnott 1989: 76).

Timber production from the country meets several restricted criteria for sustainability:

Not all forest reserves are available or intended for long-term timber production. Some are dedicated to wildlife conservation, and others are too steep or inaccessible to be commercially harvested. But about 75,000ha of natural forest are now classified as 'productive' (intended for long-term, sustainable timber production), of which 16,000 have been classified as 'intensively managed'. It is justifiable, however, to describe the whole forest reserve system as 'managed' and for ITTO purposes, the 75,000 ha of natural 'production' forest as 'managed for sustainable timber production'. They are protected to a degree by resident forest guards, their objectives of management have been defined, most of them are covered by working plans (albeit due for revision and not fully implemented), and logging is subject to some control. The 16,000 ha classified as 'intensively managed natural forest' have been logged and then closed until the next cycle, according to one of the silvicultural management systems described below (Synnott 1989).

This definition of sustainability is restricted to issues of timber production and sustainable management. It is premised on ecological and social predictability; that forests and people will respond to rational management in equally rational, predictable and known ways. Yet, forests and people have not been so reliable. Trinidad's natural forest management, despite being the oldest in the tropical Americas, is less than 80 years old, and during this period, management practices have been responding continually to unpredicted ecological developments (failure of regeneration, fire events etc.) as well as social developments (changes in social and economic policy, or at least practice), which were either not known, not predicted, or excluded from consideration in the development of the management practices. So whilst there has thus been an enduring, professional management philosophy of 'sustainable management', and the elaboration of management structures which reflect this - and which give Trinidad's forest management the trappings of 'sustainability' in the view of professional foresters, ITTO and Synnott - neither the forests, nor the management systems, we shall argue, seem to have the capacity to endure as predicted. Rather, practices of natural forest management, as we shall see, are better understood as ad hoc adaptations, responding from one problem to the next, as the forest (or society, as the management regime is a 'socio-technical', not just technical system) responds to use in unpredictable ways. This is not just true for natural forests. The performance of teak and pine plantations has also failed to reach expectations.

In international discourse, forestry in Trinidad is considered to exemplify the possibility of sustainable forest management, yet it has not pursued certification. This is curious, until one notes, as those

questioning the importance of certification do, that the market for Trinidad’s wood is local where the demand for certified timber is as yet irrelevant.

Alongside an international and professional reputation for sustainable forest management, however, many of those in Trinidad who know its forests have become deeply concerned by the state of the forest and the logic of degradation which seems to have accompanied so called ‘sustainable’ practices.

To explore this contradiction, we detail the emergence of the most ‘sustainable’ forestry practices in Trinidad in relation to (a) an evolving Trinidad Forest Division; (b) its science and practices, and (c) the interaction between Forest Division priorities and practices and those of other interest groups. In this respect, we focus principally on ‘woodworkers’ (small-scale operators who purchase private timber, or state timber under licence, fell the trees, deliver them to the roadside and sell them from there to sawmillers), who are heavily dependent for their livelihoods on timber supplied by the forest department, and to a lesser extent sawmillers and conservationists and the wider political, scientific and rural world.

Timber in Trinidad currently derives from a range of sources and land types: state forest reserves holding natural forest which are used for production; plantations on reserved and unreserved state land; forest regrowth on abandoned private agricultural land; private areas of natural forest, and new planting on private land. Here we focus on the most forested part of Trinidad, the south-east, where a particularly renowned system of natural forest management called the Periodic Block System (PBS) has developed and been applied within state forest reserves. This is also a region where many state natural forest reserves are dominated by an astonishingly gregarious natural forest tree, *Mora excelsa*, which dominates the vegetation, accounting for upwards of 60-80% of plants, and a still higher proportion of those in the upper canopy. *Mora* is a high quality timber; indeed in the 1850s *Mora* it was rated A1 as an oak substitute for shipbuilding by Lloyds, and although the advent of iron ships eclipsed this use, it had many others in building, bridge construction and as railway sleepers (Forest Department, 1933).⁴

Table 1: Silvicultural systems in Trinidad (derived from Clubbe and Jhilmit 1992)

Silvicultural system	area	Remarks
Shelterwood	c. 1,500	Arena Forest Reserve, Compartment system, now suspended
Clearfelling plantation	c. 10,000 c. 5,000 c. 2,000	Teak Pine Mixed Hardwoods
Selection Open Range Periodic Block	c. 130,000 c. 10,000	Grith control 30 year polycycle

Our focus on Trinidad’s *Mora* forests also enables us to explore the relevance of modern developments in forestry science to the way forest composition is understood and hence to sustainable natural forest management. The past two decades have witnessed the culmination of a revolution in ecological science both in general, and in relation to forests (e.g. Botkin 1990). Ideas that forests can be treated as stable vegetation communities best understood in terms of plant succession to climax formations have been fundamentally challenged. Analysts of north American and European forests now embrace non-equilibrium theory in ecology, considering forest form and composition as subject to constant variability over space and time (Peterken 1996) forcing forest management and conservation issues to be reframed

(e.g. Sprugel 1991). This perspective itself derives support from research into climatic variability and forest history (Worster 1994), and from revised assessments of the effect of human impacts (e.g. Taylor 1988).

As we shall see, Trinidad's Mora forests have long been considered by ecologists as 'invasive', yet at time-scales which enabled Mora forests to be treated as an equilibrium climax. Recently, however, climate and vegetation historians have revealed how drier climates have prevailed in tropical forests in more recent times, with northern South America no exception, inviting new questions to be asked of the status and dynamics of the Mora forest— especially relating to its unpredictable response to management.

Our strategy in this paper is to examine the development of the Periodic Block System within the Forest Division. Whilst it is considered as a 'system', it nevertheless combines aspects of earlier practices current elsewhere, and its emergence thus needs to be considered within the evolution of Trinidad's natural forest management practices more generally. Moreover, as the PBS is not only a timber production system, but also a regulatory system, we also need to explore how science and regulation/policy have mutually informed each other in the evolution of the system.⁵

As we explore, while formal research (or practices formalised as research) have been important to the legitimacy of the system and to the culture of scientific professionalism within which it is located, inquiry, innovation, creativity and adaptation by local forestry field staff and daily workers have perhaps been more significant in shaping the evolution of actual land management practices. Moreover, other interest groups and their expression in national politics, have rather different interpretations of existing practices, and have put pressure on modifications, also feeding into the development of the system. Issues of poverty and participation are raised by woodworkers, and concerns with wildlife and biodiversity conservation, aesthetics, and economics have been raised by others. In these respects, concerns with the south-east region of Trinidad and Trinidad itself are locked into assorted national and international political and academic institutions.

Our principal focus is on natural forest management of state land. Nevertheless we go on to look at the operation and significance of PBS practices amidst a range of others, particularly state plantations, and the management for timber of trees and forest on private and non-reserved state land. Exploring contrasts and similarities between the scientific and political-economic practices associated with these different types of timber production enables us to locate the PBS better within both the broader culture of the Forest Division, and the changing political economy of timber production in Trinidad.

The emergence of the Periodic Block System

In the 19th and early 20th centuries, Trinidad imported much of its timber, despite its own timber resources on private land and on the 51% of the island which was forested state land. In the late 19th century, forest reservation was proposed to secure into the future the watershed and climatic benefits that forests offered (e.g. Devenish 1875, Hooper 1887, Hart 1891, Lodge 1900). In 1899, C.S. Rogers, of the Indian Forest Service, prepared a forest management plan and was appointed as the country's first Forestry Officer (Chalmers 1981: 78). By 1934, 23% of the island was under forest reserve, and a further 22% was unreserved state land, also forested (Trinidad and Tobago 1934). Now 25.6% is legally forest reserve (Chalmers 1981: 81). While the impetus to establish reserves derived from the perceived need to protect the island's climate and soils, discussions in the 1920s instigated a change in managing state forests for more direct benefits, promoting timber production to offset imports and generate exports (Marshall 1925, Troup 1926, Robinson 1926). The largest timber resources in the colony were the two big Mora forests in Mayaro and Matura (Trinidad and Tobago 1934, the Victoria Mayaro having 54,000 acres of Mora in

128,285 acres, and Matura having 14,000 acres of Mora in 31,734 acres, Chalmers 1981: 85). In the 1920s the Mora forests were hardly used, and the timber was not locally valued. In the 1930s, however, a sawmill (the only major one in Trinidad) began to operate in the south east Mora forest. It became the most heavily cut timber in the colony (Trinidad and Tobago 1934: 58), but was nothing approaching the estimated potential annual production. Moreover imports of Mora continued from Guyana, as the port and milling infrastructure had already grown up around it, keeping it profitable.

Colonial forestry began to regulate timber extraction from 1918, and from then on the Forest Division developed and applied a succession of management systems. Until 1918, there was no restriction on felling. That year, selection felling was introduced. Certain trees under a certain girth could not be felled without authorisation, and trees meeting the girth requirement could be felled if another tree of its species over 3 foot in girth was growing within 300 feet – to ensure future seed. Mora, however, was not included among the regulated species, as at that time it was ‘barely used at all’ (Marshall 1925: 12).⁶

Selection felling was known as a poor management system; a necessary first step towards regulation. In it, felling occurring over ‘scattered areas throughout the forest, and trees [were] selected for cutting purely on the marketable value and without regard to regeneration’ (Marshall 1925: 11). In this ‘Open Range’ system (ORS), ‘Individual licensed loggers are licensed to cut a specified volume or number of trees and may select them anywhere in the reserve or range as defined and approved by the Forest Department’ (Synnott 1989). It presented numerous problems.

In many reserves it ‘amounted to a “loggers’ selection system” without close control by the department’ (Synnott 1989: 93). Although a forest officer could prevent the felling of a tree that had attained the required girth for other silvicultural reasons, this was not achieved in practice due to pressure from woodworkers, the large territories covered by forestry staff and their frequent transfer. As licensees, woodworkers creamed the crop, removing the best timber and leaving the poor (highgrading). Moreover, present foresters consider that the girth limits were set too low, more to permit colonial forest mining than to manage for long term sustainability (S. Ramnarine, interview, Rio Claro, 30th June 1999). This may, as Clubbe and Jhilmit 1992 suggest, have been necessary as the oxen used during the early part of the century to remove trees could not haul those of high girth. But as tractors came into play, extraction could capitalise on the rapid growth increments of larger trees, and afford to leave the smaller girth trees. With extraction permitted over the whole range, it was also difficult for the limited forestry staff to police illegal felling.

The ORS remains operational to this day on non-forest reserved state land, and in certain other reserves. Yet from the earliest, foresters were proposing improved systems. Marshall, in 1925 suggested an ‘improved’ practice which he called the ‘Periodic system’ in which a mixed wood of uneven aged trees would be converted into even-aged woods of a pure crop amenable to easy management and exploited on a rotation of 60 years. To do this, he proposed limiting licences to fell trees in a block of a mixed wood of uneven aged trees for a 20 year period. A 20 year block would be divided into annual coupes. All timber would be disposed of – for charcoal if not for timber. In theory, a block of even aged timber (1-20 years) regenerates. After 20 years, a second major block is chosen, the same is done. Then after another 20 years, the same is again done to a third block (Marshall 1925: 11). This practice had been ‘more and more generally adopted in tropical countries like India and Burma, where forest management has been in operation for a long time’ (Troup 19: 3).

A variant of this system was introduced in 1929 into the Arena forest reserve. But rather than fell all trees, there was careful control of the logging intensity and canopy opening, and tending, weeding and selecting out defectives of the regeneration. The shelterwood was removed (poisoned, then felled for charcoal) once regeneration had succeeded. As Synnott notes, this tropical shelterwood system became a

conspicuous silvicultural and management success in its time – pioneered in Malaysia - and later became popular in West Africa (Ghana and Nigeria)⁷. The cutting cycle was reduced from an expected 60 year monocycle to a 30 year polycycle⁸, and a second cycle was due when Synnott visited in the late 1980s. The ‘polycyclic’ selection system is locally referred to as the Periodic Block System.

Following the war, from the late 1940s, the island’s Mora forest reserves attracted management attention. In forest reserves, for which management plans were written from 1935 onwards, the ‘open range system’ was focused in blocks, which were opened for licensees to select their trees, and then closed, when appropriate (cf. Synnott 1989: 93). This was introduced into the Mora forest areas in the north-east of the country (Melajo) in 1948 and in the south-east, into Valencia reserves in 1954 (Synnott 1989: 93). Yet the objective at this time for managing Mora forest was to convert it to more productive forest, as in Arena, to encourage the natural regeneration of mixed hardwood species to replace the less valuable Mora (Chalmers 1988).

In practice, however, the regeneration of other species under Mora shelter was very poor, (Chalmers [1981] suggests that this was perhaps due to the clay soils, not the sandy soils of Arena). In 1957, a decision was taken for the northern Mora forests to clear fell a block of Mora forest each year, and replace it with pine plantation (*Pinus caribaea*). Globally, at this time, the promise of natural regeneration and natural forest management which had influenced policy in the 1950s was questioned. Indeed the practice (on which so much hope hangs today) was abandoned because:

....problems with the proliferation of sunseeking creepers, the growth of vigorous pioneers which blocked the development of valuable species and the difficulty of finding and maintaining the right balance of light. These difficulties were compounded by the many interventions widely spread through time and were difficult to justify technically and economically. This last aspect put a stop to stand improvement. Not only was it impossible to see the results immediately but also the gains in yield obtained were not quantified by prior or accompanying research. By the beginning of the 1960s, the scales tipped in favour of artificial methods... As a rule,.. enriched and natural regeneration stands as initially conceived did not fulfil the hopes of technicians and managers. Impoverished natural stands could not be naturally regenerated by had to be converted into plantations (Bertault 1993).

In Trinidad, this switch to a plantation focus was rather perverse, as the forestry department was converting Mora to pine, at least in the north, just as the demand for Mora timber was increasing. Despite increasing the block area, rationing had to be introduced to help satisfy the timber licensees operating in the three areas in the north-east where Mora was being exploited (Chalmers 1981: 85). The pine plantations, like natural regeneration with other species, was not a success due to fire and other factors. After 10 years of clear felling, by the late 1960s, 94% of Melajo and Valencia Mora forests had been totally destroyed as a source of timber (Chalmers 1981, citing Bell 1969/71). There was increased pressure on Matura (again Chalmers citing Bell 1969, 1971). Bell suggest stopping clear felling, and exploiting it under a selective system of management.

In the south, this destruction was averted. Whilst conversion to pine had been the original management option (in the Catshill Range from 1954) this was dropped in favour of natural regeneration of Mora in about 1960, two years before Trinidad’s Independence.

It is the management system that developed in the south-east which is presently considered as the periodic block system (PBS). It was first introduced in 1960 in the Rio Claro West range of the Victoria Mayaro reserve, and subsequently into other ranges.⁹ Timber management there is now totally under PBS management (excepting some trials and areas of production under the taungya system), although only

20% of it is managed for production with the rest still set aside within on-shore oil concessions, a wildlife sanctuary (Trinity Hills) or as a strategic timber reserve.

As we shall see, the PBS emerged as a set of practices which attempted to integrate control of Mora forest ecology with regulation of timber users. At first the PBS was not such a radical departure from the open range system. Felling was confined to particular blocks, demarcated each year - as had already been practised in the Arena shelterwood system and in the northern Mora forests. Whilst this had the silvicultural advantage of allowing undisturbed periods of regeneration, it also had the management advantage of enabling greater monitoring of the trees to be removed and over theft. Second, a practice of 'replacement' trees ('take one, seize one') was introduced, although this had long been ORS policy. A tree could only be sold where a replacement of the same species, and of more than 3' girth, stood within a radius of 30m. The better trees were still taken, and the poorer ones left standing. As elsewhere, standing wood was sold to licensed woodworkers, who had to buy licences permitting them to fell trees amounting to 500 cubic feet.

In the early 1970s, the PBS was further adapted to incorporate 'silvicultural marking'. In this, in theory 'stems are selected for sale by a team of highly skilled markers who go through the block systematically and physically mark trees that should be removed. In principle, the trees that are marked are those which in the next 30 years would not do as well as others that they are shading, or competing with. They may either be mature, or faulty or likely to become so. The trees in one block are sold to woodworkers over a 2 year period, after which the block is closed from sales and allowed to regenerate for the cutting cycle of 30 years' (Clubbe and Jhilmit 1992:5). In principle, one or two blocks (each of 200ha) is opened each year.

According to those now working as silvicultural markers, local forestry staff were behind the introduction of silvicultural marking. Markers today credit Mr. Boysie Rambharat, then a junior forester (Forester 1), and 'a man who lived forestry, he knew everything' (Interview, K. John, Rio Claro, 28th June 1999). His seniors, they claim, were at first reluctant to recognise an innovation from a junior and the divergence from established procedures which it entailed. Indeed junior forester's tradition has it that senior stalled the introduction of the practice by, for instance, refusing to supply Rambharat with the paint necessary to do the marking. Nevertheless, within a few years, silvicultural marking became an established part of the PBS. It was then taken over by a separate specialist branch of the Forest Division – the Forest Resource Inventory and Management section (FRIM).

PBS practices today

Silvicultural marking had been employed in the shelterwood system of the Arena reserve, in choosing which trees to fell and which to leave for the next cycle in what had become a polycyclic system. Its introduction into Mora natural forest management was to counter the perceived decline in quality of the stand with licensee selection. With the shift to silvicultural marking, the PBS thus became directed not only towards sustainable extraction from the Mora forest, but also to more active ecological management and shaping of it.

In the areas chosen for PBS, the Mora tree is often so dominant as to constitute an almost-pure stand. Management aims at the maintenance of a full range of regenerating stages, the removal of defective trees, and the harvesting of those which in 25 years time would have become over-mature or defective (Interview, K. John, Rio Claro, 28th June 1999). The intent is first to harvest the increment from each 25 year period. Second, since at present only 50-60% of the trees that are marked are sound, reflecting a particular quality of Mora to develop a hollow trunk in certain conditions or at a certain age, selection aims to increase quality up to about 80% sound trees.

Opening a block involves several preharvest operations. First, FRIM conducts an inventory of all species above 20cm dbh, and commercial species above 10 cm recording basal area and estimated volume. In practice this is not always done, as foresters consider themselves able to gauge what is likely to be in a block by comparison with neighbouring blocks and two small research sites in each block (permanent sample plots) which are monitored every two years (although recent intervals have tended to be four years due to staff and funding shortages).¹⁰ Second, FRIM staff cut vines at their base, so that by the time trees are felled, vines are weakened and will not pull down the crowns of neighbours when their tree is felled.

The block is then compartmentalised for convenience, and trees are selected and marked for felling in each compartment by two FRIM officers, each accompanied by a daily paid worker. In distinction with the ORS practice of 'take one-leave one', there is no girth limit. Trees are selected on the basis of whether they would be better felled now, or in 25 years time. 'Better' refers to the balance of a number of criteria in a process that FRIM officers describe more as an art than a strict science; one where personal judgement and experience count (Group discussion with FRIM staff and local forest officers, Victoria Mayaro Reserve, 30th June 1999). The criteria include crown form and position; tree size in relation to the officer's knowledge of the species; indicators of its decay (e.g. hollow echo when tapped or active low branching); location (even an unsound or mature tree may be left standing on a river bank or steep slope); form of bole; species rarity, and diversity of valuable timber species (e.g. if a galba is seen in a Mora forest, one would leave it). Further selection criteria balance timber production with wildlife conservation: trees that are sheltering burrows or nests, certain fruit trees for food, and vines for animal shelter are left unmarked.

More generally, a key aim is to avoid opening up the forest too much to let in pioneer species which would impoverish the forest. As Krishna John said, if more than 10 Mora per hectare are felled, a new environment is created (in group discussion with FRIM officers, Victoria Mayaro Reserve, 30th June 1999). He and other foresters consider that early felling in the north-eastern Mora reserves (the disasters of Valencia and Melajo) under 'colonial practices' unfortunately had this effect, passing what analysts today consider the 'threshold of irreversible deterioration' (Bertault 1993).¹¹ Yet the (in hindsight misguided) aim in this management had been to alter tree succession to favour other species which were then considered more valuable – although a factor which led to the policy could well have been the increased demand for timber from woodworkers, sawmillers, and the colonial power.

A second aim of selection was to improve the forest's value for timber production. Whilst there is some balance with wildlife, there are other parts of the forest reserve where wildlife take greater priority, not least the Trinity Hills wildlife sanctuary, and non-production areas of the reserve. Furthermore, balancing is reasonably straightforward in Mora forest which is relatively less diverse in vegetation and animals than other forest types.

In selecting tree species on the ecotone between Mora-dominant forest and other forest types, silvicultural markers tend to mark in ways which would enrich the ecotone with Mora, furthering the expansion of this invasive species. Equally, this positive selection for the more valuable Mora is made on burnt or once-farmed patches. Yet at the same time foresters emphasise that they are not trying to create a Mora monoculture.

After marking, FRIM make a logging operation plan detailing vehicle routes and collection points, and recalling those from earlier cutting cycles. FRIM then hands over a master list of the trees marked to the conservancy forestry staff working as sales officers, who begin to allocate and sell trees to licensees.¹²

In recent years, silvicultural management in the PBS has had to extend into a further period of post harvest operations. Forest officers had long demanded the introduction of improvement felling in blocks after harvest, and this was finally introduced in 1997 funding from the Public Sector Investment Programme. As we shall see, whilst defective trees had been marked, licensees had not felled them. Improvement felling first involves felling by the forest department of all marked trees which were left standing after harvesting so that the good stock has better growing conditions, and second, felling defective unmarked trees, including those which were damaged during harvesting. The operations are supposed to be carried out immediately following the closure of the block, but in practice the demand on FRIM staff frequently imposes a delay of several years. To date, three blocks have been treated in this way. In contrast with the main harvest, in post-harvest operations forest officers carry out the felling themselves, selling trees to licensees from the stumps. This is because woodworkers find it unprofitable to fell such trees (otherwise they would have already felled them), but profitable to use the parts they want once felled.

Science and research in the PBS

The knowledge and skills involved in silvicultural marking and the PBS are seen by forest officers as acquired through experience and creative practice. Thus while students in forestry training school (ECIAF) might learn silvicultural management techniques, 'they only learn the basics: real learning is by apprenticeship, once posted to FRIM' (Interview, K. John, Rio Claro, 28th June 1999). It is now a Division policy to allow all forest officers to pass through FRIM. When they begin, they are posted to work alongside experienced officers. Once they begin to work on their own, they also do so with daily paid workers who as some officers note, 'should never be underestimated; they really know their stuff... Daily paid workers are experienced and would be capable of doing FRIM officers' work' (Interview, K. John, Rio Claro, 28th June 1999). The importance of this sustained knowledge base among daily workers has increased since the policy of frequent transfer of forests officers was introduced. Now 'forest officers come and go, but workers are always there' (Interview, K. John, Rio Claro, 28th June 1999). John therefore sees the need to create a handbook for silvicultural marking, so that the accumulated skills and knowledge will not be lost (Interview, K. John, Rio Claro, 28th June 1999). In some senses, then, those working as markers in FRIM have little respect for the Forest Division's usual hierarchy of ranked Forest officers (3, 2, 1) and workers; instead, 'you just know your work' (ibid.). Nevertheless, creativity is not unlimited. There is also an overt feeling that officers must follow instruction from their seniors and the Forest Officers' Handbook, and should not interpret these for themselves; otherwise it would 'defeat the purpose of the system' (Interview, K. John, Rio Claro, 28th June 1999).

Compared with the centrality of judgement by those on the ground, 'formal' research and inventory seem to have been rather peripheral to the development of PBS practices. For example in 1983 a system of Permanent Sample Plots (PSP) was established as part of a 'statistically designed sampling programme for forest management rather than as a research study' the only examples of their kind in Tropical America (Synnott 1989: 92). Yet while data on species composition and size are regularly collected, they are not analysed by the Forest Division, at least partly because of the overstretched staff and limited resources of the central FRIM office. Designed for management use, the only use to which the data have been put is for academic research at the University of the West Indies, which has not been designed to feed back to inform forest management (interview, M. Oatham, St. Augustine, 4th May 1999). The significance of the PSP to forest management rather emerges through informal practice, as the forest officers in collecting the data observe, remark on and discuss the ecology and evolution of trees on the site (Group discussion with FRIM staff and local forest officers, Victoria Mayaro Reserve, 30th June 1999). While the data sit unanalysed in offices, the experience of gathering then feeds valuably into the 'art' of silvicultural marking.

The importance local foresters attribute to gaining knowledge of the forest and its management possibilities from the experience of working it contributes to their cynicism concerning higher-level education in forestry science (Group discussion with FRIM staff and local forest officers, Victoria Mayaro Reserve, 30th June 1999). Senior staff – those of the Assistant Conservator rank or above – must be graduates in forestry, yet with no degree course available in the Caribbean, degrees are obtained from North American or European universities with a temperate or Mediterranean bias. A common quip heard among lower ranking foresters, and critics of the forest division is that those with such degrees are seen to become ‘office foresters’, not forest officers, increasingly divorced – by their qualifications and the locus of their work – from the everyday realities of Trinidad’s forests and their field-level forest management. Yet while local foresters may consider themselves to be doing the ‘real’, on-the-ground research in their daily work, this is neither encouraged nor recompensed. Their field science, as they see it, is increasingly divorced from the ‘hard’ science of the ‘office foresters’. This cynicism extends further into international PhD culture, with those graduates who continue to work in the field through FRIM concerned that those they meet with PhDs in the increasingly international world of natural forest management know so little of field-level realities. Indeed this cynicism extended to the Oxford Forestry Institute. For Trinidad foresters this Institute iconises high level forestry research and education. It was the academic focus for emergent knowledge of Trinidad forest ecology and management in the colonial era. One experienced FRIM visitor who held the institute in awe from a distance, was disillusioned after a training visit, astounded by the mediocre knowledge of tropical forests displayed by those he encountered. While somewhat disdainful of the way formal forestry science is conducted, then, local foresters are nevertheless also concerned that their own inputs to it – as data collectors – go largely unacknowledged.

The formality and ‘trappings’ of hard science are nevertheless important for policy influence and change, and in maintaining the external reputation of the Forest Division. Thus, some staff in FRIM would like the periodic block system applied in *Carapa guayanensis* (crappo) forest, where felling is currently regulated only by girth. Local foresters have an idea of the approximate rotation age for crappo – 40 years – and feel they could develop appropriate practices on the ground through experimentation. Yet they recognise that formal research would be needed in order to gain legitimacy and permission to move ahead from the Director of Forestry and the Minister. In other words, changing the system needs formal scientific justification. This research has not been done. FRIM lacks analysis of crappo growth rates, and the Permanent Sample Plot data have not been entered (Interview, S. Ramnarine, 30th June 1999).

Woodworkers, sawmillers and the PBS

The woodworkers whose livelihoods depend heavily on the timber made available from the reserves, have a very different perspective on the PBS which shapes the way pressures of timber demand are manifested. In particular, they critique its practice in the context of national political economy (in which they are disadvantaged) and question the balancing of priorities within the system – especially the trade-off between future quality and current production.

Notably, woodworkers have developed their perspectives and critiques not only in relation to the Forest Division, but also to sawmillers, within a changing political-economic context. Sawmillers in the south-east vary from small operators working niche markets (e.g. sawing lowest grade timber for disposable pallets) to large-scale lumber industrialists who import timber from Guyana and distribute it throughout the country. Although assorted forms of vertical integration between woodworkers and sawmillers exist, woodworkers remain a distinct interest group in Trinidad’s south-eastern forests, not least because they have organised.

In 1964 licensed woodworkers formed the Nariva-Mayaro Woodworkers’ Association. In 1971 they became a Cooperative Society, stimulated to do so in an ultimately unsuccessfully attempt to purchase a

communal sawmill. The Association now remains as both a lobbying organisation for woodworkers' rights and interests, and a partner with the South East forest conservancy in orchestrating the allocation of licences. There are 72 licensed woodworkers, although a further 19 would like to be licensees. As R. Singh, a Forester 1, put it, those seeking to become licensees are advised by the Forest Division to approach the Woodworker's Association; 'It is their union' (Interview, R. Singh, Rio Claro, 29th June 1999). The Forest Division nevertheless vets potential new licensees. The association develops a list of licensees with the Forest Division and revises it annually. The order in which licensees feature on the list is crucial because when a block is opened, the order dictates which woodworkers can enter the block first to choose the trees they will fell. The list is in order of length of licenseeship (although the woodworker's co-operative society itself occupies the top position, out of order). Each license given by the forestry department allows 500 cu ft of timber to be cut. All 72 licensees are entitled in turn to obtain an appointment with the forest officers to go together and mark the trees they will fell, during which they will enter the block with a Forest Officer and locate their trees. Frequently, however, those after about 20th on the list will obtain little wood of value. No licensee can have more than three licenses open at any time, and theoretically at least, each license must be filled before a new one is allocated.

The Association – or at least the president and other representatives to whom we spoke - have a generally positive view of the PBS which their organisation has co-evolved with. Indeed, the forest service had a history of protecting the rights of woodworkers as part of social policy (Interview, C. De Grilla, Rio Claro, 29th June 1999), which was reflected in the close association of woodworkers and PBS managers. Also, as the Association's president put it: 'Without the PBS the whole area would become savanna and our children would not see forest. The PBS is good for both the small man and the state' (ibid.).

In making such positive remarks, the Association draws comparisons with the operation of licensing in the Open Range System, less for silvicultural than management reasons: where there was no register of licensees: 'it was a free for all, and the big operators [large sawmillers] just creamed the timber. Without a register [i.e. a woodworker controlled register], the license system was open to abuse, and one sawmiller could use ten 'decoys' to obtain ten extra licenses' (Interview, C. De Grilla, Rio Claro, 29th June 1999). The register of licensees was created early in the development of the PBS in 1964. 'It is through organising that we have managed to keep the livelihoods of the poor' (Interview, C. De Grilla, Rio Claro, 29th June 1999). Furthermore, purchasing wood under licence from the Forest Division is extremely profitable, since the low price at which the state sells timber in effect subsidises the woodworkers.¹³ It is not surprising that woodworkers seek as much state licensed timber as possible – and that as we shall see, sawmillers attempt to cash in on the profits to be made.

But while viewing the PBS as a potentially ideal 'socio-technical system' (Pfaffenberger 1993), in the same way as have international observers, woodworkers nevertheless critique the actual practice of it, at least in recent years – making this distinction between ideal and practice themselves.

First, the woodworkers complain that the quality of timber in the blocks that is made available to them is very low. Those marking the trees (FRIM) 'mark the sick and the dead – there are very few good solid trees. They care for the forest at the woodworkers expense' (Interview, C. De Grilla, Rio Claro, 29th June 1999). They critique the ways foresters balance what to fell and what to leave and would like 'at least a few' more good trees left for them. As it is now, the woodworkers' sense is that the burden of improving the forest falls on them.

Moreover, woodworkers are naturally hesitant to fell the poorer quality trees which are unprofitable, and those lower down the list, whose licences are filled by such trees have even more cause to complain. In the 1980s, the forest department attempted to introduce a requirement that licensees fell all marked trees (including the sick and the dead) in one licence, and in one block, before another licence and another

block is opened. It did not work, however, as the less profitable mopping up fell disproportionately on those lower on the list. It was this that led to the need for the forest department to conduct improvement felling.

The basis for these criticisms of silvicultural marking practices are accentuated because certain sawmillers recently appear to have been able to gain priority access to blocks and to fell the best timber before the block is opened to woodworkers. Once the high quality timber has been 'creamed', this leaves more woodworkers with the lower quality wood. Worse, once sawmillers have the wood they require, woodworkers have no market for theirs. As the Association president put it: 'Even a year after felling, our wood is still by the road' (Interview, C. De Grilla, Rio Claro, 29th June 1999). The main mechanism by which sawmillers gain such access is the 'government order'. The government needs timber for its own construction projects in bridges, buildings and so on, and passes the order to a sawmiller, who can use it to purchase timber directly from the state, without having to buy it from the licensees. Woodworkers see these 'government orders' as a mechanism by which certain sawmillers allied to people in higher levels of government can subvert the power and market control of the woodworker's association (Group discussion, Woodworkers's Association, Rio Claro, 5 July 1999). At the same time, the incentive for sawmillers to oust woodworkers has been greatly accentuated by technological changes, as power saws and tractors now make it economic for sawmillers to do the woodworkers' work.

Woodworkers make an explicit critique of this arrangement, saying that sawmillers have many sources of livelihood but they have only one; sawmillers should be made to purchase all their timber from licensees, otherwise the licensees will face greater poverty. The structure of the sawmilling industry has also changed. As C. De Grilla says (Interview, Rio Claro, 5th July), in the past the licensees had good relations with smaller sawmillers. But 'big boys' - lumber industrialists - are now pushing many of these sawmillers out of business, and most of those who once respected woodworkers, and worked with them, have now dropped out. Only 5 sawmillers (out of 72 in the country) constitute these 'big boys' and are the main beneficiaries of privileged state timber access. But other sawmillers, aspiring to these same privileges and more profit-oriented than in the past, have also ceased to support woodworkers.

The 'big boys' as woodworkers understand it, are also close to the powers of the present government, which is less sympathetic to the woodworkers than the previous government which woodworkers appear to have supported. Moreover, a rationalisation of sawmillers into 'quote' for economic efficiency, and to reduce over capacity, has been recommended in the forestry sector.

Woodworkers complain that government orders are sold before any announcement is made that a block is to be opened to licensees. At Catshill range, for example, in the last block to be opened a sawmiller was given prior access to 16 trees on a government order (Interview, Michael Bridgler, Rio Claro, 5th July 1999). In the case of one recent block, the Woodworkers Association is actually taking the Forest Division to court over its privileged granting of access to sawmillers before the block was opened.

A second area of Woodworkers' complaint concerns the timescale of the Forest Division bureaucracy. Licensees are required to pay up-front for their licences, but the Division is frequently slow then to open the block. Woodworkers say that they sometimes have to provide free labour to forest officers to offset staff shortages and ensure that blocks are opened. Even once trees are marked, woodworkers say, the Division keeps stalling on opening (Group discussion, Woodworker's Association, Rio Claro, 29th June 1999). They see these delays as caused by the Forest Division's lack of staff to perform necessary tasks as well as its slowness in processing the paperwork, with data on the market trees, expected timber volume etc. having to be sent first to Port of Spain, and then San Fernando. Even once the trees are felled, it can take a year before paperwork and measuring by forest officers is complete and the woodworkers are free to remove the trees. During delays such as these, woodworkers' money is tied up, and since they

frequently have to borrow money to pay for their licences, they are left indebted. If, as is sometimes the case, a block is marked but then not opened for 3-4 years, further problems arise. The tree marks become invisible, and the Forest Division may deny that the tree is for sale. Between felling and authorisation, felled trees become hard to find as they have become buried in undergrowth opening (Group discussion, Woodworker's Association, Rio Claro, 29th June 1999).¹⁴ Woodworkers argue that they should be allowed to take all unmarked damaged trees, windfalls, broken crowns etc. (including those damaged accidentally during their felling operations) straightaway when first felling in a block, rather than just letting these trees rot to be dealt with much later in post-harvest felling.

A third area of complaint in the practice of PBS refers to radical changes in procedure, following fires which have affected large areas under PBS management, forcing changes in the rhythm of block opening, the numbers of blocks that can be opened, and which have led to the introduction of 'salvage blocks'. These have had major ramifications for woodworkers and their livelihoods. This we will discuss, after considering the broader question of sustainability in PBS which are raised by these fires, and the management transformation they have provoked. This requires a reflection on the ecological dynamics of the Mora forests, and the ways these dynamics should be understood in the light of transformations in ecological science to embrace non-equilibrium dynamics, and increased attention to climate variation and the legacy of historic land use.

Ecological dynamics in PBS tropical forest management - Mora, and the relevance of non-equilibrium ecology to Trinidad.

The management of Mora forest under the PBS is geared towards maintaining a stable state productive forest; a kind of equilibrium. Yet since the PBS was introduced, a major shock to the system – in the form of extensive forest fires in 1987 - has forced system adaptation. The fires, linked to a particularly deep and prolonged dry season, burnt about 20,000 ha of good forest, including some block and non-block land in Mayaro range (Interview, K. John, Rio Claro, 28th June 1999) – only 10,000 ha under PBS. In response, the Forest Division replanned their block rotations to make most productive use of the burned areas and to ensure forest sustainability. They enabled 'salvage cuts' of burnt areas, and held back opening what came to be called 'green' blocks. To date the Division has surveyed and made available the damaged and fallen trees in three 'fire-burned blocks'.

In explaining the fire event, foresters consider it a one-off external variable to an otherwise stable system over the longer term. The Forest Division even suspected that the woodworkers had burnt the forest deliberately in order to gain access to it, and FRIM's delayed opening of the block until 1991 was in part a strategic response to this (Group discussion with FRIM staff and local forest officers, Victoria Mayaro Reserve, 30th June 1999).

However taken alongside other evidence, the fire even might call into question both the premise of stability in sustainable natural forest management, and the management implications which flow from this. Trinidad experiences very high variability of rainfall, especially the length and depth of the dry season, which can be everything from almost no dry season, to a six month one. In this context one could expect major fire risks to occur several times in the course of a century – as forestry records themselves reveal.

The management system, as it has been developing in Arena, is for increased stability in a system of sustained production. Such management practices are configured in accordance with equilibrium ecology. From this perspective, factors 'outside the system' (fires in the destroyed Mora forests of the north, and in 1987, in the Mora of the south) have caused radical changes. Yet it can be argued that Mora forest in

Trinidad should be understood in a 'non-equilibrial' way, with 'external factors' such as drought and fire hazard as part of the system. This requires elaboration.

Marshall (1934, 1939) was the first to note that *Mora* was an invasive tree. The gregarious *Mora* forest (86-95% of all trees forming forest canopy) had a rather sharp boundary which does not correspond with any physical feature, except fortuitously, as it is found on hilly, undulating, flat and swampy areas and on most of the soil types of the island (Beard 1946b: 181). Saplings of *Mora* can be found in neighbouring associations, an indicator of onward march into these. Beard agreed: 'It seems indisputable that *Mora* is invading the crappo-guatecare forests, and that if undisturbed by man it would eventually come to dominate them over the entire island' (1946). Moreover, studies of fossil flora (Hollick 1924, Berry 1925) indicated to him that *Mora* was absent from the island (miocene 14 million years ago) where moist evergreen forest similar to today's could be found. He deduced from present distribution, where *Mora* arrived and how it spread, and on a rate of natural advance of *Mora* calculated by Marshall, he hypothesised when *Mora* arrived (30-50,000 years ago). *Mora* is believed to have crossed over to Trinidad from Guyana by a land bridge in late Pleistocene to subrecent times. In the Pleistocene, Trinidad was part of continental south America, and was savanna clad, save for northern and central ranges, and gallery forests. He argued that in the Pleistocene, when Trinidad was divided from the mainland, its savanna soils rejuvenated and trees advanced from hills and gallery forests. When forest conditions returned, *Mora* must have been a late comer upon the scene, as it would have advanced with the rest, which in fact it is only now invading. As there are numerous other trees which are limited in distribution only by the time factor, Beard suggested that Trinidad may be an island whose forest flora may be immature due to the recent return of forest conditions, and it becoming an island. *Mora* came to dominate due to lack of competitors (it is not so dominant on the mainland). That Trinidad, has no strict 'rainforests' (evergreen seasonal forests, which are lower and more open than rainforests) meant that it offered less competition with *Mora*. Arguably we could add, the edaphic range in which *Mora* can compete meant that it could also benefit from the interannual variability in rainfall.

Thus over a long timescale, the vegetation of Trinidad is certainly not usefully understood in relation to equilibrium. It is also possible that this is the case over much shorter timescales, for two reasons. First, whilst Beard appreciated that Amerindians might have been responsible for distributing *Mora* within Trinidad in certain locations, he may have radically under-estimated the population and impact of Amerindians when considering their impact on vegetation. Second, recent climatic history forces us to be cautious in accepting that Trinidad's climate has supported a similar vegetation as today in a timeframe relevant either to today's vegetation or to Amerindian farming. Indeed, more recent climatic history may force us to question Beard's deductions concerning the gradual colonisation of *Mora*, as over the 30-50,000 year timescale, there will have been dramatic climatic fluctuations. Much of the vegetation of the island may perhaps best be seen as a scar tissue, two or three generations of trees old, following 16th century Amerindian depopulation. It may be layered over a vegetation history during the Amerindian period which reflected a complex of anthropogenic management and vegetation response to climate rehumidification from c. 2000 years ago.

If recent climatic variation combined with the legacy of past land use has been shaping Trinidad's vegetation, then the reasons for particular forest formations appearing in particular locations may relate more to (or at least in part to) 'path dependent history' than any natural tendency towards equilibrium. The formations found today may not be as long-lived and stable as assumed, and – more importantly – may respond very unpredictably to major disturbance. Quite plausibly, the apparent difficulty for *Mora* to regenerate following fire may be a manifestation of this. The Forest Division which eschews such questions, continuing to manage on the presumption of stability, may in this be pursuing illusory goals. This is particularly significant given that ad hoc management changes to cope with unpredictability have been among the factors provoking tension between woodworkers and the Forest Division.

Socio-political dynamics: relations between woodworkers and the Forest Division

Woodworkers argue that they have borne the brunt of changes in management in response to ecological dynamics – geared ever more towards restoration and forest improvement following the fires.

First, woodworkers complain that the Forest Division has not kept to its stated policy of opening up two blocks per year. The licensees became used to the division doing this, but found that they stopped around 1996, perhaps opening one instead, or only allowing access to fire-burned blocks in a given year. Recently they were told that no new blocks would be opened until another salvage block is finished. When 2 blocks a year were opened, as had occurred, ‘one could have a decent livelihood, work 6 licences a year and eat chicken twice a week like everyone else’ (C. De Grilla, interview, Rio Claro, 29th June 1999). This is not the case now.

Moreover, long delays, now of up to 12 years, have occurred between the burning (in 1987) and the opening of the blocks. As a result much of the timber is quite rotten, with the holes in Mora trunks much bigger, and the sap decayed. Equally in both fire-salvage blocks and post-harvest operations, the Forest Division frequently fells the trees up to two years before opening the block. This further spoils the timber, while the bush regrowth around the felled trees makes it harder to find them, and prolongs the work. So ‘If you buy 100 cubic metres of timber in a salvage block, you might sell only 40-50 cubic metres’ (C. De Grilla, Interview, Rio Claro, 29th June 1999).

De Grilla wrote to the director of forestry about the reduced number of blocks, and claims to have received a reply saying that the Division could do nothing over and above the policy that the Minister had made. De Grilla interprets this as ‘political interference’. Furthermore, sometimes the blocks which are opened are not large enough; the most recent block to be opened provided wood sufficient for only 20 licences; profitable timber was exhausted for the rest of the 72 licensees. Moreover, the licensees are also angered that the forest division recycles old blocks when there is still ‘virgin forest’ available. They see these old blocks as inferior. Notably, this perception contrasts with that of the foresters who would see the forest improved from a timber production viewpoint after a 25 year cycle.

FRIM officers are well aware of these critiques (Group discussion with FRIM staff and local forest officers, Victoria Mayaro Reserve, 30th June 1999). They say that they could bring more blocks into the system, and that there is more forest where new blocks could be established. More wood could be released. But the licensees cannot be satisfied; they can never get enough. Thus to give them a little more would be the thin end of a wedge of expanding, insatiable demand. The officers tend to dismiss the woodworkers’ perennial claims about being given insufficient timber. They might complain about being given fire burned blocks (salvage blocks) instead of new blocks, but they still harvest them. Licensees might complain that each license fails to give enough timber, but this is because their perspective differs from that of the PBS: woodworkers think in numbers of trees, not cubic metres, and would like ‘10 trees’; they are always surprised at being told their license is filled at 2 or 3. Forest officers run a tragedy of commons argument, saying that woodworkers want to maximise individual gain, whereas the foresters’ duty is to regulate the system and keep everyone’s allocation low enough for all to get a share; ‘all should get tangibles’.

Krishna John’s statements imply that this tension between forest managers and woodworkers in the south-east is a microcosm of the situation in Trinidad more broadly. Nationally, he claims, the demand for timber cannot ever be met; ‘Trinidad has imported more than 50% of its timber since the 1940s, and 90% since the 1980s’ (Krishna John, Interview, Rio Claro, 30th June 1999). In effect, given a perception of

insatiable demand, forest officers feel it would be inappropriate to attempt to close the supply-demand gap. This in turn allows them to operate on the precautionary principle in forest management and conservation, taking a highly cautious approach to the release of new blocks and guarding large areas of Mora forest unexploited.

Despite cause for tensions, however, there is a sense of common purpose between local representatives of the Forest Division and the woodworkers, a relationship concretised in the organisation of the PBS. This is partly because local forestry staff also feel themselves vulnerable to many of the same political-economic processes of which woodworkers complain.

As the Forester I Singh explained, the government originally aimed to provide employment for rural people, and woodworkers are justified in their claims that sawmillers are now taking their rights (Interview, R. Singh, Rio Claro, 29th June 1999). Singh, who is to speak for the Forest Division in the court case brought by licensees against the Division's prior allocation of felling rights to sawmillers (described above) actually finds himself highly sympathetic to the woodworkers' plight. Furthermore, large sawmillers are now pushing to be granted forestry concessions, of around 400 ha. Local forest officers are concerned about the sustainability of timber production under such conditions, especially given the profit orientation of big business. In this way they see support to the woodworkers as important for maintaining the integrity of the forest and PBS.

Forestry field staff, moreover, are threatened by large operators. As Krishna John put it 'a small forest officer may take them to court, but because of their [political] connections, you find yourself in difficulty and you get a transfer' (Krishna John, Interview, Rio Claro, 30th June 1999). Policing the activities of well-connected large sawmillers only magnifies more general difficulties they now face in policing timber theft. Following a recent ruling the Minister has required officers to take all forest offences to court (rather than settle them directly – by 'compounding' - which foresters of rank 3 and above were once entitled to do). 'But unfortunately they find that if they do not have all the evidence and know all the rules, the prosecution case will fail. Moreover, magistrates do not value the environment, consider forests to be wasteland and might impose a trivial 50 dollar fine and a reprimand' (Krishna John, Interview, Rio Claro, 30th June 1999). In some cases, where an offender has agreed to compound at 25,000 dollars, an appeal and a court case can find the operator guilty but impose a fine of only 1,000.

Conservancy forest officers are thus vulnerable to – relatively powerless in relation to – processes operating at higher levels and in Port of Spain. In some respects it is better for them to work with those less powerful than they, such as licensees. Woodworkers, to a certain extent, acknowledge these conditions in which local forest officers work, seeing them largely as conduits for orders and political interference that comes from above. Indeed their major calls for change are to higher-level policy makers, where De Grilla summarises their demands as first, to stop sawmillers from obtaining licenses, and second, to ensure that government orders are filled through woodworkers (C. De Grilla, Interview, Rio Claro, 5th July 1999). Oil companies are a further type of 'big boy' with high-level political connections; neither the woodworkers nor local forest officers like their impact on the forest, their profit orientation and their overriding influence on Port of Spain politicians, and are allied in both this dislike and a sense of incapacity to alter the situation.

Yet other remarks and instances suggest persistent tensions between woodworkers and forest officers. The suspicion that woodworkers set the 1987 fires is a case in point. In another instance, the Forest Division had planned to open a block near the Trinity Hills Wildlife Sanctuary, and went as far as silviculturally marking the trees. But a decision was made from above not to go ahead with the extraction, linked to problems of opening a road there, with the Director of Forestry 'erring on the side of conservation'. Woodworkers reinterpret this issue, however. They claim that the Forest Division wanted to give sawmillers half and woodworkers half of this block. The woodworkers objected to this allocation, and

fought and won their objection. Yet wanting to 'get back at them', the national Forest Division withdrew the block on the claimed grounds of conservation.

This instance, and others like it, illustrates a general perception that the Forest Division uses arguments about conservation and sustainability (e.g. in limiting woodworker's access to 'green blocks' and imposing on them improvement and salvage work) as a 'greenwash' to hide their real political-economic interests. These are interests which both local and national forest officials are seen to have in developing good relationships with large sawmill operators, from which they benefit economically or politically. Thus woodworkers critique aspects of PBS science and its local praxis on the grounds that it is politically motivated. For example the slow opening of blocks, justified on grounds of fire damage and sustainability is just an excuse for foresters who want to 'weed the licensees out of the system' and build up their relationships with the 'big boys' (C. De Grilla, Interview, Rio Claro, 5th July 1999).

The sense of woodworkers being squeezed out is easily understood given that 10 years ago there were ten Woodworkers' Associations in the country. Now they have all 'died out' except for those in the SE. Furthermore, whereas the Nariva-Mayaro Woodworkers' Association now has only 72 members, it once had 600; 'the forest used to provide bread in this region, but now this is only for a few' (C. De Grilla, Interview, Rio Claro, 5th July 1999). Woodworkers who cannot make a livelihood from timber are forced to turn to other occupations: they search for temporary employment such as in construction at times when there is no wood, they hunt, or they find a piece of land to squat on – frequently having no choice but to turn to 'illegal' activities.

In the Woodworkers Association-Forest Division relationship, then, some degree of alliance coexists with considerable and mutual lack of trust: a lack of trust in an expert institution, balanced by a reciprocal lack of trust in a civil institution. To a certain extent, each side blames problems in the operation of the PBS on the other side's supposed links with politicians, and sees its claims about inappropriate PBS scientific practice as masks for 'unreasonable', individualistic profit-seeking behaviour. A basis for citizens' lack of trust in the institutions of the state might be traced to Trinidad's colonial history, and its subsequent ethnically 'divided politics'; it certainly is aired in mass-media where, as well as in people's own discourses, there is (to an outside observer at least) an almost 'cultural' tendency to exaggerate interpretations of corruption and misdemeanour; to talk of others as if they were engaging in outrageous 'boldface' behaviour and carnivalesque 'bacchanal'. In other words, while there may be real mistrust rooted in material experiences, styles of Trinidadian discourse also tend to amplify images of mistrust and its rootedness on other's outrageous behaviour.

While at one level, then, the PBS can appear as a 'blueprint' system of science and management – the image given in the Forest Officer's Handbook, and the image around which the Forest Division has partially constructed its own image of scientific professionalism in forestry – it is at the same time a field of social and political struggle. In this, actual management practices (which trees are marked when and how; which blocks are opened when and how) may be responses to more day-to-day dilemmas forest officers face in dealing with woodworkers, sawmillers and politicians, as well as with the exigencies of ecology. To some extent, the 'system' as it emerges on the ground is a structured and partially unintended product of these socio-political practices, which science appears to give a natural validity to. It is a product which, in sum, has a number of varied effects, ranging from balancing objectives in the use of state reserve land, producing subsidised wood for woodworkers or sawmillers, and providing surveillance in the forest, to altering the structure and diversity of the Mora forest. At the same time the PBS is instrumental in maintaining the existence (and justification for) these state reserves themselves, and in maintaining the image of the Trinidad Forest Division – via FRIM – as one of scientific professionalism in forestry.

Trinidad has been practising the periodic block system for about 40 years, on a 25-30 year polycycle. Several blocks have therefore been open to timber extraction twice. Yet in this time, the system has adapted in two major ways to problems in the system; first towards silvicultural marking, and second towards salvage of fire-blocks. Sustainability is not easily achieved, and both of these developments 'stabilising' the forest have placed greater strain on woodworkers and their relationship with forest managers.

Unpredictable ecological events in the short-term also affect the course of the forester's work, in interaction with the exigencies of labour and resource availability – placing extra demands on woodworkers. Demands to perform unexpected timely operations beyond normal duties, such as doing surveying in the inventory of fire-burned areas, and doing the work of labourers in this due to a lack of their availability or the finance for it, can interrupt the normal flow of work. Their performance varies depending on both the weather, and the equally fickle availability of workmen and surveyors. In this context, they see as somewhat invidious the current Forest Division system of awarding salaries and promotions as based on performance of a pre-agreed work programme. This fails to acknowledge the day-to-day and year-to-year flexibility required to respond to ecological and social contingencies, and the initiative foresters must frequently take to cope with unpredictable field conditions (Group discussion with FRIM staff and local forest officers, Victoria Mayaro Reserve, 30th June 1999).

PBS and timber plantations

The PBS exists among several other sets of practices for managing forest for timber in Trinidad. One of the most commercially significant and yet controversial has been the practice of clearfelling 'degraded' forest, removing all saleable timber, and replanting with teak, Caribbean pine or mixed hardwoods. Teak was introduced in 1913, and some plantations were installed in the 1920s and accelerated with a major wave of teak and pine planting in the 1950s. The Forest Division is now promoting the establishment of Colombian cedar which (as was at first the case with teak and pine) appears to be highly productive.

Plantation forestry began in a period when the colonial forest service was re-orienting its aims from simply forest conservation, to production, and producing in plantations epitomised this new focus. Arguably, it fitted within and contributed to the development of a professional forestry culture oriented around silviculture and production, which could be studied and promoted in the relatively controlled, uniform environment of the plantation. That plantations and silvicultural experiments within them carried high status in international scientific forestry circles encompassing Europe and Asia, and that Trinidadian foresters had to satisfy upper level degree requirements in temperate countries where silviculture and plantations were the focus, contributed to this orientation in the colonial period. By the wave of planting post 1957, further economic concerns influenced policy; notably high levels of import of construction pine lumber from Honduras and the southern United States, which it was thought could be substituted by local production (Eden Shand, 'Forest Division must engage in conservation', Daily Express June 23 1999). When the Eastern Caribbean forestry training school (ECIAF) was established in 1966, its training programme for forest officers (at least until 1980) was strongly centred around plantation silviculture concerns, in keeping with the emphases of commonwealth forestry at the time, as by then as we noted earlier, natural regeneration in tropical forests had become outmoded (Interview, Anthony Ramnarine, 17 June 1999; Bertault 1999). A generation of forestry staff emerged skilled in plantation forestry, and defining the culture and everyday practices of forestry.

At first sight plantation forestry and natural forest management in the Periodic block system may appear to work from quite different premises. Yet there are strong similarities between these in the ways scientific forestry attempts to control 'nature'. In effect, the PBS (as the Arena shelterwood systems)

shapes natural forest to become (more) like a plantation. It is perhaps no accident that the system developed in the rather homogeneous Mora forest, with its mono-specific characteristics – a monospecificity resonating with the mono-culture of the plantation. PBS management, as we have seen, aims to accentuate the simplicity of an already-simple ecological system by encouraging evenness of growth, uniform quality of bole, etc, notwithstanding some concession to multiple objectives such as conserving wildlife. Mora also has very strong regeneration. The particular natural forest ecology of Mora, then, is particularly amenable to the ‘scientific culture’ of plantations, perhaps accounting for its endurance as a management system in Trinidad at a time when globally, Natural Forest Management was out of fashion. Just as the plantations are managed for order and stability in the forest, and are not good at accommodating hazards such as fire, so in the PBS such hazards have required major ‘adaptations’ to the system (such as the introduction of ‘fire-burned blocks’). And because Mora ecology is relatively non-diverse, ‘taking account of multiple objectives’ is not onerous to the culture of production forestry in that ecological setting. The similarity between PBS of Mora, and plantation forestry can, however, be painted in a different light. Through the mono-specific ecology of Mora, the ‘plantation’ culture in the forest department finds easier engagement with natural forest management. This can then be a bridge into more complex natural forest management issues, for example in the desire to introduce PBS into more complex Carapo forest.

At the same time as creating order in the forest, the PBS and plantation forestry ‘systems’ have also been managing foresters, producing the ‘Trini’ forester as a particular type of manager and controller of disorder, with specialised technical knowledge and work routines to suit. At the same time – as we have seen – this image of order is somewhat at odds with the practices of the PBS, as local level staff employ creativity in dealing with less than predictable social, political and ecological circumstance.

The same story can be told of plantations. In the 1980, analysts were still optimistic in the capacity of plantations to dominate timber supply. To quote Chalmers in 1981:

There is not doubt that within the next 10-15 years, teak will be making a major contribution to meeting local timber requirements , and to the local construction and furniture industries. The implications of the availability of a large volume of highly valuable teak timber will be even greater with the modernization and expansion of the sawmilling complex... The forecast is an extraordinary.. increase in the output of sawn timber, to 4.3 million board feet in 1977 to 7.0 million board feet in 1985 (Chalmers 1981).

And for pine:

By 1990, local pine plantations should be producing 1.5m cu ft., and 1.0m cu ft. of thinnings (Chalmers 1981).

The Forest Division’s experiences with teak and pine have also raised scientific debates and dilemmas, and opened the Division to serious critiques from a range of different perspectives and interest groups. First, for reasons Chalmers noted – the almost inevitable annual leaf fires, and worse ‘thinning fires’ in teak plantations, and subsequent sheet and gully erosion – teak does not live up to foresters’ expectations. Teak has proved perpetually vulnerable to fire; plantations are routinely devastated by burning, especially in those years of unusually serious fire which occur unpredictably yet frequently in Trinidad’s climate. Such is the frequency with which teak plantations burn that a public perception has arisen that teak actually needs fire for successful growth, and that these fires are set by foresters as part of plantation management strategy (Trinidad and Tobago Forester, 196x).

This is partly because, some observers claim, the Forest Division has not performed technical management operations to standard. Of the pine plantation programme, one critic asked:

...do we have an indigenous pine lumber industry of any significance? The answer is no! Why? Because the FD had entered into industrial production forestry beyond their prime area of competence – forest conservation. They did not produce the raw material in the quantity that would sustain an import substitution industry. The seriousness of the FD in growing pine timber for industry is doubtful. How else would one explain the FD's neglect of the plantations once established? Pine plantations are supposed to be thinned and pruned at prescribed intervals so that a final crop of good quality, fat, merchantable trees results. The FD did little thinning or pruning...so that by the time they reached rotation age, the trees were spindly and knotty and not good for much' ('Forestry Division must engage in conservation', *Daily Express*, June 23 1999)

The same could be said of much teak.

Second, the Forest Division faces dilemmas at the end of the plantation growth cycle, and in how to treat plantation lands after felling. The teak and pine plantations established in the 1950s and 60s were intended to mature in about 40 years' time, so this issue roes strongly to the fore at the end of the 1990s. The plantations are clearfelled at harvest. Unfortunately due to the annual fires and the soil erosion under teak nothing will regenerate in teak plantations except teak from coppices. Thus second-rotation teak is an important economic possibility for these plantations. This has become an important area of research practice within the Forest Division, and indeed the focus of a revitalised research effort within FRIM where formal scientific studies had otherwise been sidelined during the last 20 years due to funding and staffing constraints (Interview, Anthony Ramnarine, 17 June 1999). Seepersand Ramnarine has been examining growth rates under second rotation teak and treating different plots to different management practices, including thinning regimes and cutting only 80-90% of trees when felling, leaving advanced regenerating stems. He is producing guidelines for forest officers in following these experimental practices.

Third, there are heated debates about access to the timber from plantations and who has rights to this. From 1977, plantation timber of teak and pine was sold to Tanteak, a state enterprise with monopoly status (Symes 1991). Nevertheless, small-scale woodworkers could get licences in teak; Tanteak was the concessionaire and sold timber to licensees. However since 1996/7 and in response to repeated criticism that Tanteak was performing inefficiently, plantation timber sales have been liberalised. According to the Woodworkers' Association, the Forest Division (p.48 para 8, Forest Officer's Handbook) states that teak from state plantations must be sold to the general public, and in the next paragraph, notes that it should be sold especially to the licensees in the area. But in practice teak is not sold to licensees, only to sawmillers and manufacturers who now have the option on 100 acres for 100,000 TT dollars. Woodworkers gain access only to occasional remnants. They argue strongly that they should be given access, perhaps by arranging to group to harvest larger areas: 'It is simple. The teak should be optionable to the working classes, to those who have been depending on wood all these years' (Interview, Michael Figaro, 5th July 1999). De Grilla applied for access to teak for the Association from the Director of Forestry but claims to have received a polite letter saying it was 'not available'. He feels that over the teak issue that 'we need now to go political; we need to start to work by saying vote for him, not him. It has come to that' (C. De Grilla, Interview, Rio Claro, 5th July 1999). At the same time, woodworkers feel themselves cornered by links between local politicians and sawmillers, while pursuing their rights through the legal system proves expensive and often ineffective.

Fourth, monoculture plantations are strongly critiqued by other interest groups within Trinidad who give priority to biodiversity and wildlife conservation. In the south-east they have, for example, been strongly

criticised by the South-East Hunters' Association, as 'creating animal deserts in the interests of commercialisation' (Interview, Mohan Bholasingh, 30 June 1999). Indeed the Association was started in 1994 in response to the sense that forestry in Trinidad was too geared towards commercial production, not wildlife, and to lobby government and educate the public on the problems of monoculture plantations. The Association perceives that the Forest Division's abandonment of monocultural teak planting relates partly to their influence. However they now criticise the government's turn to cedar for just the same reasons. Whilst Colombian cedar is now being promoted as a 'profitable plantation crop' the hunter's association points out that it has shallow roots and is particularly vulnerable to hurricane damage.¹⁵ The Association advocates that if plantation forestry is to continue, plantations should at least be mixed, accommodating a greater variety of plant and animal diversity.

Concluding remarks

Much international emphasis is now being given to sustainable natural forest management, and to its certification. Trinidad is one of very few cases drawn on to show its feasibility, as the periodic block system has been operational since the 1960s. Yet the extent to which the experience in Trinidad is pertinent elsewhere needs to be questioned.

First, there are specific conditions in which the PBS has been operating: (a) a pre-existing natural monoculture of a valuable tree; (b) a dependent woodworking community, capable of absorbing much of the work resulting from 'unforeseen' 'externalities' of the system; (c) large subsidisation of the forestry department in an economy which is rich in oil and which inherited a professional forestry service, and (d) a professional forestry culture trained in and supportive of such monoculture, which echoes the particularities of Mora 'natural forest management'.

Second, there must be clear questions concerning the actual sustainability of the forest. Whilst the 'management system' continues, it has had to continuously adapt to unforeseen impacts on the forest. Whilst there are stands of Mora which have gone through two felling cycles, and which are of very high quality, there are also such stands which are highly degraded, swept by fire. There may well be unrecognised non-equilibrial dynamics which felling cycles are interacting which accentuate this sustainability problem.

New pressures on the forest management system may threaten its sustainability. First, squeezing out the woodworkers may break down the sustainability of the system. International consultants have proposed that an increase in profitability and efficiency would be possible if there was a rationalisation of sawmillers (to 5), enabling improved capacity for state regulation of sawmillers, and to proceed with this regardless of implications for livelihoods – for example of woodworkers who may be undermined.¹⁶ But if it is the case that (a) they are self-exploiting at present; (b) have borne the brunt of improvement, and (c) have been cooperative with the PBS, will their eradication help sustainable practice? There must be serious doubts about this. Larger, more powerful millers may easily be able to apply political pressure to gain concessions – as they have been attempting – and may not be prepared to bear the costs of improvements. This might lead to increased profitability at the loss of such sustainability as there is. Moreover, in as much as woodworkers have contributed to the present quality of PBS forest through their own work, there must surely be a serious ethical question that they should be its beneficiaries.

Second, there must be real questions as to whether the PBS, if properly costed, would be economically sustainable. Trinidad has been able to maintain a culture of scientific forestry as opposed to economic forestry largely due to state subsidisation which has only been possible because of the country's relatively high revenue base, mainly from the oil and gas sector. Forestry has not had to be financially autonomous,

enabling its science and practice to continue in particular ways. One of them has been to invest heavily in PBS management over a relatively small area where management requirements are large (although costings do not appear to have been conducted). Moreover, revenues to the forest service are low, which is effectively subsidising woodworkers.

Third, there is pressure in Trinidad from environmental lobbies to stop logging all state forested land due to the impact that it has had on national forests. The argument is to shift all timber production to plantations and private land. In response, foresters have drawn on the PBS to suggest that natural forest management can balance timber and other (conservation) objectives on state land. Indeed the PBS serves as icon of scientific professionalism (and indeed of participation, in co-evolution with woodworkers), in an otherwise vulnerable forest division, saddled with an embarrassing history of poorly performing plantation forestry and a less than participatory ethos. Yet the extent to which PBS in Mora even as presently operating can really ensure 'maintenance of the ecological functions and integrity of the forest' can still be questioned, despite the clear advantages of the system and its capacity to endure to date. The recent history of the PBS suggests that the more chaotic aspects of ecological dynamics may disturb not only the ecological integrity of the system, but also – as managers adapt – its socio-political integrity. As we have argued here, tensions between the Forest Division and the Woodworkers are in part the result of such disturbance, as woodworkers interpret management adaptations as working against their favour. The socio-political struggles so generated may further compromise the sustainability of this dynamic socio-technical system, at least in so far as sustainability is understood in equilibrational terms. Such interlocked dynamics also make it clear that issues of ecological and of social sustainability should not be considered apart.

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². Quote continues: 'Even in Trinidad, management is not intensive but it does qualify as sustainable, even though silvicultural treatments are rarely applied and working plan prescriptions are not followed in strict detail.'

³. See also World Bank 1991.

⁴. The main Mora stands occur in Irois, Matura and Mayaro. The first sawmill was established in the Irois forest in 1855 to supply timber to Port of Spain. In the 1930s, mills existed in each Mora region (Forest Dept: 1933).

⁵. Our methodological approach to science and policy is to focus on the constellation of particular practices and procedures which can be considered as policy. Ideally, such a perspective allows each practice – each workshop, meeting, report, legislative decision, funding flow - to have its own biography, which at once contributes to ‘policy’ without conforming to any particular totalizing narrative of its evolution, enactment, or meaning. Equally, practices that are scientific have their own specificity (permanent sample plots, characterization of ecological zones), and need not conform to any totalizing narrative of scientific method and scientific advance. Second, we explore important ways in which science and policy may be co-produced (by processes such as funding, practices of ‘applied, policy relevant research’, research conceived of to contesting policy, and by the ways scientists define the evidence can be produced, its policy significance), may co-endure (a scientific idea enacted in policy becomes harder to refute) and are co-validated (as policy enactment gives science credibility, and vice versa).

⁶. Cedar, less than 10 feet girth at 8 feet from ground; balata, 8 foot at 5 feet; acoma, balsam, lezard, cypre galba, locust, 6 foot at 5 feet; poui and fustic, 4½ foot at 5 feet.

⁷. See also FAO Forestry paper 55.

⁸. Most SFM employ polycyclic felling; the term polycyclic refers to the fact that only larger trees are cut during the initial harvest so that smaller trees may provide another crop in 25-40 years.

⁹. The Mora forests of Rio Claro East and Guaya ranges, and the mixed/Mora forests of the Catshill range.

¹⁰. Interview, K. John, Rio Claro, 28th June 1999.

¹¹. This is considered, a priori, 40% of the standing volume by Bertault.

¹². This led to problems of licensees not felling defectives.

¹³. Woodworkers purchase standing Mora at 90 cents + VAT/cubic foot, but sell it for 12-13 dollars per cubic foot as logs at the roadside. Cedar they purchase from the state at 1 dollar 10 cents, whereas for private purchases, they would have to pay 20-40 dollars/cubic foot.

¹⁴. There are several further complaints of this genre. Under the silvicultural marking system, each of Trinidad’s four classes of timber is marked at the same time. But according to the Forest Officer’s Handbook, sales of 1st and 2nd class timber – the latter including the dominant Mora – should be closed after the first year that the block is open, leaving only sales of 3rd and 4th class timber for the second year. While this practice seems to be adhered to in some ranges, following the ‘bible’ of the Handbook, the FRIM officers we spoke to seemed unaware of it and felt its sense was debatable (Interview, K. John, Rio Claro, 28th June 1999). The woodworkers feel strongly that the practice disadvantages the many woodworkers who have not managed to fell all of their 1st and 2nd class trees during the first year, and would like to see the Forest Officer’s handbook changed on this issue, but say their requests have fallen on deaf ears (Group discussion, Woodworker’s Association, Rio Claro, 5th July 1999). Furthermore woodworkers explain that it frequently takes them longer than two years to extract their lumber. The conservancy foresters are generally in sympathy with this position, agreeing that while keeping a block open for only 2 years is important to enable rapid and consistent regeneration, under present conditions woodworking conditions there is a need to relax the policy as stipulated in the Handbook.

¹⁵. Whilst teak and pine are not being expanded, FRIM conducted provenance trials for cedars in the 1980s. Of 10-12 provenances tested, one did very well, was planted in sites in 1989, and seeds became available in 1991. One of the reasons for the success of cedar is its strong apical dominance which enables it to overcome stem borer. In an overharvested area of forest reserve in the south-east, degraded *Mora* and crappo was planted with Caribbean pine in the late 1950s and felled in 1993. This was left for natural regeneration, except for a hectare or so which was put to Columbian cedar. This achieved 2m girth in 15 years, encouraging the Division to proceed to further cedar plantations (Interview, S. Ramnarine, 30th June 1999).

¹⁶. The Woodworker's Association (de Grilla, Interview, Rio Claro, 5 July 1999) was in favour of this policy. Dardaine under TFAP suggested rationalise to 5 national sawmills which government would hand over to private enterprise after 5 years. This would have been good; they would have been efficient and modern, while Dardaine was a 'gentleman' who was supportive of woodworkers (and would probably have imposed that these mills buy from them).