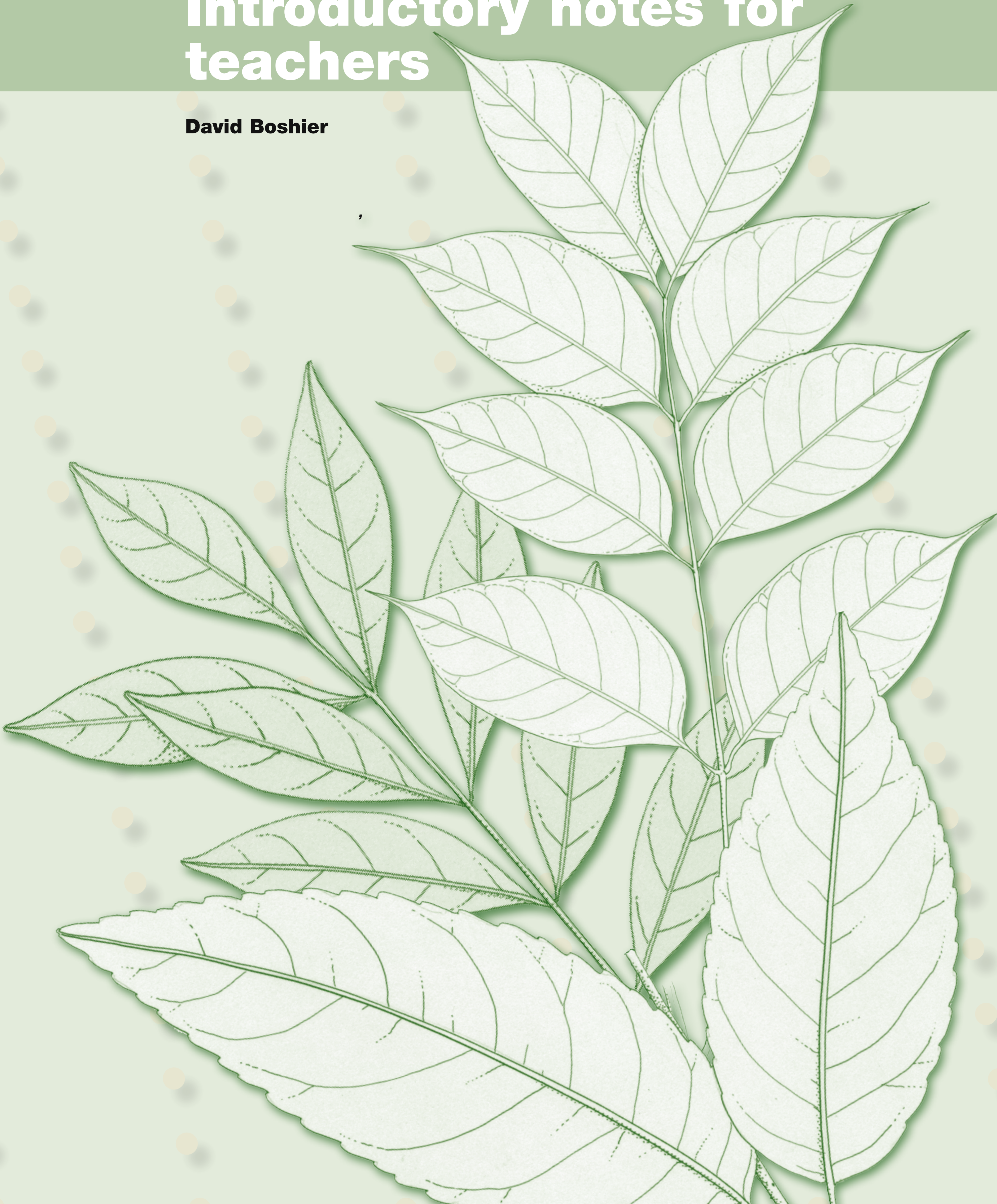
Bioversity International

MODULE 4
Forest Management

Introductory notes for teachers

David Boshier



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Module 4
Forest Management – is sustainable harvesting possible?

Introductory notes for teachers

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Background

Throughout history, people have exploited forests for a wide range of uses (e.g. timber, fuel and food) and have cleared forests to provide land for habitation, agriculture and grazing. Indeed, the decline and disappearance of whole civilizations have been linked to the overexploitation of forests. While such extreme impacts of extensive deforestation are obvious, the impacts of forest exploitation vary depending on the type and intensity of use. Deforestation and logging, for example, may have obvious effects, such as the elimination of some species. They may also have less immediate effects on the longer-term viability of species through impacts on ecological and genetic processes. As such, managers must consider the reproductive and regenerative capacities of priority species and employ management practices that allow natural or artificial regeneration to ensure forests and their constituent populations have a long-term future.

Selective logging involves extracting a proportion of trees, usually the healthier, larger, better formed trees, of one or more species. Many selective logging practices yield substantial profits but are unsustainable, resulting in extensive canopy opening, collateral damage to remaining trees and existing regeneration. Reduced Impact Logging (RIL) techniques were developed to reduce damage through pre-harvest planning, careful felling and use of extraction methods that protect existing regeneration (saplings and seedlings), maintain water quality and minimize soil damage. Although RIL techniques are an essential component of sustainable forest management, they do not address many of the issues related to such management; e.g. RIL alone does not guarantee subsequent timber yields, or ecological or genetic sustainability of the remaining trees. While forest certification (e.g. as accredited by the Forest Stewardship Council-FSC or the Programme for the Endorsement of Forest Certification-PEFC) can give forest owners the incentive to manage forests sustainably by providing access to markets, the ability to deliver sustainable forest management does, however, depend on understanding the effects of extraction practices on the remaining trees.

Logging can have serious implications for the regeneration and population genetic dynamics of both commercial and non-commercial species (e.g. reductions in genetic diversity and heterozygosity, increases in inbreeding and reduced fitness), as well as species' persistence if loss of genetic diversity reduces future adaptability. Selective logging removes large trees (and thus their genes) that probably contribute more to reproduction than smaller trees. It reduces the overall population density of reproductive trees and increases the distance between reproductive trees of the same species. Logging may also affect the abundance, diversity and behaviour of animal pollinators; this, in turn, can have an impact on the reproductive biology and regeneration of species. Similarly, the extraction of non-timber forest products may affect the maintenance of specific species, e.g. through overharvesting of fruits.

Knowledge of the reproduction and genetics of many forest species and their forest interactions is, however, incomplete, limiting attempts to draw conclusions on how to promote genetic sustainability in species' management. Many questions remain, e.g. does the forest recover sufficiently over a set cutting cycle (e.g. 30 years)? Are there enough trees to reproduce after logging and do they produce seed? Are pollinators affected by logging? If the forest management that is promoted or legally required in a region/country is arbitrary with regard to species (i.e. all species are treated equally), are all tree species actually affected in the same way by selective logging?

A further concern about logging has been the possibility that selective logging might reduce the genetic quality of populations. Loggers tend to selectively harvest trees with the best stem form and avoid diseased, small or very large and poorly formed trees. As a result, logging tends to increase the proportion of poor quality trees in the population and may reduce the reproductive contribution of trees that are genetically superior for commercially or ecologically important traits (e.g. growth rate, form, fitness). The extent of such dysgenic selection and associated impacts on fitness are a matter of debate, requiring examination of the basic underlying genetic principles

Introduction to Module 4 Case studies

This module allows students to explore how different types of forest extraction and management (i.e. selective logging and harvesting of a non-timber forest product) may affect the sustainability of the forest and associated tree genetic resources. The three case studies in this module are based on information from published studies and cover a number of issues related to the overall question '*Is sustainable harvesting of forest resources possible and how are the viability and genetic resources of harvested species affected?*' The issues addressed include:

- Inbreeding – changes in mating patterns after logging
- Population bottlenecks and genetic drift
- Modelling – evaluation of long-term impacts of extraction
- Dysgenic selection – high grading, logging of the best trees
- Reproductive materials – source of regeneration

Case study 4.1 Impacts of selective logging on the genetic diversity of two Amazonian timber species. This case study allows students to explore the conditions under which selective logging for timber may sustain the regeneration and genetic diversity of Amazon rainforest tree species. The study presents information from ecological, genetic and modelling research in the context of Brazilian legislation governing logging of these forests. It focuses on two timber species, *Jacaranda copaia* (Bignoniaceae) and *Dipteryx odorata* (Leguminosae), that have contrasting ecology, reproductive syndromes and growth rates. Using the data provided, each group of students develops recommendations for changes in current logging practice or regulations (e.g. minimum diameter cut, cutting cycle) to ensure the sustainability of yield, regeneration and genetic diversity of both species. They also consider the characteristics that make species genetically susceptible to logging. Suits 1-3 groups of 4-5 students per group.

Case study 4.2 Does selective logging degrade the genetic quality of succeeding generations through dysgenic selection? This case study allows students to explore whether selective logging might have led to deterioration in the genetic quality of mahogany populations. Information is presented on the likely incidence and degree of such dysgenic effects, based on consideration of mahogany logging practices, their expected genetic effects and empirical data on phenotypic selection in forest trees. Each group is asked to examine the factors that are likely to affect the probability of a given harvesting regime leading to dysgenic selection and how any negative affects might be mitigated. Suits 1-3 groups of 4-5 students per group.

Case study 4.3 Conserving Prunus africana: spatial analysis of genetic diversity for non-timber forest product management. This case study allows students to explore options for the maintenance of *Prunus africana* and its genetic diversity while sustaining harvesting of its bark. *Prunus africana* is valued for the proven medicinal properties of its bark, which has given rise to an extensive and commercially important international trade. Over the last decade, thousands of tonnes of bark have been harvested by felling trees in natural stands. The study presents information from research on the distribution of the species and its genetic diversity in Cameroon and Kenya and allows students to review it using Geographical Information Systems (GIS). Using the data provided groups either make recommendations for expanding planting of the species in Cameroon or conserving high value populations in Kenya. Suits 2-4 groups of 4-5 students per group.

How to use the case studies

The module provides exercises on selective logging, dysgenic selection and harvesting of a non-timber forest product. Teachers can use one or more of the case studies, depending on geographic interest, particular conservation issue, class size and availability of time. Although all the case studies are based on tropical species, extensive testing shows that students from tropical and non-tropical countries are equally interested in them. If class sizes are larger than the numbers indicated, it is better to use several case studies from the same module, rather than increasing the size of each group. If groups are larger than six, some students tend to not contribute to the discussion and work of their group.

Each case study consists of:

- **The Case Study** - introduces the exercise to be assigned to the students and presents information from research on the particular forest genetic resources issues.
- **Teacher's notes** - give extensive tips on how to prepare and run the exercise and discuss the main learning points that students should be able to derive from the case study.
- **Additional background information** - can be used to introduce the case study to the students. It includes video and PowerPoint presentations.
- **Reference materials** - include PDF files of key publications relevant to the case study.

The exercises can be run in a number of ways depending on the time available and size of the class. The exercises work best if students work in groups of 4-5 (no more than 6). It is best if the students have already read the paper before they start the exercise. *This way valuable class time is not lost with students reading the paper during the class*. So teachers should hand out the case study in a previous class with instructions to read it before the next class. It perhaps goes without saying that it is vital that the teacher and any assistants are fully familiar with the whole text. Each exercise last approximately 3 hours, broken down as follows:

- **Introduction**: use the video and/or PowerPoint - *approx 30 minutes*.
- **Group work**: students discuss the case study amongst themselves, responding to the specific points raised in the case study and developing their strategy. The teacher should circulate among the groups to answer any queries the groups have. However, it is not essential that all of the time is spent with the whole class together with the teacher. Once the teacher and groups are happy that they understand the assignment and issues, the groups could meet, discuss and prepare the exercise outside of class time - *1.5 hours*.

- **Presentations**: each group presents its recommendations to the class verbally, supported by a flipchart or PowerPoint presentation showing the main points – *10 minutes per presentation*, with *5 minutes* after each presentation for questions or comments by the rest of the class and the teacher.
- **Final discussion**: led by the teacher allowing them to make general comments about what was good about the presentations, what was missed, etc. – *10 minutes*.

Key background publications

The following documents can be found on the accompanying DVD, or at the Forest Genetic Resources Training Guide webpage at www.bioversityinternational.org. They give more background to the issues raised in this module and can be used by teachers to strengthen their knowledge and help give ideas about the topics. NB: The three Forest Genetic Resources Conservation and Management volumes: volume 1 - FAO et al. (2004a); volume 2 - FAO et al. (2001); volume 3- FAO et al. (2004b) have examples from both tropical and temperate ecosystems. The Finkeldey (2005) book is of more direct relevance to tropical contexts, whereas the Geburek and Turok (2005) book is of more direct relevance to the temperate, particularly European, context.

Forest management themes

- *Logging – unsustainable use*. FAO et al (2004a), pp. 8.
- *Levels of utilization and their effects on genetic conservation objectives*. FAO et al (2004a), pp. 18–24.
- *Forest management for conservation of forest genetic resources*. FAO et al (2001), pp. 13–44. Jennings et al (2001), Ledig (1992), FSC (2012), CIFOR (n.d.)
- *Glossary of genetics terms*. FAO et al (2004a), pp.103-106, FAO et al (2001), pp.87-90, FAO et al (2004b), pp.83-86.

CIFOR. n.d. *Criteria and indicators toolbox* [online]. Bogor, Indonesia: Center for International Forestry Research. Available from: http://www.cifor.org/acm/pub/toolbox.html [Accessed 21 November 2013]

FAO, DFSC, IPGRI. 2001. Forest genetic resources conservation and management. Vol. 2: In managed natural forests and protected areas (*in situ*). International Plant Genetic Resources Institute, Rome, Italy.

FAO, FLD, IPGRI. 2004a. Forest genetic resources conservation and management. Vol. 1: Overview, concepts and some systematic approaches. International Plant Genetic Resources Institute, Rome, Italy.

FAO, FLD, IPGRI. 2004b. Forest genetic resources conservation and management. Vol. 3: In plantations and genebanks (*ex situ*). International Plant Genetic Resources Institute, Rome, Italy.

Finkeldey, R. 2005. An Introduction to Tropical Forest Genetics. Institute of Forest Genetics and Forest Tree Breeding, Georg-August-University Göttingen, Germany. 219pp.

Forest Stewardship Council. 2012. *FSC Principles and criteria for forest stewardship*. FSC-STD-01-001 V5-0 EN. Bonn, Germany: FSC. Available from: https://ic.fsc.org/principles-and-criteria.34.htm [Accessed 21 November 2013]

Geburek, T, Turok, J. eds. 2005. Conservation and management of forest genetic resources in Europe. Arbora Publishers, Zvolen and IPGRI, Rome. 693pp.

Jennings, SB, Brown, ND, Boshier, DH, Whitmore, TC, Lopes, J. do CA. 2001 Ecology provides a pragmatic solution to the maintenance of genetic diversity in sustainably managed tropical rain forests. *Forest Ecology & Management* 154: 1-10.

Ledig, FT. 1992. Human impacts on genetic diversity in forest ecosystems. *Oikos* 63: 87-108.

Forest Genetic Resources Training Guide

Other modules to be published among the following:
Plantation forestry, Tree domestication, Forest restoration, Genetic modification