Institution: University of Oxford

Unit of Assessment: UOA5

Title of case study:

Saving the world's forests: maintaining biodiversity alongside economic development

1. Summary of the impact

Research by Oxford University has led to the development of a biodiversity assessment tool based on three biological indices, that has been used in many parts of the world to prioritise and protect biodiversity hotspots, particularly in landscapes that are at major threat from logging or conversion to agriculture. In Ghana these methods have led to the protection of ~2,300 km^2 of forest reserves (13% of the total forest network) and were codified in a simple field guide. In Liberia a multinational mining company made important conservation decisions based on the application of these methods. Use of the tool has led to the retention of substantial areas of high biodiversity forest in West Africa, despite competing economic and political drivers, and amidst a continuing general decline in forest condition across the region.

2. Underpinning research

Research by Dr William Hawthorne, originally as a Research Scientist in the Oxford Forestry Institute and latterly in the Plant Sciences Department, has had a major impact on forestry conservation and biodiversity in Africa and South America. In 1996 Dr Hawthorne published a study of the ecology of the forests of Ghana, in which he described (a) a new taxonomy for identifying plant species and (b) novel approaches to the analysis of biogeographical and ecological data[1]. This research showed that:

- Vegetative characters can be used to differentiate even closely related tree taxa.
- Globally rare plants are clustered in hotspots that are present at all geographical scales.
- Heavily exploited timber species are clustered in different areas to globally rare plants.
- Most timber species are well dispersed, light-demanding and not globally rare.

The Oxford University research developed three *Biological Indices* to express and map forests:

- The *Bioquality Index*, which is based on a 'Star' system of categorising species. Black Star species are the most globally rare whilst Green are the most globally widespread. The balance of different Star species in a particular plant community reveals 'Bioquality hotspots' within the forest.
- The *Economic Index*, which highlights the concentration of commercially exploitable tree individuals in a forest. Relative to the standing crop, Scarlet Star species are exploited three times as intensively as Pink species, with Red species intermediate.
- The *Pioneer Index*, which quantifies the balance of pioneer (light-demanding) species germinating after forest damage and is used as a proxy for forest recovery.

The use of these indices made it possible to carry out large-scale '**Rapid Botanical Surveys (RBS)**' in a timely and cost-effective manner and thus to assess species richness and threats within forest communities. Subsequent research used statistical methods to validate the Pioneer Index as a proxy for regeneration state[2] and to corroborate species richness distribution patterns[3].

3. References to the research

1. Hawthorne WD. (1996) Holes and the sums of parts in Ghanaian forest: regeneration, scale and sustainable use. Proceedings Royal Society Ed. Series B 104: 75-176. doi: http://dx.doi.org/10.1017/S0269727000006126 ***Paper introducing the Star system of species classification and 'bioquality' indices.***

2. Sheil D, Salim A, Chave J, Vanclay J, Hawthorne WD. (2006) Illumination-size relationships of 109 coexisting tropical forest tree species. J. Ecol. 94: 494-507. doi: 10.1111/j.1365-2745.2006.01111.x ***Paper confirming the correlation between recovery state of the forest and the Pioneer Index.***

3. Poorter L, Hawthorne WD, Bongers F, Sheil D. (2008) Maximum size distributions in tropical forest communities: relationships with rainfall and disturbance. J. Ecol. 96: 495-504. doi: 10.1111/j.1365-2745.2008.01366.x ***Paper using regression analyses to demonstrate that the largest tree species in Ghana occur in drier and more disturbed forests. Wet forests were associated with high species richness.***

Funding for research: Since 1993 around £2.5M has been received for Dr Hawthorne's research, in grants from the Overseas Development Agency, the Department for International Development, EU FP6, The Oxford Martin School, Intercontinental Hotels Group and BP Biofuels.

4. Details of the impact

Since Hawthorne introduced the concept of the Bioquality index in 1996, RBS has been used to:

- Set forest conservation and management practices in Ghana (1996-ongoing);
- Identify biodiversity-rich forests on Mount Cameroon leading to sustained protection (1997);
- Assess logging impacts in forests in Malaysia leading to the long term protection of important areas (1998);
- Prioritise areas for conservation management in Mexico (2003);
- Develop offsetting strategies after construction of a hydroelectric dam in Sierra Leone (2006 and ongoing);
- Influence mining practices in Liberia, Senegal and Guinea (2008-2012);
- Support biodiversity management decisions in Trinidad & Tobago (2012);
- Inform plans for the expansion of biofuel production in Brazil (2012-ongoing).

Examples in Ghana, Liberia and Brazil illustrate the reach and significance of these impacts.

Ghana

In 1997, the Oxford University Researchers proposed a conservation strategy for Ghana's forests that was based on the use of Star and Bioquality indices[4]. The strategy aimed to reconcile the demand for the conservation of biodiversity with the production of timber and non-timber forest products, and to protect forest reserves. The Ghanaian Government responded by introducing the Timber Resources Management Act (Act 547) and Timber Resources Management Regulations (LI 1649) in 1998. These legislations underpin current Forest Regulations and the enforced logging manual is framed in the context of Star categories (e.g. only limited numbers of Scarlet Star species are approved for logging whereas Black Star species are wholly protected).

In 1999 the Ghanaian Government established the High Forest Biodiversity Conservation Project (HFBCP), which was funded by $9 million from the World Bank. The project's objective was to *"target the forests in Ghana that, based on a comprehensive national forest inventory, rank highest in terms of their global importance for biodiversity"*[5]. The project aimed to conserve biodiversity in these forests through the establishment and protection of Globally Significant Biodiversity Areas (GSBAs). These regions were identified on the basis of their bioquality index as defined by the Hawthorne inventory[1].

One of the objectives of the Globally Significant Biodiversity Areas programme was to engage local communities whose livelihood depended on resources and income from the forest. To facilitate engagement at community level, Dr Hawthorne developed his plant identification methodology into a **field guide for non-specialists**[6]. Development of this user-friendly guide was essential to Ghana's new wave of community participation in forest management as it enabled local people to identify forest flora and thus to measure and monitor bioquality indices. The guide was developed using evidence-based methods to assess optimal content and layout for a non-scientific audience.

Drafts were field-tested with more than 600 potential users across rural Ghana, including school-children, foresters, and the general public. The guide is based on photographs and drawings, and is designed to minimise the need for reading complicated botanical text. It includes 326 species, representing virtually all of Ghana's forest canopy and emergent trees. The field guide is now used by timber companies to ensure accurate identification prior to logging. All of the 2000 copies that were printed have been distributed and are in circulation in West Africa.

At the end of the World Bank funded programme, a post-project evaluation report was commissioned by the Global Environmental Facilities/United Nations Development Program. This concluded that government organisations had successfully introduced new policies, and that the establishment of GSBAs had achieved positive and measurable environmental impacts[7]. In discussing the strengths of the programme, the report stated that "*the outputs included the establishment of 29 forest reserves and their exclusion from timber harvesting on the merit of their high significance as biodiversity-rich areas"* (these 29 form the core of the GSBAs). It also stated that the environmental impacts of establishing the GSBAs were *"(1) afforestation and rainfall patterns improved, (2) illegal tree felling and group hunting reduced, (3) seasonal reduction of volumes of water bodies subsided, and (4) use of poisonous chemicals in fishing ended".*

In 2007, continued forest depletion was estimated to cost 3.5% of Ghana's annual GDP in loss of economic and environmental assets, prompting the International Union for Conservation of Nature (IUCN) to report a *"new paradigm shift of inclusive forest governance in Ghana"*. Conservation of the Globally Significant Biodiversity Areas remains a high priority and key advances since 2008 include:

- Introduction of Dr Hawthorne's field guides, which are now central to all forest survey work. The Head of the IUCN Forest Conservation Programme writes[8]: *"the Star scoring system is now standard knowledge across the forest profession in Ghana. Most foresters are aware of it and understand the importance in terms of rarity values of Black and Gold species. They also understand the importance of protecting these species. The significance of imbuing this knowledge amongst the professional cadre in an economically developing country should not be under-estimated"*.
- In 2009, Ghana was the first country to sign a FLEGT (Forest Law Enforcement Governance and Trade) Voluntary Partnership Agreement (VPA) with the EU[9]. As a condition of the VPA, it is stated that no Black Star species, as defined by Hawthorne[1] can be felled; no timber can come from a GSBA; and regulations and guidelines recommended by Hawthorne[4] must be adhered to. The first FLEGT licenses will be issued in late 2013.

Liberia

In 2010, Dr Hawthorne's group was commissioned by the international mining company, ArcelorMittal (AML), to carry out a Bioquality assessment of the West Nimba region of Liberia, a mountainous area and global biodiversity hotspot. AML used the botanical survey to assess the environmental impact of proposed iron ore mining activities, and to investigate the scope for offset or mitigation. A second assessment in 2011 and recommendations published in 2013[10] have guided AML's operations in the area. The Environmental Adviser for AML reports[11] that key activities in relation to conservation and mitigation have been:

- To position all new roads, ore concentrators and waste centres away from high quality forest, and some existing roads are being re-aligned.
- To avoid mining one of the ore bodies because of its co-location in high-quality forest.
- To carry out plantation trials with species that are important to local communities for medicine, food and construction materials, to compensate for any loss from forests.
- To protect culturally important and rare species at mine sites, and collect seeds from individual trees to propagate in a local tree nursery.
- To cultivate globally rare and taxonomically distinct species in nurseries for restoration and re-vegetation when mine sites are closed (estimated ~2030).

Brazil

Currently, the University of Brasília and BP Biofuels are using Hawthorne's RBS tools to assess

biodiversity in the *Cerrado* hotspot of Brazil. *Cerrado* is attracting international attention because of its agricultural and biofuels potential, and associated biodiversity conflicts. RBS is being used to prioritise areas for conservation, whilst supporting agricultural and economic development[12].

5. Sources to corroborate the impact

4. Hawthorne WD, Grut M, Abu-Juam M. (1998). Forest Production and Biodiversity Conservation in Ghana, and Proposed International Support of Biodiversity Conservation. CSERGE working paper (held on file). ***This paper was presented at the hearing of the World Commission on Forests and Sustainable Development in 1997. It proposed the now adopted conservation strategy for Ghana's forests.***

5. Appraisal document for the World Bank grant to support the HFBCP project (1998). Held on file and also available from: http://www.thegef.org/gef/sites/thegef.org/files/gef_prj_docs/GEFProjectDocuments/Biodiversity/Ghana%20-%20Natural%20Resource%20Management/Project%20Document.pdf ***Outlines the strategy to establish GSBAs (page 46, Annex 2, component 5).***

6. Hawthorne WD, Gyakari N. (2006). Photoguide for the forest trees of Ghana. A tree- spotter's field guide for identifying the largest trees. OFI. ISBN 9780850741643. ***Definitive guide used by timber companies to ensure accurate identification prior to logging.***

7. Global Environment Facility (GEF) and United Nations Development Programme (UNDP) evaluation document. Country Programme Case Study: Ghana. (2007). Held on file and also available from: sgp.undp.org/index.php?option=com_docman&Itemid ***Final report confirming positive effects of establishment of GSBAs.***

8. Letter from the Head of IUCN Forest Conservation Programme (held on file), ***confirming the importance of the Star Scoring system in terms of helping to preserve Ghana's forests.***

9. Voluntary Partnership Agreement between the European Community and the Republic of Ghana on forest law enforcement, governance and trade in timber products into the Community (2009). Held on file and also available from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:22010A0319%2801%29:EN:NOT ***Annex II outlines the definition of legal timber. Compliance with the criteria for both sourcing and harvesting timber requires adherence to legislation in Act 547 and/or LI 1649, both of which are framed in the context of Star categories.***

10. Nimba Western Area Iron Ore Concentrator Mining Project Environmental and Social Impact Assessment. Held on file and also available from: http://www.arcelormittal.com/liberia/documents/Volume_4_Part_1_1_Forest_Botanical_Impact_Assessment.pdf ***This document was drafted by Hawthorne and issued by the environmental consultants URS/Scott Wilson. It contains details of both the 2010 and 2011 botanical surveys in Nimba County, Liberia. It provides management recommendations in the context of how mining operating procedures could be modified/implemented in order to conserve both global and local biodiversity. The RBS methodology and results are included.***

11. Letter from the Environmental Adviser for ArcelorMittal (AML) Liberia (held on file), ***confirming key conservation and mitigation impacts in relation to Liberian forests in mining areas.***

12. Letter from the CEO of BP Biofuels (held on file), ***corroborating the use of RBS to help prioritise areas for conservation in Brazil.***