FINAL TECHNICAL REPORT

(17th February 2006)

DFID Project Reference Number	R6913
NR International Contract Number	ZF 0034
Title of Project	Conservation through use of tree species diversity in fragmented Mesoamerican dry forest
Research Programme	Forestry Research Programme (FRP)
Research Production System	Forest Agriculture Interface
Research Programme Purpose	New knowledge applied to problems in forest and tree resource management, the resolution of which benefits poor forest and tree - dependent people within the Forest/Agriculture Interface.
Project Leader & Institution	Dr. Kate Schreckenberg, Overseas Development Institute
Geographic Focus	Mesoamerica, specifically Honduras and Mexico
Start and End Date	15/9/1997 – 31/1/2006
Total Cost	£248, 012 for ODI part; £499,392 for total project

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EXECUTIVE SUMMARY

Preparation of a four year multidisciplinary research project began in 1995 as two separate projects whose merger involved compromising objectives and staff changes. The final stages of preparation and early implementation also coincided with a re-orientation of donor priorities, which whilst not enshrined in the project document were to influence implementation. Early in-depth consultation with local organisations involved in rural development and tree diversity conservation also led to an accommodation of their interests. The influence of these changes and the inherent complexity of multidisciplinary applied research are discussed with respect to the directions taken by the research and the conclusions, recommendations and outputs.

The research took place in four case study communities in each of two *case study areas*: coastal Oaxaca in southern Mexico and the departments of Choluteca and Valle on the southern pacific coast of Honduras.

The research consisted of:
1) botanical sampling of forests patches and fragments across the two case study areas;
2) socio-economic and botanical surveying in all the case study communities;
3) supporting economic investigations in two communities in each case study area;
4) policy studies, integrated vertically from community to national level in both countries.

In the Southern Honduran case study communities and three of the Oaxacan communities, natural regeneration was revealed to be the principle source of tree products and services for resource poor farmers, often as part of crop-fallow cycles. This was true even in southern Honduras, a densely populated area with little room for extensive areas of forest. A checklist of all trees found in the study areas was produced. The relative proportion of rare species in any given location (or bioquality) was used to determine that site’s genetic heat index (GHI). GHI varied greatly between case study areas, with mature forests and long cycle fallows in parts of Oaxaca being of outstanding conservation value. Strong community management of land resources in these areas was found to be a key to maintaining tree cover.

In Southern Honduras, low GHI scores suggest there is little prospect for advancing tree diversity conservation in the region. Instead there is a need to better understand the role of trees, especially naturally regenerating trees, in the context of marginal farming systems. Farmers respond to a complex set of motivations and constraints in tree management. The abundance and many uses of natural regeneration needs to be considered more fully before more expensive means of artificial regeneration are proposed as solutions to rural development problems.

Overall there was very little overlap between the minority of species classified as rare and those considered most useful by farmers. Thus the most simple application of conservation through use – the enhanced use of rare species – is severely limited in the context of mesoamerican dry forests. However, in Oaxaca, the conservation through sustained use of high bioquality forests and fallows has the potential to contribute to tree diversity conservation.

1. BACKGROUND

1.1. Development of the project

A presentation of the complicated history of this project provides an important insight into how the demand for the project was ascertained, its objectives developed, and why the project outputs were not all as easily achieved as hoped.

The project began as three separate submissions to FRP in 1995:

- An application by David Boshier of the Oxford Forestry Institute (OFI) for an extension of his FRP-funded work (R5729) on 'Genetic diversity and population structure of trees in fragmented dry zone forests of Central America'.
- A proposal by Colin Hughes (OFI) for a new project entitled 'Conservation of tree species in Mexico and central America' to identify which species in Southern Honduras could successfully be conserved through *circa situ* conservation. This project aimed to produce a checklist of species, map the distribution of the species, group the species into categories of conservation priority, and build up a picture of farmers' preferences for particular species to assess their *circa situ* conservation potential.
- A proposal by Elizabeth Cromwell and Angus Brodie of the Overseas Development Institute (ODI) following up the conclusions of a 1994 pilot study of multi-purpose tree germplasm management in Honduras (R6054), which had showed that farmers faced problems in obtaining sufficient good quality tree germplasm. The new project was entitled 'Forest genetic resources management in small-farmer communities' and aimed to investigate the importance of multi-purpose trees in farming systems, identify the principal tree characteristics and functions demanded by farmers, identify the most convenient way for farmers to obtain germplasm, and assess the potential for *circa-situ* conservation using cost-benefit analyses. Research was planned in Honduras only.

The latter two projects already planned to work in the same field sites, but FRP reviewers requested greater integration. At a meeting of all the researchers concerned in August 1996, it became clear that David Boshier's work was sufficiently different (and already underway) that it should continue independently of the other two projects, but that active exchange of information should be maintained (as has indeed been the case - see resulting publication by Boshier, Gordon and Barrance in section 6). It was also decided to use the preparatory phase foreseen in the Hughes proposal to prepare a joint submission covering the main aims of both the Hughes and the Cromwell proposals. In combining these two, the research was clearly refocused on looking at the links between conservation and development, and considering the range of options between *in situ* and *circa situ* conservation for local species.

The main activity during the resulting two-month project preparation phase (R6514) was a visit by Angus Brodie, Michael Richards and Kate Schreckenberg to Honduras and Mexico in October 1996. The first two members of the team were both very familiar with Honduras and the main purpose of the visit was to discuss the combined project and finalise collaboration details with CONSEFORH and NGOs, particularly in the proposed study area in the South of the country. In Mexico, the aim was more fundamental, namely selecting the geographic area in which the project would work (choosing between Manantlan Biosphere Reserve, the Northern Yucatan Peninsula and the Oaxaca coast) and making links with collaborating governmental and non-governmental organisations as appropriate.

Implications of the merging of the two proposals:

- The botanical content of Colin Hughes' original proposal – a conservation biology project – was reduced to work at only four field sites in each country.
- The socio-economic work in the ODI proposal had to be extended to Mexico. This arose not just out of the integration of the two projects but also from the fact that Honduras was due to slip off the bilateral priority list in 1998.
- The conservation focus of the OFI project and the development focus of the ODI project had to be combined, leading to a continuous tension between these two aspects. Although mostly constructive, this tension was not always easy to work with.
- The size, multidisciplinary and multi-institutional nature of the project required a larger-than–foreseen amount of management time.

- Methodological changes were necessary to align the fieldwork schedules for the botanical, socio-economic and economic project components, which were not completely satisfactory to anybody.
- A large budget. The separate projects had been worth £332,000 for 36 months (OFI) and £181,000 for 28 months (ODI). The combined project was well over the approximate ceiling of £100,000 per year for FRP projects. In an effort to reduce the budget, field and office time of the project coordinators in the UK was severely reduced, no progress meetings were budgeted for, etc. This became a serious issue after two of the originators of the projects withdrew, each for separate and unforeseen personal reasons (see Box on staff changes).

Staff changes

Although perhaps inevitable, staff changes can have important implications for projects. In this particular project, all key staff changed very early on in the process.

- The first change came when Elizabeth Cromwell pulled out of the ODI proposal in mid 1996 (i.e. before the project preparation mission) due to maternity leave followed by other work pressures and handed over to Kate Schreckenberg and Michael Richards. This resulted in a loss of interest in germplasm as a key issue.
- At the Oxford Forestry Institute (shortly afterwards integrated into the Oxford University Dept of Plant Sciences, DPS), Colin Hughes withdrew from the project in late 1996 just before the project began. He was replaced by Jamie Gordon, with some additional supervision being provided by Dr. Will Hawthorne. Neither Jamie nor Will had Colin's familiarity with the tree flora in the study area, and they therefore faced a steep learning curve.
- At the Overseas Development Institute, Angus Brodie had to withdraw from the project just as fieldwork began (January 1997) and was replaced by Adrian Barrance with just two weeks of overlap. While Adrian had the advantage of knowing the Honduras study area well, he had not previously used the methodologies in the way planned by Angus.

The original project proposal had been written to make best use of the strengths of the planned field team (Brodie and Hughes). The new field team (Gordon and Barrance) had different strengths and interests and, not having been involved in the planning phase, did not have 'ownership' of the project in quite the same way. They joined the project at a time when fieldwork had to get underway very quickly and little time was available for lengthy induction. Thus, although best efforts were made by all concerned to transmit the long history and key concerns of the project planners, a lack of time and the lack of supervision/project review foreseen within the curtailed budget meant that some points inevitably fell by the wayside. Based on the strengths and interests of the new team, the project document was interpreted in a way that resulted in some activities being carried out rather differently from what was originally foreseen. The lack of annual reviews and field supervision time (for Kate Schreckenberg and Michael Richards – the only remaining members of the project planning team) meant that the implications of these changes in emphasis did not emerge clearly until quite late in the project's lifetime.

Changes in the donor context

Given the project's four-year duration, it is perhaps not surprising that it was affected by changes within DFID and FRP. Thus DFID's growing focus on poverty eradication exacerbated the tensions already existing between the conservation and development components of the project, favouring the latter at the expense of the project's original primary focus on conservation.

The requirement that all FRP projects produce policy briefings and carry out maturity and training workshops came in the last year of the project. While a welcome introduction in the general sense, it did mean some serious juggling of activities (with associated opportunity costs) to fulfil the requirements.

1.2 Key development constraints addressed by the project

The key developmental problems addressed by the project were:

1. The loss of forest and tree cover, and specifically the loss of tree species diversity, from the dry forest zone of Mesoamerica.
2. The assumption that loss of tree cover and diversity results in the sustainability of local farming systems being threatened, due to the breakdown of traditional interdependencies between livelihoods and the natural resource base
3. The lack of understanding by local NGOs of farmers' decision-making processes regarding tree management, leading to their provision of a narrow range of quick-fix technical solutions not always appropriate to local conditions.
4. At a methodological level, the lack of integration of natural and social-science based methods within the same environment, resulting in piecemeal approaches and partial solutions

1.3 Summary of significant previous research

In the wake of the 1992 UN Conference on Environment and Development, biodiversity conservation became an increasingly prominent public policy issue and a central goal for international conservation agencies (WWF, 1993). Earlier, Janzen (1988) had already raised the alarm about the threatened dry tropical forest in Mesoamerica, estimating that it had been reduced to only 2% of its original extent and was one of the most fragmented and endangered tropical ecosystems. When the project began, concern was being voiced about the lack of success in the region of conventional *ex situ* and *in situ* conservation methods (Utting, 1993; Kemp, 1993; Green, 1990). There was growing interest, therefore, in *circa situ* approaches (Altieri and Merrick, 1987; Cooper *et al.*, 1992; del Amo, 1992a and 1992b; Pimental *et al.*, 1992; Kanowski and Boshier, 1997).

The main regional socio-economic analysis of farmers' decision-making with respect to tree management had been carried out by CATIE, mostly in the context of agroforestry adoption. Work by Scherr (1992) and Current *et al.* (1995) had highlighted the key factors – land, labour and capital, as well as opportunity cost – underlying farmers' decision-making. A small unpublished report from Southern Honduras (Colindres *et al.*, 1995) had compared farmers' needs for different tree species in villages in different altitudinal ranges.

By 1996, there was beginning to be recognition at the international level that conservation and development objectives could not always be easily integrated (Blaikie and Jeanrenaud, 1996). Locally, work by Cromwell *et al.* (1996) in Honduras had drawn attention to the fact that NGOs involved in tree-planting activities often had little understanding of either the farmers' needs or the characteristics of the species they promoted.

On the methodological front, there was no relevant literature on how to integrate social and natural-science based methods for conservation and development research. The different components of the project were, however, able to draw on a varying range of experience in their respective areas. With respect to biodiversity assessment methods, for example, very little formal guidance was available at the time (Hawthorne and Hughes, 1996) but the project adapted methods being developed by Hawthorne (1996) that included a weighting system to assess 'bioquality'. The preparation of botanical checklists was facilitated by the use of recently developed BRAHMS botanical software (Filer, 1996) to capture specimen information. On the socio-economic side, the project used more standard approaches, based in part on Participatory Rural Appraisal (Chambers 1994 a, b and c) and in part on more conventional household interview techniques. The economic component of the project required some methodological innovation. This drew on work on a review of economic valuation of direct use benefits of trees by Current *et al.* (1995), the IIED 'Hidden Harvest' (e.g. Guijt, 1996), and attempts to tackle the difficult problem of contingent valuation of indirect use values of trees by Richards and Escobar (1995) and Emerton (1996).

1.4 Identification of demand for the project

Demand for the original OFI and ODI submissions (1995) was based, in each case, on the previous experience of the principal field researchers (Colin Hughes and Angus Brodie) in the study area. Particularly strong contacts existed with CONSEFORH, the then British-funded Honduran forestry research arm, and with the national herbarium in Mexico. Demand for the combined project was confirmed during the project preparation visit in late 1996 during which meetings were held with government agencies, bilateral project staff, international and local NGOs, academic institutions, independent consultants and farmers.

2. PROJECT PURPOSE

The project's purpose was 'Biodiversity conservation methodologies, appropriate to existing cultural and tenure systems developed and promoted'. Specifically, the project sought to evaluate the potential for conservation of tree species diversity through use within the farm-forest landscape in the tropical dry forest zone of Mesoamerica. The potential role of conservation-through-use within an overall conservation strategy was to be determined through the assessment and analysis of socio-economic, economic and conservation values of tree species in areas of differing degrees of forest fragmentation.

The project's aim, to collect data to enable it to make recommendations regarding tree biodiversity conservation strategies, directly addressed the first development constraint, namely the loss of forest and tree cover, and tree species diversity, from the dry tropical forest zone of Mesoamerica.

The project's aim, to contribute to an improved understanding of the socio-economic factors underlying the problem of forest cover and tree species diversity loss, directly addressed the assumed relationship between these two problems and the sustainability of farming systems. Furthermore, it intended to help fill the gaps in NGO understanding of farmers' tree management practices. The latter constraint was also addressed by the project's adoption of a methodology that involved training local NGOs, working with them, presenting results to NGO networks, etc.

The project's aim, of developing a multidisciplinary methodology to investigate biodiversity-related issues, addressed the final development constraint, namely the previous lack of integration of natural and social science-based methods.

3. RESEARCH ACTIVITIES

3.1 Study site selection

A Project Preparation Mission was carried out from 26th October to 16th November 1996 in Honduras and Mexico, in order to identify potential study areas and collaborators. On the basis of this mission, two case study areas were chosen in the Mesoamerican dry forest zone: the southern Honduran Departments of Choluteca and Valle and the Pacific Coast of the state of Oaxaca, Mexico. The reasons for the selection of these areas (summarised in Table 1) were the following:

- contrasting conditions of forest intactness
- contrasting social, tenure and policy conditions
- pre-existing or promising institutional links.

Table 1. Criteria for study area selection

Criterion	Southern Honduras	Coastal Oaxaca
Forest condition	Almost complete conversion to cyclical basic grain cultivation, ranching and export agriculture	Large areas apparently intact, but significant areas converted to shifting and permanent agriculture
Social conditions	High levels of poverty and polarisation, low levels of organisation	High levels of poverty, interesting organisational structures
Tenure	Almost exclusively private (de jure/de	Largely communal/ejidal

	facto) and individual, highly polarised, much renting	
Culture	Almost entirely mestizo	Largely mestizo, some indigenous areas

In each of these two areas, four case study communities were chosen to provide foci for the investigations (Table 2 and Table 3). The socio-economic survey work was carried out entirely within these communities; the economic investigations were carried out in two communities in each area; and the botanical *farm survey* to compare tree diversity between land uses was realised within these communities. This relatively small sample size was chosen to permit in-depth study in each community. A small and non-randomly chosen sample does not allow extrapolation of results with known levels of confidence to elsewhere in the two areas. However, given that a range of conditions was covered by non-random selection, and that on-going discussions about emerging findings were conducted with institutions across these regions, it is felt that some area-wide generalisations are justified.

Botanical sampling was also carried out beyond the study communities. A *forest survey*, methodologically similar to the farm survey, was carried out in forest fragments across the two areas. These forests were not selected at random but were biased a) in order to maximise geographical coverage, and b) towards larger forest fragments.

The separate policy studies carried out in Mexico and Honduras went well beyond the immediate case study area, given their aim of elucidating the vertical integration of the policy and institutional framework within which conservation and rural development takes place from within the two areas and up to a national level.

The basis for the selection of the study communities was that, between them, they should approximately represent the diversity of physical, socio-economic and vegetation conditions commonly found in rural communities in each of the study areas. The principal criteria applied were:

- geographical location and altitude
- principal crops and cropping systems
- access to markets and out-of-community employment
- level of NGO or government presence.

Table 2. Honduran study communities

Community	Municipality	Department
San Juán Arriba	El Corpus	Choluteca
Agua Zarca*	Langue	Valle
San José de las Conchas	Marcovia	Choluteca
Los Coyotes*	El Triunfo	Choluteca

*Focal communities for economic field work

Table 3. Oaxacan study communities

Community	Municipality	District
El Sanjón	San Pedro Tututepec	Juquila
La Jabalina	Santa María Huatulco	Pochutla
El Limón*	Santo Domingo Tehuantepec	Tehuantepec
Petatengo*	San Miguel del Puerto	Pochutla

*Focal communities for economic field work

3.2 Botanical Fieldwork

Botanical fieldwork was carried out in Honduras from January to September 1998 and in Oaxaca from November 1998 to November 1999. Herbarium work was ongoing throughout this period, initially in Honduras and continuing to April 2000 in Mexico City.

The basic method employed was based on the Rapid Botanical Survey (RBS) of Hawthorne (1996) as described in the Project document. RBS has three components:

(i) define species quality (called 'star categories' by Hawthorne) by assessing as far as possible with available data, the various ecological and biogeographic characteristics of each species which can be used as the basis for defining values for patches of forest or other vegetation;

(ii) sample a representative, random subset of species (ideally more than 40 species) present in a patch of vegetation (forest, secondary forest or other tree systems) of similar overall structure, landscape position and history;

(iii) calculate scores for samples based on species present using a 'weight' calculated for each species star category. Each species' star category is determined principally by its geographic distribution as revealed by herbarium specimens (see below) with adjustments made for ecology (weedy species are marked down, i.e, put in a category of lower importance.), taxonomic distinctness (species from monospecific genera are marked up) and relation to economically important species (congeners of economically important species were marked up). A dichotomous key for ranking is shown in Appendix 1.

This procedure proved suitable for surveying trees in vegetation (land-uses) of highly variable structure, from mature forest to shade trees in pasture.

The farm survey was generally carried out on a randomly selected subset of land units farmed by households interviewed in the socio-economic survey. Random selection was compromised in some cases when householders were available and willing to accompany the survey team to parts of their farm, thus allowing for informal discussions about farm biodiversity. Given its proximity to the home, this meant that the most commonly sampled land use type was the home garden. In communities with land use types not well represented elsewhere these land use types were over-sampled relative to the others, e.g. coffee fields in San Juan Arriba, Honduras, long cycle fallows in El Limón, Oaxaca and lemon plantations in El Sanjón, Oaxaca. The other land uses encountered and sampled were grain fields, pasture, woodlots ('forests') and some orchards.

Research in the herbaria of El Zamorano, Honduras (EAP), and Mexico City (MEXU) consisted of identification of botanical specimens and the determination of species distributions for ranking species in star categories. It was originally intended to determine species distribution by logging specimens from the two herbaria in the botanical database BRAHMS. However the limited and inconsistent secretarial support available at EAP and the vast size of the collection at MEXU meant that a more rapid approach needed to be adopted. Distributions were estimated, only of those species encountered in the field, by sifting through the specimens of each species encountered in the field and noting its occurrence in each Mexican state or Central American Country.

Having surveyed land units, identified the species and assigned them to the star categories, the Genetic Heat Index for each sample was calculated. This index allows direct comparison of the samples, with those samples having the highest content of narrowly distributed species having the highest score.

Why use stars instead of IUCN categories?

IUCN has developed a complex system for categorising species according to the threat faced by each. However in the context of this project the system (whose application has succeeded in classifying but a small minority of the dry forest tree species of Mesoamerica) was not useful. This project required a more rapid system to ensure every species identified could be categorised. Thus in relatively short time and using mainly information from two collaborating herbaria (EAP and MEXU) plus additional information from published checklists and monographs where available, the star system was able to provide an approximation of the relative likelihood that each species would go extinct. Furthermore, the IUCN system does not lend itself easily to producing aggregate scores for samples based on the occurrence of various species at a particular location. Each star category can be given a numerical value (based on estimated distribution) that allows for the weighted mean of the sample (the GHI) to be calculated. In this way, the necessary between sample comparisons were possible.

Data processing and analysis
The forest management database TREMA (4.1) was used for both data storage and analysis (calculation of genetic heat indices for each sample). Vegetation samples were also analysed using the ordination method of DECORANA (de-trended correspondence analysis). For this the software PCordwin was used. TREMA 4.1 prepares vegetation data in the form of matrices for export into such ordination programmes and thus the two software packages 'interface' well. However, TREMA 4.1 is far from user friendly and would not have been a useful database had the project not had the developer of this programme (W. Hawthorne) on call.

In total 280 land units (forests, home gardens, pastures, arable land) were surveyed and analysed in Southern Honduras and Oaxaca.

3.3 Socio-economic Fieldwork

Socioeconomic research was carried out in the communities listed in Table 2 and Table 3 between January and September 1998 in Honduras, and from October 1998 to April 1999 in Mexico. Field research consisted of the following:

i) **Initial meetings** in each community, with open invitation, in the course of which permission was sought to conduct research, and the objectives and *modus operandi* of the project were explained;
ii) **Initial collection of generalised information** on the characteristics (demography and economics) of each community, through participatory exercises (matrices) in the course of the same initial meetings;
iii) **Participatory stratification** of community members according to socioeconomic criteria defined by participants, during the initial meetings;
iv) **Selection of interviewees** (farm households) through stratified random sampling, based upon the strata identified during the initial meetings. A minimum sample size of 20 households per community was set as a target; time constraints meant that this was also the maximum achieved (see Table 4 for sampling intensities);

Table 4. Sampling intensities for household level surveys

	Community				
Honduras	**San Juán Arriba**	**Agua Zarca**	**San José de las Conchas**	**Los Coyotes**	**Total**
Total households interviewed	20	20	20	19	79
Total households in community	160	62	150	57	429
Sampling intensity (%)	12.5	32.2	13.3	33.2	18.4
Mexico	**El Sanjón**	**La Jabalina**	**El Limón**	**Petatengo**	**Total**
Total households interviewed	20	20	20	20	80
Total households in community	30	32	43	Approx. 100	205
Sampling intensity (%)	66.7	62.5	46.5	20.0	39

v) **Household level data collection**, through semi-structured interviews focusing on agricultural production systems, the roles and uses of trees, the species most used for different products, tree management practices and the interviewees' perceptions of trees in different situations within the farm. The interviews were very flexible and conversational in nature, depth of understanding and opportunities for exploring unforeseen themes being considered of primary importance. Given the cumulative length of the interviews, data was recorded manually rather than taped, and then entered as text into computer;

vi) **Visits to agricultural plots**, in the company of a subset of farmers, in different stages of the agricultural cycle, to discuss agricultural and natural resource management practices;
vii) **Community-level data collection**, through focus groups dealing with production systems, organisational structures and tenure (see Table 5 for list of focus group topics). Participants (between five and eight in each meeting) were identified during the interview phase as being knowledgeable and reliable informants. A range of tools borrowed from Participatory Rural Appraisal, such as flow charts and using cards and matrices for preference ranking, was applied to stimulate discussion and clarify points. The meetings were held in the houses of key informants, to avoid attracting excessive numbers of people and the discussions developing into the more stilted affairs typical of public meetings. Given the difficulty of taking written notes of discussions with multiple participants, they were taped and subsequently transcribed;

Table 5. Focus group topics

Community	Topic
Honduras	
San Juán Arriba	Coffee cultivation
	Fruit production
	Off farm employment
Agua Zarca	Basic grain cultivation
	Livestock raising
	Firewood and timber use
San José de las Conchas	Basic grain cultivation
	Livestock raising
Los Coyotes	Firewood and timber use
	Fruit production
Mexico	
El Sanjón	Differences between flat and steep land
	Agricultural production systems
La Jabalina	Tree management and use
	Trends in resource management and welfare
El Limón	Resource management and control structures
Petatengo	Resource management practices
	Resource management and control structures

viii) **Feedback meetings** in each community to present and discuss results, supported by community feedback documents (Barrance and Flores, 1999a; Barrance and Ortiz, 1999a).

In addition, desk studies were carried out in order to gain a broader understanding of patterns and trends, and triangulate information obtained from the socioeconomic fieldwork:

i) **Study of landscape and land use patterns and trends,** through aerial photographs (where available, in time series; see Table 6);
ii) **Analysis of population and agricultural census data**;
iii) **Review of existing literature** on natural resource management practices and history in the study areas.

Table 6. Availability of aerial photographs

Study areas and communities	Date	
Honduras	**1954**	**1983**
San Juán Arriba	x	x
Agua Zarca	x	x
San José de las Conchas	x	x
El Triunfo	x	x
Oaxaca	**1985**	**1995**
El Sanjón	x	-
La Jabalina	x	x
El Limón	-	x
Petatengo	x	x

Data Processing and Analysis

Following initial verbatim input of interview transcripts into computer as text, the data were organised and analysed in the following ways:

i) Responses to interview questions were **grouped into themes**; given the open and conversational nature of the interviews, this in effect represented a post-fieldwork definition of questions.

ii) A **database of interviewees** was constructed in Excel, with one file per community and one row per interviewee (interviewees being allocated unique three digit codes, the first digit representing their community). Information in the database included:
- household characteristics (*e.g.* age, family size, house construction)
- income sources
- training received and institutional affiliations
- holding size and farm components
- land management practices (*e.g.* rental, fallow, burning, agrochemicals)
- sources of tree products
- availability of tree products
- species used for different uses.

iii) Species were ranked according to the number of interviewees by whom they were mentioned as used (this did not necessarily reflect their individual importance to each interviewee).

iv) Species were ranked according to the frequency with which they were mentioned as being managed in different ways.

v) The relative importance of different sources of tree products (as determined by numbers of interviewees mentioning each source, rather than quantities obtained from each) was compared across socioeconomic groups.

3.4 Economic studies

The economic studies took place over October-December 1999. The Honduran study, carried out in Agua Zarca and Los Coyotes communities, aimed to assess how existing economic incentives to manage or maintain trees are likely to impact on on-farm tree biodiversity, and how the latter is likely to change in response to economic pressures in the future.

The approach used was to estimate the economic value added by trees to the basic grains production system, and how this might change with increasing population/land pressure or market demand for tree products. Larger less-intensive (longer fallow period) and smaller more-intensive (shorter fallow) farms were compared. The methodology involved household surveys; individual key informant farmer discussions to collect economic data on tree products and basic grain production; and workshops of key informants to rank forest benefits and discuss the opportunity costs of tree retention. A particular difficulty in the calculations was tree density, although rough estimates by farmers were elicited in the survey.

3.5 Policy studies

Policy studies were commissioned in each country in early 2000. The implications of existing laws, policies and institutional structures for the conservation status of the dry forest were analysed by means of a literature review of present and past laws (and the institutional arrangements which they specify); tendencies in policies; and interviews with key informants at a number of levels from high levels of central government through to community representatives. The methodology, together with an initial list of laws and policies to be analysed and actors to be interviewed, was discussed and refined through initial "scoping" meetings in each country attended by representatives of a range of governmental and non-governmental institutions.

Further to the policy study consultancy carried out in Honduras, a policy briefing paper was produced in Honduras to inform the formulators of the forthcoming new forestry law on the specific conditions and requirements of the dry forest (Barrance *et al., 2000*).

3.6 Changes in the planned methodology

Over the course of the project, several of the planned methods were amended or changed. In some cases, methods had been left fairly open in the project document, in the knowledge that they could only be finalised in the field. In other cases, planned methods were found not be practical or could not be implemented with the time and human resources available. In this section, we try to document some of the changes as a way of 'learning lessons' for future projects.

3.6.1. Involvement of NGOs

The project planning team had originally envisaged very close collaboration of NGOs in the field research and data analysis. It was intended to select villages together with NGOs and to have NGO staff 'seconded' to the project team for the duration of the fieldwork in the communities in which they worked. This process was begun in Honduras where, after lengthy consultation with all the conservation and/or development NGOs in the Choluteca region, fieldwork began with a three-day training course for NGO staff. This provided some background to the project and an introduction to both the botanical and (particularly) the socio-economic methods the project intended to use.

Whilst project funds were sufficient to cover NGO staff costs for fieldwork, they were insufficient to cover the cost of replacing these staff members in their NGOs. It was therefore difficult to get these staff members to commit sufficient time to the project, whose research was of interest but not fundamental to the immediate goals of their work. In addition to this, technical capacity within the NGOs was low. The project need was for consistent counterpart support, so independent researchers were recruited from within the host country and supported by continuous feedback with local NGOs in every possible forum. The on-going interest this sustained in project activities ensured interest in project results and recommendations, beyond completion of the project.

3.6.2 Participatory nature of the research

It was intended from the outset that the research, particular on socioeconomic aspects, should be highly participatory in nature, in order to maximise the reliability of the results and their utility to local and institutional stakeholders. A number of concrete actions and strategies were undertaken with the aim of maximising participation:

- Invitation to NGOs and Government representatives to participate directly in the research;
- Realisation of a workshop in Choluteca in 1998 to train potential NGO and Government collaborators in participatory research methodologies;
- Involvement of NGOs and Government representatives in the selection of study communities, with the aim of maximising the utility of the results for them;
- Formulation of a multi-institutional steering committee in each study area;
- Production and dissemination of periodic information bulletins for institutional counterparts;
- Publication of articles on the research in local and national newspapers, and broadcasting of radio spots (see Part 7);
- Participatory stratification of each community on the basis of wealth criteria defined by community members;
- Utilisation of PRA tools in focus group meetings;
- Use of community members as "para-botanists" in the botanical survey team;
- Realisation of feedback meetings to local communities at the end of the field research period;
- Realisation of 'maturity workshops' in each of the two study areas involving NGO and Government counterparts.

The following lessons were learnt on participation:

- NGOs and Government institutions tend to face time and resource constraints which limit their ability to participate directly in research (see previous section).

- While it is possible and desirable for study community selection to be influenced by the preferences of counterpart institutions, this must be balanced by the need for the research to be scientifically valid and replicable.
- Steering committees can prove useful, but given the need for scientific soundness there is a limited degree to which their recommendations can be taken into account. Their most useful role in practice may be as a source of information on changing local conditions (particularly in the policy sphere) and an organ for dissemination of project progress and results.
- The use of PRA-type tools does not equate to participatory research. Essentially the agenda of research of this kind is externally formulated and designed principally to generate answers for external actors, even if these aim eventually to generate benefits for the local stakeholders through improved institutional effectiveness.
- It is possible to provide information of potential use to local stakeholders and especially to NGOs and other institutions supporting local communities, without distracting from the original objective of the research. However given the limited time span of the research and its specific objectives it is unlikely in most cases that the researcher will be able to form a genuine part of participatory development processes underway in the study communities.
- Differences of approach and even conflicts may exist between NGOs and other institutions and this may place the researcher in a difficult position; the very presence of the researcher in the community may in some cases exacerbate frictions and suspicions.
- Para-botanists drawn from the local population can be extremely useful, especially in allowing the botanical research to be linked to the socioeconomic research through the provision of information on local names for plants; however it is more effective for the botanical research to continue using one good para-botanist in all of the study communities, rather than one for each community.
- Interest in the community feedback meetings was variable, and responses from the participants very limited. These meetings were a means of fulfilling a commitment to feedback made to community members at the outset of the research; however they would need more careful planning, and possibly collaboration of local NGOs, to be really useful to stakeholders.

3.6.3 Limited integration of socio-economic and botanical fieldwork

It was originally intended that socioeconomic and botanical research would be carried out jointly. However it soon became evident that this was impractical, for the following reasons:

- Although the Rapid Botanical Survey (RBS) was relatively fast, the botanical research was still more time-consuming than the process of discussing tree uses and farming systems, involved in the socioeconomic research, and to integrate the two would have placed undue burdens on the time and patience of the farmers, on whose presence the socioeconomic research depended.
- The botanical work was restricted to a particular season (when trees were in flower or fruit) by which time the socio-economic work (including selection of communities and sample farmers as well as at least some interviews with sample farmers) had to have been completed.

It proved more important to integrate the two aspects of the research in the initial and ongoing planning of sample selection and research methodologies (which showed a high degree of flexibility in response to lessons learnt on the job), in the comparison and harmonisation of results (for example the linking of very variable common names to scientific names) and the interpretation of the results.

3.6.4 Limitation of quantitative on-farm inventories

Initially it was intended to supplement the RBS with plot based sampling in the farm surveys, to assess abundance within plots, in order to determine whether tree numbers and species diversity were related to the socio-economic (or other) status of farmers. This was not carried out, due to the need to cover as much ground as possible with the time and resources available for the botanical survey in order to determine conservation priorities, a goal to which the RBS methodology used proved well suited.

However an inventory, not foreseen in the project document, was carried out in early 2000 of germplasm in the fields of a subset of the farmers involved in the socioeconomic and economic research, in two contrasting study communities in Honduras (see 0). Temporary sample plots were established in 10 fields, and live stumps, seedlings and trees were identified and counted; in addition, a complete count and identification was made of standing trees in each field surveyed. Due to the small sample size, there were limited possibilities for the resulting data to be integrated with the results of the other components (botanical/socioeconomic/economic) of the project; the chief value of these results was to demonstrate the scale of the tree germplasm resource present within the basic grain production system, disaggregated by size class and species, and thereby to place the information gathered on farmers' protection of trees in fields in perspective in relation to the rest of the germplasm present.

3.6.5 Economics in consultancy style

Research into economic aspects was carried out in the form of relatively short-term consultancies, relatively late on in the process. A problem that transpired with this "consultancy" style was that, although significant previous desk-based discussion had occurred during the initial planning phases of the project (before the study sites were chosen or the botanical and socio-economic research carried out), detailed planning of methodology only really started once the economics teams arrived in country, with the result that they had limited time to develop methodologies adequately tailored to answering key questions and building upon the results of the other aspects of the work to date. An early one-off visit to the study sites, while the other research was in progress, might have been useful to get a feeling for the situation, before going back to UK to plan the methodology.

There was discussion as to whether the economics work should have been carried out early on, in order to generate hypotheses to be examined through the other aspects of the research, or later, to complement and validate the results of the other aspects. It is likely that the second approach, which was the one applied, was the more practical; if the economics study had not had access to the information, provided by the socioeconomic research, on how farming, tree management, livelihood and tenure systems worked in qualitative terms, there would have been a significant risk that they would have been asking the wrong questions.

The economic research included household surveys to gather basic household data on quantitative economic aspects. This occupied time, which was of the essence under the conditions posed by the short term consultancies; however, at least in the case of Honduras, it proved impossible to identify a suitable local assistant to collect these data in advance. It would also have been possible to collect these data in the course of the semi-structured household interviews carried out in the socioeconomic research; however, while these interviews did collect basic quantifiable data, introducing additional detail would have risked trying the interviewees' patience too much and would have limited opportunities for the qualitative discussions of farmers' decision-making processes.

4. OUTPUTS

The proposals contained in the original project document were subject to continuous review throughout the execution period, in order to ensure that maximum advantage was taken of lessons learnt and of the results of the regular productive discussions that occurred between team members and with project counterparts. This approach was applied both to the research methodologies used (as explained in the previous section) and to the formulation of the outputs of the project. The principal factor taken into account in considering the reformulated outputs was their utility and relevance to the achievement of the objective. Table 7 compares the outputs originally set out in the project document with those that were subsequently proposed and achieved.

Table 7. Reformulation of project outputs

Outputs proposed in original project document	Proposal of reformulated outputs
▪ An annotated checklist of tropical dry forest species developed for the case study areas, consisting of a species database including botanical, socio-economic and economic information relating to each species. ▪ A methodology developed to integrate botanical, socio-economic and economic information held	▪ An annotated checklist of tropical dry forest species developed for the case study areas ▪ A list produced of species of global conservation priority in both case study areas ▪ A list produced of sites and land uses of high bioquality in both case study areas ▪ Farmers' relations with trees and forests in the

in the species database into categories of 'conservation through use' potential ▪ The conservation, economic and socio-economic value of forest remnants and their surrounding agricultural interfaces analysed ▪ Strategies for the conservation and use of tropical dry forest species diversity recommended ▪ Research results effectively disseminated	two study areas characterized ▪ The current status and roles of conservation through use defined in the two case study areas ▪ Conditions for conservation through use to contribute to global conservation goals and livelihood promotion identified ▪ Opportunities and needs for intervention identified ▪ Research results effectively disseminated

The principal factors taken into account in formulating this revised list of outputs were the following:

- As the study progressed, differences between the two study areas became increasingly apparent, in terms of the level at which trees were managed (principally as individuals in southern Honduras and principally as parts of forests in Oaxaca) and of their global conservation priorities (low in the case of southern Honduras and high in Oaxaca). It became evident that the applicability of conservation through use (CTU) varied on a case by case basis, depending on a wide range of factors; it was concluded that a simple formula linking botanical, socio-economic and economic factors contained in a database would be excessively simplistic. Emphasis was placed instead on producing recommendations of the factors to be taken into account in case-by-case analyses.
- Given the relatively low global conservation priority, but high livelihood importance, of trees in Honduras, together with the increasing prioritisation by DFID of poverty reduction, additional emphasis was given in the analyses to differentiating between the potential of CTU for contributing to global species conservation and local livelihood support.
- It was recognised that more emphasis was needed than originally proposed in the project document on understanding how local people's farming systems and decision-making processes worked, in order to allow workable conservation strategies to be developed.

4.1 An annotated checklist of tropical dry forest species developed for the case study areas
A total of 280 sites were sampled, including forest and farm samples, and over 600 species of woody (tree and shrub) species were identified. An annotated checklist was produced as planned, and made available on the internet at www.mesoamerica.org.mx[1]. This database, which included all of the species found in the botanical surveys, focused principally on the location and conservation priority of the species, with additional information on the land uses in which they were typically found.

4.2 A list produced of species of global conservation priority in both case study areas
All of the species found were categorised according to the Hawthornian 'star' system described above. Hawthorne's original star categories were labelled according to the colours of the Ghanaian flag, but, for the Mesoamerican context, it was decided to replace these with categories A-D. The list of priority species, by conservation category, is presented in Appendix 2. The results of this process are summarised in Table 8.

Table 8. Numbers of species by conservation category

	Category A (very high conservation concern)	Category B (high conservation concern)	Category C (medium conservation concern)
Honduras	0	4	7
Mexico	17	18	33
Total	17	22	39*

*One blue star species (*Rondeletia deamii*) occurs in both Oaxaca and Honduras)

[1] The host organisation was paid to maintain the checklist for a few years but it has since been removed from the site. However, the checklist will be included in the project book that is in preparation.

Of the more than 600 species found, 78 are considered to be of conservation concern due to their restricted ranges (see Appendix 2). Of these, 17 are endemic to the Pacific dry forest zone of Honduras or Oaxaca and are therefore classified as Category A (highest conservation concern). In addition, two species (*Bombacopsis quinata* and *Guaiacum sanctum*) were found that were not classified as category A, B or C, but are listed by IUCN as 'vulnerable' or 'endangered'

There is a striking difference between Oaxaca and southern Honduras in terms of the numbers of species, which are of high global conservation priority, as defined by their restricted range. This study found no category A (highest priority rating) species at all in southern Honduras. It should be noted, however, that the presence of such species should not be ruled out, as the present study only covered a sample of the area. Nonetheless, the consistently higher relative content of restricted range species found in the surveys carried out in Oaxaca, when compared to those carried out in Honduras, suggests that Oaxaca's Mesoamerican Tropical Dry Forest is of greater global importance for the conservation of threatened tree diversity than that of Honduras.

4.3 A list produced of sites and land uses of high genetic heat in both case study areas

Each of the sites sampled using the Rapid Botanical Survey (RBS) methodology in the two study sites was allocated a Genetic Heat Index (GHI) value based on the numbers of high conservation priority species which it contained. The results are summarized in Appendix 3.

This analysis confirmed the suggestion, based on the total numbers of high priority species in each area, that Oaxaca is of significantly greater importance for the conservation of globally rare tree species than southern Oaxaca.

The least disturbed mature forest fragments of Oaxaca, together with some associated fallows, contain particularly large numbers of species of high global priority. The most obviously important area is the coastal belt of Oaxaca, between Huatulco and the western end of the Isthmus of Tehuantepec. Within this belt, four areas particularly stand out:

- Extensive tracts of mature deciduous forest on the coastal plain;
- Deciduous forest on the steep hill of Cerro Guiengola;
- Deciduous beach front forest;
- Semi-deciduous forest on the steep hill of Cerro Huatulco.

Also notable in Oaxaca is the large number of high priority species in a number of non-forest sites, located near to areas of mature forest; examples of such sites were found in the study communities of La Jabalina (close to the mature forests of Huatulco) and El Limón (close to Cerro Guiengola).

4.4 Farmers' relations with trees and forests in the two study areas characterised

Analyses were carried out, based on the results of semi-structured interviews carried out with a total of 159 farmers and thematic focus groups in each of the study communities, of the functioning of farming systems, and how farmers perceive, use and manage trees and forests. The questions asked were different in the two study areas given the marked differences between the themes of relevance in each.

Southern Honduras

Tree Uses

Farmers described a wide range of uses (20) obtained from trees, the most frequently mentioned of which were firewood, timber (for construction and sale) and fruit (for domestic consumption).

Perceptions of benefits and disadvantages of trees on farm

Farmers recognised a range of implications of maintaining trees in association with crops; negative implications were mentioned far more frequently than positive ones. Negative implications included: reduction of crop yields by tree shade; competition for space by low-spreading trees; damage to crops from raindrops falling from the leaves; young crop plants being crushed by the leaves of large-leaved species; the yellowing of maize plants hit by exudate falling from *Gliricidia sepium*; crop growth being affected by tree species considered to be 'hot'. Positive effects included: improvement of maize yields by falling leaves of *Albizia saman* and *A. caribaea*; conservation of moisture in the postrera (second) sowing of maize; and provision of beneficial 'heat' by *Mimosa tenuiflora* to maize in cool periods.

Table 9 shows the contribution that the sale of trees for timber can make to smallholder farm economies. In the best case (large-scale farmers with many trees), the net benefit from trees is at least ten times greater than that from agricultural crops, with combined tree and agricultural income about 30% higher than that obtained by small-scale farmers with fewer trees. Agricultural incomes are reduced by less than 20%, implying that tree production need not have significant impacts on food crop production. The higher per hectare net benefit from tree production achieved by larger-scale farmers is explained by their greater capacity to access markets for tree products (Richards et al., 2000).

The situation in Los Coyotes is by no means typical of southern Honduras. In the community of Agua Zarca, the net benefit from tree production only constituted between 9 and 13% of the combined net benefit. The difference between these situations is not due to the amount of tree material present, which was approximately equal in the two communities (Box 5.5); rather, the principal factor is the availability of easily accessible markets in the case of Los Coyotes, compared to Agua Zarca where road access is difficult and there are no nearby market centres for timber.

Table 9. Annual average economic benefits ($/ha) from trees and crops in Los Coyotes (Richards et al., 2000)

	Small-scale farmer (<3.5ha land and ca. 21 trees per ha) ($/ha)	**Large-scale farmer (>3.5ha land and ca. 42 trees per ha) ($/ha)**
Agricultural production		
Income	288	238
Costs (without family labour costs).	108	92
Gross agricultural return[a]/ha	180	145
Cost of family labour in agriculture	159	139
Net benefit[b]/ha	**21**	**6**
Tree production		
Income	51	188
Costs (without family labour costs).	4	49
Gross return of tree production[a]/ha	47	142
Cost of family labour in tree production	23	40
Net benefit[b]/ha	**54**	**98**

[a]*Gross return = value of production minus costs of production, including the opportunity cost of capital, but without deducting the cost of family labour*
[b]*Net benefit = value of production minus costs of production, including family labour.*

Tree use by species

The farmers interviewed mentioned 67 species as being used for timber, 44 for firewood and 39 for posts (0). However, a few species were listed much more frequently than most, including *laurel* (*Cordia alliodora*), *quebracho* (*Lysiloma* spp.) and *madreado* (*Gliricidia sepium*).

Table 10. Species most reported as used for firewood, timber and fence posts in southern Honduras study communities

Species most reported as used for firewood	**Species most reported as used for timber**	**Species most reported as used for fence posts**
1. *Lysiloma* spp.	1. *Cordia alliodora*	1. *Gliricidia sepium*
2. *Cordia alliodora*	2. *Bombacopsis quinata*	2. *Cordia dentata*
3. *Albizia caribaea*	3. *Enterolobium cyclocarpum*	3. *Lysiloma* spp.
4. *Caesalpinia eriostachys*	4. *Albizia saman*	4. *Mimosa tenuiflora*
5. *Mimosa tenuiflora*	5. *Lysiloma* spp.	5. *Cordia alliodora*
6. *Gliricidia sepium*	6. *Swietenia humilis*	6. *Mimosa platycarpa*
7. *Acacia hindsii*	7. *Conocarpus/Rhizophora*	7. *Bursera simaruba*

8. *Calycophyllum candidissimum* 9. *Lonchocarpus* spp. 10. *Guazuma ulmifolia*	spp. 8. *Calycophyllum candidissimum* 9. *Cedrela odorata* 10. *Simarouba glauca*	8. *Acosmium panamensis*

Access to tree products

The majority of farmers said that they did not have problems in satisfying their needs for firewood, timber and posts (0.

Table 11. Proportion (%) of informants in Honduras considering availability of different tree products to be sufficient (Suff.) and insufficient (Insuff.)

Community	Firewood		Timber		Posts	
	Suff.	**Insuff.**	**Suff.**	**Insuff.**	**Suff.**	**Insuff.**
San Juán Arriba	86	14	74	26	90	10
Agua Zarca	70	30	85	15	95	5
San José de las Conchas	87	13	90	10	90	10
Los Coyotes	71	29	95	5	100	0
Total	77	23	86	14	93	7

Farmers in lower wealth categories tended to experience greater problems of scarcity (see 0). However, the landless did not report problems obtaining posts or timber, as they had no land to fence in or build upon.

Table 12. Proportion (%) of informants in different wealth categories in Honduras considering availability of tree products to be sufficient (Suff.) or insufficient (Insuff.)

Socioeconomic category	Firewood		Timber		Posts	
	Suff.	**Insuff.**	**Suff.**	**Insuff.**	**Suff.**	**Insuff.**
A (landless)	66	33	100	0	100	0
B (with backyard, but have to rent other land)	66	33	77	23	85	15
C (<10mz, do not rent land)	66	33	73	27	73	27
D (10-50mz)	92	8	92	8	100	0
E (>50mz)	100	0	100	0	100	0

Tree management and conservation

In spite of farmers´ concerns about the negative impacts of trees on crops, 82% of interviewees reported protecting certain species in their fields. This protection consists of taking care, when clearing fallow areas or weeding, not to cut seedlings or stump regrowth of these species. An inventory carried out on 10 farms (see 0) found between 13 and 139 trees/ha protected in the fields.

Table 13. On-farm tree material in Los Coyotes and Agua Zarca, southern Honduras

	Agua Zarca (n=6)		***Los Coyotes (n=4)***	
	Average	***Range***	***Average***	***Range***
Trees/ha. (>2m height)	43.0	13-139	75.6	27-102
Stumps/ha. (<2m height)	5,636.1	2917-7550	6495.8	3983-8500
Seedlings/ha. (<2m height)	4,627.8	1567-10167	1545.8	1367-1650
Stumps+seedlings/ha.(<2m height)	10,286.1	6567-17717	8041.7	5633-10067
Species/plot (100m^2 area)		8.8-13.3		13.0-16.0
Total species found	89			

Farmers listed 46 different species as being actively protected in fields, but a few species are protected with much more frequency than others (0). These include *laurel* (*Cordia alliodora*), *caoba* (*Swietenia humilis*) and *quebracho* (*Lysiloma* spp.).

Table 14. Numbers of farmers reporting the active protection of different tree species in their fields in southern Honduras

Species	**Farmers**	**% (n=79)**
Laurel (*Cordia alliodora*)	30	38.0
Caoba (*Swietenia humilis*)	18	22.8

Quebracho (*Lysiloma* spp.)	16	20.2
Guanacaste (*Enterolobium cyclocarpum*)	8	10.1
Carreto (*Albizia saman)*	8	10.1
41 other species (of which 7 are exotics)	1-5 each	1.3-6.3

In addition to the trees which are actively protected, an average of nearly 6,000 live stumps and 3,400 seedlings of tree and shrub species were recorded per hectare, suggesting that active protection has a relatively small impact on population structure and dynamics. The stumps persist in fields from one fallow period to the next, and the seedlings originate from the seed rain from neighbouring trees, or germinate from the latent soil seed bank once conditions are favourable. A total of 89 species were found in the 6,000 m^2 area sampled, however a single species (*Casearia corymbosa*) made up more than 25% of all the individuals found, and 10 species between them accounted for more than 80% of all of the individuals.

Oaxaca

Tree Uses
The range of different uses and benefits obtained from trees and forests, listed by the informants in coastal Oaxaca is as diverse as that previously reported for southern Honduras. Of the uses and benefits mentioned, the majority are obtained from individual trees, either within the forest or in the agricultural landscape. Only four of those mentioned depend on the existence of the vegetation in general (hunting, soil fertility restoration and ecotourism). In addition to benefits, farmers also mentioned a number of disadvantages and problems caused by trees in relation to agriculture, health and in their domestic situation.

Sources of tree products
In contrast with southern Honduras, most farm families in the Oaxaca study area obtain their tree products from communal land that can be freely accessed by all community members, rather than from their own plots (Table 15).

Table 15. Sources of firewood and timber reported by farmers in Oaxaca case study communities.

Source	% of farmers (n=80)	
	Firewood	Timber
Communal land	62.5	53.8
Backyards	30.0	3.8
Agricultural plots	18.8	16.3
Pastures	0	1.3
Others' land	5	3.8
Purchase	3.8	10.0

Tree use by species
The species most reported as used for firewood and timber are shown in Table 16. A total of 56 different species were listed as being used for firewood, 97 for timber and 31 for medicines. The species used varied widely between communities: 79% of firewood species and 75% of timber species were only reported as being used for these purposes in one community.

Table 16. Species most reported as used for firewood and timber in Oaxaca case study communities

Firewood	Timber
1. *Hesperalbizia occidentalis*	1. *Cordia eleagnoides*
2. *Apoplanesia paniculata*	2. *Comocladia engleriana*
2. *Gliricidia sepium*	2. *Hesperalbizia occidentalis*
4. *Citrus* spp.	4. *Cordia alliodora*
5. *Guazuma ulmifolia*	5. *Enterolobium cyclocarpum*
6. *Acacia collinsii/hindsii*	6. *Gliricidia sepium*
6. *Cordia alliodora*	7. *Apoplanesia paniculata*
8. *Acacia cochliacantha*	7. *Cocos nucifera*
9. *Acacia farnesiana*	9. *Calycophyllum candidissimum*
10. *Cocos nucifera*	10. *Tabebuia rosea*

Forms of protection and management of trees and forests

1. Tree planting

The active planting of trees is concentrated in backyards, principally for fruit production. Only three of the 10 species most commonly reported as being planted in backyards (*Spondias mombin, Leucaena esculenta and Byrsonima crassifolia*) are native.

In one of the study communities, Petatengo, community members have been encouraged by a local NGO to carry out enrichment planting of native species in communal forests, aimed at increasing the commercial value of the forest, both in terms of direct products for the community and of hydrological services for downstream neighbours, thus increasing the community's incentive to conserve it. The programme encountered some opposition from larger ranchers, concerned that reforestation activities in the *agostadero* (communal razing lands) would lead to restrictions on grazing. Other community members were fearful for the community's tenure over the reforested lands.

2. Protection of trees by individuals

Unlike southern Honduras, active protection of trees is concentrated in the backyards, where it focuses on planted, rather than naturally regenerated trees. Trees in cropping areas rarely receive active protection; rather, the negative effects of tree shade on crops are normally overcome by simply eliminating the trees in question, rather than pruning them as occurs in Honduras. In only one of the four communities, Petatengo, was this reported, largely in response to motivation by an NGO.

Trees are also protected through unwritten rules governing the relations between individuals. These apply principally to areas where communally owned lands have been enclosed for individual use.

3. Silvicultural management

The principal forms of silvicultural management used are irrigation and the pruning of branches. Both practices, but particularly irrigation, are more frequent in backyards than in cropping areas.

4. Community-based protection

In all of the study communities, formal controls exist (at least in theory) at community level on the felling of trees for timber and the clearance of forest areas, in order to prevent over-exploitation and guarantee the provision of tree and forest services. In some communities these controls can be highly effective and have led to the persistence of large areas of unbroken forest of high conservation importance.

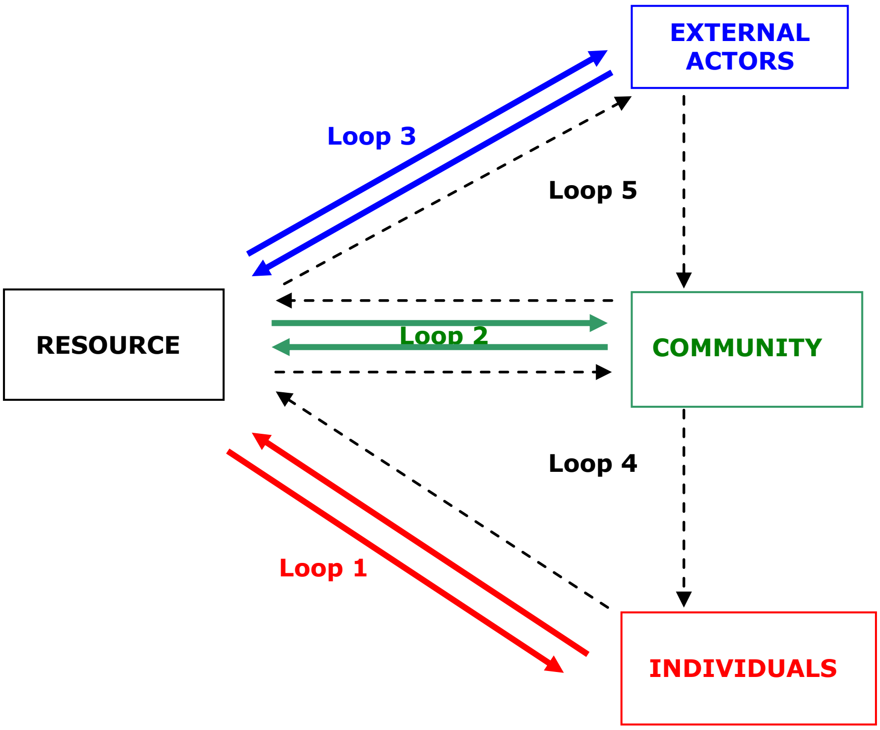
4.5 The current status and implications of conservation through use defined in the two case study areas

Conservation through use is a reality in both of the study areas, but its form and implications differ widely:

- In southern Honduras, naturally regenerated native trees valued for their products (principally timber) are actively protected by farmers in fields. This **species level CTU** is of significant importance for livelihoods as it helps to ensure the continued supply of tree products; however its global importance for tree species conservation is low as the species involved are, almost without exception, of low priority for conservation.
- In Oaxacan dry forest, communities conserve forests (rather than individual trees) from which valuable products and services are obtained. This **ecosystem level CTU** has important livelihood benefits in ensuring the continued supply of these products and services, and also leads to the effective protection of a large number of species of high global priority, many of which are 'free riders' (i.e. not actively valued in their own right but benefiting from farmers' valuation of other species in the forests where they occur). The species which benefit are those listed in Appendix 2, which are of high global conservation priority and also occur in communally managed forests.

The different forms of CTU encountered are presented as a series of 'loops' in Fig. 1.

Fig. 1 Alternative mechanisms of conservation through use



Examples of these loops, found in the study communities, are presented in Table 17.

Table 17. Examples of CTU loops encountered in study communities

CTU Loop	Example
Direct CTU	
Loop 1: Benefits to individuals lead them to conserve.	Protection of trees in fields by farmers in southern Honduras
Loop 2: Benefits to communities lead them to conserve.	Community-level regulations on forest use in La Jabalina, El Limón and Petatengo, Oaxaca
Loop 3: Benefits to external actors lead them to conserve the resource.	Declaration of Huatulco National Park in Oaxaca by federal authorities
Indirect CTU	
Loop 4: Benefits to communities result in conservation by individuals.	Avoidance of felling and burning by individuals in La Jabalina, El Limón and Petatengo, Oaxaca (overlaps with Loop 2 as largely motivated by community regulation)
Loop 5: Benefits to external actors lead to conservation by local actors.	Forest protection in Petatengo due to the prospect of compensation for environmental service provision to hotel complex downstream (overlaps with Loop 2 as compensation leads to benefits to the communities)

It was also clear that there is a range of relationships between use and conservation, other than CTU. In the case of *Bombacopsis quinata* in Honduras, for example, use has led to over-exploitation and reduction in local abundance, a situation also reported at local level with *Amphyteringium adstringens* in Oaxaca. The conditions which determine the nature of the relationship between conservation and use are set out under section 4.6.

4.6 Conditions for conservation through use to contribute to global conservation goals and livelihood promotion identified.

In section 4.5 it was recognised that CTU occurs at both species and ecosystem levels, and in different situations can have benefits for global conservation and/or local livelihood support. The research results allowed the definition of a series of conditions for it to be effective in contributing to conservation and livelihood support.

Conditions for CTU to contribute to global conservation goals

Characteristics of species that could benefit from species level CTU:
The examples studied show that species level CTU can only contribute to the conservation of tree species diversity in the case of species with a very specific set of characteristics:

- Of high conservation priority.
- With uses which lend themselves to sustainable management (such as fruit, which does not entail felling of the tree, or timber if the species is prolific or vigorous enough to allow extraction to be compensated for by regeneration).
- With uses which are of sufficient importance to farmers to motivate them to invest in protection, even if this involves negative impacts on crops or other costs.
- With uses which cannot easily be provided by substitute species.
- With the ability to regenerate and compete in highly disturbed agricultural environments (particularly for timber trees, which farmers tend to maintain in their fields rather than the more protected backyard environment).

Conditions under which CTU may contribute to conservation at the species level
In addition, species level CTU is more likely to be successful if the following socioeconomic and environmental conditions apply:

- Secure individual long term rights to tree use.
- High levels of demand or need, either for subsistence use or for sale, for the goods and services produced by the tree (in the case of sale, this implies easy market access).
- Scarcity of the products and services provided by the species in question.
- Low levels of opportunity cost associated with tree management, for example in the case of low value crops where the economic costs of crop losses caused by tree shade are low, or shade resistant crops.
- Awareness on the part of farmers of the silvicultural potential and yield of the species involved.
- A favourable regulatory context, which minimises the restrictions and administrative difficulties associated with marketing tree products (this may require the decentralisation of controls and the strengthening of social auditing, in order to avoid abuses).
- A biophysical environment which is favourable to tree regeneration; this may, for example, largely rule out many flat lands where mechanised cultivation is used.

Conditions under which CTU may contribute to conservation at the ecosystem level
The research results indicate that a specific set of conditions must be met for use to motivate effective conservation at ecosystem level:

- The goods and services produced by the ecosystem confer greater benefits on the community than alternative land uses. This implies the existence of a need or demand for the goods and services and, where the benefits are financial, functioning markets.
- The ecosystem has the long term capacity to produce the goods and services which motivate investments in its conservation.
- The goods and services produced by the ecosystem are compatible with the long term conservation of its individual components (e.g. species) of high conservation priority.
- Effective structures exist for formulating and enforcing regulations, based on awareness of the condition and potential of the resource in question.

Conditions for CTU to contribute to local livelihood support

Tree level CTU

- Large numbers of individuals (including seeds, seedlings and stumps) of species which yield useful products and services, can regenerate easily in fields and tolerate pruning and other management activities.

- Access to markets (either within or outside the community) for the tree products.
- Secure individual long term rights to tree use.
- A favourable regulatory context.
- An environment which is favourable to tree regeneration (for example without excessive intensity of burning or soil compaction).

Ecosystem level CTU

- Potential of the ecosystem to contribute to livelihoods through the provision of goods and services.
- Appreciation by the people who manage the ecosystem of its provision of, or potential to provide, products and services.
- Compatibility of the enjoyment of the products and services with the long term conservation of the resource.
- Effective mechanisms for the distribution of the benefits and/or the compensation of the costs of conservation to those who invest in it.
- Effective mechanisms for the participation of those who receive products and services from the resource in decisions relating to its management.
- Effective regulation of the management and use of the resource.

4.7 Opportunities and needs for intervention identified

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Given the wide range of factors affecting the applicability of CTU and the wide variability in these conditions across the MTDF zone, it was concluded that case-by-case analyses of whether investment should be made in the promotion of CTU would be more appropriate than providing set recommendations regarding its applicability to particular species or sites.

Definition of scenarios where CTU may work

For guidance and illustration purposes, a range of scenarios were defined under which CTU may prove useful, depending on the relative priority of the objectives of species conservation and the promotion of the livelihoods of local people (Table 18).

Table 18. Checklist of situations in which to pursue CTU as an option

Objective	Alternative scenarios
Conservation of rare or threatened species	**Scenario 1: Priority species which are valued by local people, growing in agricultural landscapes** Conditions for CTU to work: - Farmers have security of use rights over their trees; - The species in question is able to regenerate easily (naturally or artificially) in highly disturbed conditions; and - The species is capable of yielding the products and services for which farmers value them without long term detriment to its population viability. **Example:** *Leucaena salvadorensis* managed in fields in southern Honduras.
	Scenario 2: Priority species which are not specifically valued by local people, growing in forests which are valued by local people Conditions for CTU to work: - Local people have rights and capacities to use, manage and conserve the forests where the species occurs; and - The use by local people of the forests (for example through the selective harvesting of other species) does not negatively affect the species in question. **Example:** *Achatocarpus oaxacanus* in forests and mature fallows in Oaxaca.
	Scenario 3: Priority species which are valued by local people, growing in forests Conditions for CTU to work: - Local people have rights of use, management and conservation of the forest where the species occurs - The species is capable of yielding the products and services for which people value them (for example through NTFP or timber extraction) without long term detriment to its population viability. **Example:** None found in this study.

Livelihood support	**Scenario 1: Trees which give livelihood benefits, in agricultural landscapes** Conditions for CTU to work: - Farmers have security of use rights; - The species is able to regenerate easily in highly disturbed conditions; and - The species is capable of yielding the products and services for which farmers value them without long term detriment to their population viability. **Examples:** *Cordia alliodora* and *L. salvadorensis* managed in fields in southern Honduras
	Scenario 2: Trees which give livelihood benefits, in forests - Local people have rights and capacities for use, management and conservation of the forests where the species occurs; and - The species is capable of yielding the products and services for which people value it without long term detriment to its population viability. **Example:** *Comocladia engleriana* and *Swietenia humilis*, both of which are used for timber in forests in Oaxaca
	Scenario 3: Forests which give livelihood benefits - Local people have rights and capacities for use, management and conservation, of the forests in question; and - The forests are capable of yielding the products and services for which people value them without long term detriment to ecosystem viability. **Example:** communal forests of Santa María Huatulco, used for water supply and environmental and recreational services.

Procedure for case-by-case determination of potential of CTU
A procedure was defined for the case-by-case determination of the potential applicability of CTU, as follows:

1) Determine which species, types of vegetation, or specific areas of vegetation are of greatest global conservation concern.
2) Identify which species farmers and other resource-users value or depend upon.
3) Identify which of the species important to local people are most in danger of becoming scarce and thereby affecting livelihoods.
4) Determine whether CTU can work with, or build upon, existing forms of use and management.
5) Predict how the use considered may affect the populations or ecosystem in question.
6) Characterise the dynamics over time of the landscape where the species or ecosystem occurs.
7) Determine resource users' rights.
8) Characterise the regulatory and policy contexts.

Priority needs for intervention
Priority forms of intervention were also identified in cases where, on the basis of the analysis proposed above, CTU is considered to have potential.

1. Promote tenure and usufruct rights
2. Research and promote income generation activities
3. Promote processing and marketing opportunities
4. Develop awareness and strengthen community organisation
5. Promote benefit distribution mechanisms
6. Monitor impacts

General recommendations were also developed for the case study communities and areas with similar characteristics:

Priorities for conservation in the Mesoamerican Tropical Dry Forest (MTDF):

- In order to maximise the impact of the resources available globally for conservation, initiatives aimed at conserving MTDF tree species diversity should focus primarily on mature forest patches of high bioquality such as those of coastal Oaxaca, rather than agroecosystems of relatively low bioquality such as those of southern Honduras. Actions focused in this way on specific sites with high bioquality are likely to offer better value for money in global terms than transnational biological corridors, which encompass large areas of low bioquality.
- Specific strategies should be developed for the conservation of each of the very few globally rare species (such as *Bombacopsis quinata* and *Leucaena salvadorensis*) which are not well represented in conservable mature forest fragments.

Recommendations for the Southern Honduras case study area

- Actions related to promoting CTU in the dry zone of southern Honduras should focus principally on its potential contribution to livelihood support, due to the high levels of poverty, the limited livelihood support options available to its population and their heavy dependence on tree products.
- At the same time, it is important to promote the conservation of the few species of high global priority that exist there, for example through promoting awareness of their conservation status and management options among local conservation and development organisations.

The following specific actions should be taken, in order to realise the potential of CTU to contribute to rural livelihoods in the area:

1. Streamlining of regulations and procedures governing the harvesting and marketing of trees which regenerate naturally in agroecosystems, in order to make it more attractive for farmers to manage trees as an easily-saleable cash crop.
2. Promotion of local (municipal and community) level control over the harvesting and marketing of trees which regenerate naturally in agroecosystems, accompanied by provisions for local social auditing.
3. Participatory activities to assist farmers to appreciate the potential of CTU to contribute to their livelihoods, and the potential compatibility of naturally regenerated trees in fields with agricultural practices.
4. Promotion of markets and local processing facilities for timber coming from naturally regenerated trees in agroecosystems (subject to the introduction of effective, streamlined local controls).

These recommendations are applicable in general terms throughout much of the Central American dry forest agroecosystem, particularly in central and eastern El Salvador, the southern parts of the departments of Intibucá and Lempira in western Honduras, and much of western Nicaragua, as broadly similar conditions of resource scarcity and tree tenure exist throughout this area. However the conclusions presented here with regard to species-level CTU do not necessarily apply to:

- large land holdings whose owners' livelihoods are not significantly affected by the scarcity of tree products;
- areas where, as a result of physical conditions which permit the production of high-value crops, there is a high opportunity cost associated with tree conservation; or
- areas where the tradition of using fire to clear vegetation or control pests inhibits natural regeneration.

Recommendations for the Coastal Oaxaca case study area

- In order to conserve tree species of global conservation priority, particular attention should be paid to the conservation of the largely intact forests and mature fallows of coastal Oaxaca, especially those between Huatulco and the western end of the Isthmus of Tehuantepec.
- High bioquality patches in these areas should be managed as part of the wider agro-ecosystem, in order to increase their effective size and maximise the gene flow between them. Priority should also be given to assessing the conservation priority of similar areas elsewhere in southern Mexico.

There is strong potential in coastal Oaxaca for CTU to contribute both to the conservation of globally important tree species diversity and local people's livelihoods through the following specific actions:

1. Participatory initiatives to raise awareness among rural communities of the products and services provided by their forests and the options available for conservation through use.
2. Participatory initiatives to develop and strengthen community-based structures for decision-making and regulation in relation to tree and forest use.
3. Promotion of policies which value and support community-based structures for land management and decision-making, for example in the areas of agricultural incentives, land tenure and regulation.
4. Further investigation of strategies for making community-based models of natural resource management compatible with increased productive efficiency, including the identification of technologies and systems for the management of communal lands and the development of a supportive policy framework.
5. Participatory development of mechanisms for the payment for environmental, recreational and other services from forests, and for the effective distribution of the resulting benefits to the people involved in, or affected by, forest conservation.
6. Policy and regulatory support to the development of mechanisms for the payment for environmental services.

Future research priorities in relation to CTU in the MTDF

1. The local level work carried out in the course of this study in identifying species of global conservation concern (particularly those most susceptible to the effects of fragmentation and forest conversion) and the sites where they are found, should be repeated elsewhere in the region in order to ensure the objective setting of conservation priorities.
2. The objective approach presented here for assigning conservation priorities should be applied to other life forms (with modifications, where necessary, to the methodology and criteria used for assessing priorities). Attempts should be made to develop a methodology for prioritising sites on the basis of the combined 'bioquality' indices of the different life forms which they contain.
3. Future research should aim to distinguish between cases where conservation is required at the level of whole landscapes, land use systems or vegetation types, and cases where it should focus on the conservation of individual species within the landscape.
4. The implications for the conservation status of dry forest, of changes in laws and policies in Mexico relating to communal tenure and community-based natural resource management, should be monitored.
5. The hydrological benefits resulting from non-forest land management systems which allow the survival of large amounts of live tree material (including live stumps) should be studied, in order to determine under what circumstances such systems should be promoted and the nature and scale of compensation which it may be appropriate to provide to farmers for the provision of such benefits.

4.8 Research results effectively disseminated

Research results were disseminated in a variety of ways as tabulated in Section 6. These included a regular newsletter in both Mexico and Honduras during the main fieldwork period of the project, a large number of oral presentations in the research areas, policy briefings, peer-reviewed journal papers and book chapters. The preparation of a book summarising the results of the project is in preparation.

5. CONTRIBUTION OF OUTPUTS

The project's outputs contribute in the following ways to DFID's developmental goals:

- *Development of an annotated checklist of tropical dry forest species for the case study areas*, *production of a list of species of global conservation priority* and *production of a list of sites and land uses of high bioquality*: these outputs will enable conservation activities to be focused in high priority areas, thereby maximising the efficiency of use of the limited resources available for conservation and, conversely, help to free small farmers in areas of low bioquality from restrictions on their use of tree resources for livelihood support.

- *Characterisation of farmers' relations with trees and forests in the two study areas* will help to increase the relevance and effectiveness of interventions in rural communities, aimed at improving livelihood sustainability through tree establishment and management.

- *Definition of the current status and roles of conservation through use in the two case study areas:* the recognition of the importance for diversity conservation of communal systems of organisation and resource control in Mexico will motivate the promotion of such systems, resulting in increased conservation and, as an additional benefit of stand-alone importance, strengthened social capital.

- *Conditions for conservation through use to contribute to global conservation goals and livelihood promotion identified* and *opportunities and needs for intervention identified.* The identification of strategies for the conservation of threatened TDF species will contribute to global welfare by reducing the risk of biodiversity loss. The identification of strategies for the support of CTU of species which are of global use value (even if not rare or threatened) will contribute to rural livelihoods worldwide, given the international socioeconomic importance of many of these species The identification of strategies for the support of CTU in areas where trees and forests are of high livelihood importance will contribute to livelihoods locally, given the potential of these systems to provide tree products on a sustainable basis, and will ease pressures on small farmers who are currently perceived by many actors as having wholly negative impacts on tree resources.

The following actions and research are required to maximise the development benefit of the project findings:

1) Documentation of project findings in a lasting format, for reference use by development and conservation actors in the Mesoamerican dry forest. A book is in preparation and will be available in English and Spanish in 2006.

2) Promotion of the broader adoption of the tree management systems identified by the project, throughout the Central American agroecosystem. Such promotion would need to be backed up by participatory inventory work to determine the adequacy of germplasm resources for the natural regeneration of valuable species.

The following actions and research are required to maximise the conservation benefits of the project

1. Means of technically and financially supporting conservation initiatives sympathetic to local needs in the high bioquality areas of Oaxaca need to be found.

2. Areas with landscapes and tenure systems similar to those found in the high bioquality areas of Oaxaca need identification and their biodiversity assessed. Where appropriate, conservation activities need to be initiated and supported in such areas.

3. Surveying in such areas needs to be extended beyond trees to other components of biodiversity.

6. PUBLICATIONS AND DISSEMINATION OUTPUTS

Project publications

Project Newsletter	CUBOS (1998) Boletín Informativo No. 1. Honduras. April. [Project newsletter circulated electronically and as 50 paper copies] Spanish. 4 pp.
Project Newsletter	CUBOS (1998) Boletín Informativo No. 1. Mexico. May/June. [Project newsletter circulated electronically and as 50 paper copies] Spanish. 4 pp.
Project Newsletter	CUBOS (1998) Boletín Informativo No. 2. Honduras. September. [Project newsletter circulated electronically and as 50 paper copies] Spanish. 4 pp.
Project Newsletter	CUBOS (1998) Boletín Informativo No. 2. Mexico. December. [Project newsletter circulated electronically and as 50 paper copies] Spanish. 4 pp.
Newspaper article	BARRANCE, A.J. (1998) ¿Quién Cuida los Arboles Sureños? *La Tribuna, Honduras (16 August)* 2 pages. Spanish. (Newspaper article)
Newspaper article	BARRANCE, A.J. (1999) La Selva Baja. *Las Noticias, Oaxaca, Mexico (18 February)* pp. 13A. Spanish.
Newsletter	BARRANCE, A.J. and GORDON, J.E. (1999) Conservation through use of tree species diversity in fragmented Mesoamerican dry forest (CUBOS). *European Tropical Forest Research Network News 28* pp. 17-18. (Newsletter)
Project newsletter	CUBOS (1999) Boletín Informativo No. 3. Honduras. June. [Project newsletter circulated electronically and as 50 paper copies] Spanish. 4 pp.
Project newsletter	CUBOS (1999) Boletín Informativo No. 3. Mexico. July. [Project newsletter circulated electronically and as 50 paper copies] Spanish. 4 pp.
Project newsletter	CUBOS (2000) Boletín Informativo No. 4. Honduras. April. [Project newsletter circulated electronically and as 50 paper copies] Spanish. 4 pp.
Briefing note	BARRANCE, A.J., DIAZ ARRIVILLAGA, E., GORDON, J.E, SCHRECKENBERG, K., RICHARDS, M. and FLORES, L. (2000). El Bosque Seco y el Anteproyecto de Ley en Honduras. Policy briefing paper. Spanish. 400 copies. 2pp. Overseas Development Institute, London. [Policy] (Briefing note)
Newsletter	GORDON, J. E. (2000) Assessing bioquality in Mesoamerican dry forest. Oxford Plant Systematics 8 pp 8-10 (newsletter).
Briefing note	GORDON, J.E., BARRANCE, A.J. and SCHRECKENBERG, K. (2001) Tree diversity conservation in Mesoamerican dry forest: a briefing paper for international conservation agencies. 400 copies. 2pp. Overseas Development Institute, London. [Policy] (Briefing note)
Journal paper	BARRANCE, A.J., FLORES, L., PADILLA, E., GORDON, J.E. and SCHRECKENBERG, K. (2003) Trees and farming in the dry zone of southern Honduras I: campesino tree husbandry practices. *Agroforestry Systems* 59 (2): 97-106. (Journal paper)
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Journal paper	GORDON, J.E., BARRANCE, A.J., SCHRECKENBERG, K. (2003) Are rare species useful species? Obstacles to the conservation of tree diversity in the dry forest zone agro-ecosystems of Mesoamerica. *Global Ecology and Biogeography* 12: 13–19. (Journal paper)
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Book chapter	BOSHIER, D. H., GORDON, J. E., and BARRANCE A. J. (2004) Prospects

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Project Internal Reports

Internal report	RICHARDS, M., RODRIGUEZ, A., GARCIA, A., and ZULETA, M. (2000) Análisis económico de árboles en explotaciones agrícolas en el sur de Honduras. Overseas Development Institute, London. 23 pp. + Appendices. Spanish. (Internal report)
Internal report	RICHARDS, M., RODRIGUEZ, A., GARCIA, A., and ZULETA, M. (2000) Economic analysis of trees on farms in southern Honduras. Overseas Development Institute, London. 23 pp. Appendices. (Internal report)
Internal report	DAVIES, J., ESCALONA LUTTIG, I. and ORTIZ BLAS, T. (2000) Aspectos económicos que influyen sobre la conservación de la diversidad de especias arbóreas de la selva baja de Oaxaca. Overseas Development Institute, London. 40 pp. Spanish. (Internal report)
Internal report	DIAZ ARRIVILLAGA , E. (2000) El Contexto de políticas e instituciones para el desarrollo y la implementación de estrategias para el manejo y la conservación de la diversidad de especies arbóreas en la zona sur de Honduras. Overseas Development Institute, London. 25 pp. (Internal report)
Internal report	BELTRAN, E., GONZALEZ, A.R. and BARRANCE, A. (2000) Contexto de políticas e instituciones para el desarrollo y la implementación de estrategias para el manejo y la conservación de la diversidad de especies arbóreas en la zona seca de la costa de Oaxaca. Overseas Development Institute, London. 69 pp. (Internal report)

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Oral presentation	BARRANCE, A.J. and GORDON, J.E. (1998) Proyecto CUBOS. CONSEFORH, La Soledad, Comayagua, Honduras. September. [Presentation on project objectives and methodology to 10 members of CONSEFORH staff] Spanish. (Oral presentation)
Oral presentation	BARRANCE, A.J. and GORDON, J.E. (1998). Proyecto CUBOS. Hotel Pierre, Choluteca, Honduras. September. [Presentation on project objectives and

	initial results to 15 members of the Red Lemas network] Spanish. (Oral presentation)
Oral presentation	BARRANCE, A.J. and GORDON, J.E. (1998) Proyecto CUBOS. WWF offices, Oaxaca. October. [Presentation of project objectives to 3 members of WWF staff] Spanish. (Oral presentation)
Oral presentation	ZÚNIGA, R. A. and GORDON, J. E. (1998) Proyecto CUBOS. Annual Congress of Mesoamerican Society for Conservation, Managua, Nicaragua. July. [Presentation on project objectives to 100 participants] Spanish. (Oral presentation)
Radio	BARRANCE, A.J. (1998) The CUBOS Project. Radio interview. *Radio Valle, Choluteca, Honduras.* July. [Honduras, local]. Spanish. (Radio)
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Electronic discussion	BARRANCE, A.J. (1999) Various contributions to: Mountain People, Forests and Trees: Strategies for Balancing Local Management and Outside Interests. Synthesis of an electronic conference at the Mountain Forum. 12 April – 14 May. (Electronic discussion)
Oral presentation	BARRANCE, A.J. and GORDON, J.E. (1999) Diversidad Arborea en el Bosque Seco. 11th Multisectoral Forum on the Environment. FAO Building, Tegucigalpa, Honduras. 16 July. [Presentation to 20 representatives of NGOs, Government agencies and international agencies] Spanish. (Oral presentation)
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Synopsis	BARRANCE, A.J. and FLORES, L. (1999a) Los Arboles y la Gente de San Juán Arriba, Agua Zarca, San José de las Conchas y Los Coyotes. Resultados de un Estudio Realizado por el Proyecto CUBOS junto con los Miembros de las Comunidades entre enero y septiembre de 1998. Community feedback document. Spanish. 25 copies. 25 pp. Overseas Development Institute, London. UK [Field] (Synopsis)
Synopsis	BARRANCE, A.J. and FLORES, L. (1999b) Arboles y Agricultores en el Sur de Honduras. Resultados Iniciales de Investigaciones Socioeconómicas en los Departamentos de Choluteca y Valle entre enero y septiembre de 1998. Preliminary site description report. Spanish. 25 copies. 25 pp. Overseas Development Institute, London. UK [Field] (Synopsis)
Synopsis	BARRANCE, A.J. and ORTIZ, T. (1999a) Los Arboles y la Gente de El Sanjón, La Jabalina, El Limón y Petatengo. Resultados de un Estudio Realizado por el Proyecto CUBOS junto con los Miembros de las Comunidades entre octubre de 1998 y marzo de 1999. Community feedback document. Spanish. 25 copies. 25 pp. Overseas Development Institute, London. UK [Field] (Synopsis)

Synopsis	BARRANCE, A.J. and ORTIZ, T. (1999b) Arboles y Comunidades en la Costa de Oaxaca. Resultados Iniciales de Investigaciones Socioeconómicas en cuatro comunidades entre octubre de 1998 y marzo de 1999. Preliminary site description report. Spanish. 25 copies. 25 pp. Overseas Development Institute, London. UK [Field] (Synopsis)
Oral presentation	BARRANCE, A.J. (1999) El Aprovechamiento No-Maderable de la Selva Baja (Bosque Seco) Mesoamericana y su Contribución a la Conservación. Seminar on Oportunidades para el aprovechamiento sostenible de especies forestales no maderables en Centroamérica y México. Fiesta Inn, Oaxaca, Mexico. 23 November. [Presentation to 45 representatives of Mesoamerican NGOs and Government agencies] Spanish. (Oral presentation)
Factsheet	BARRANCE, A.J., GORDON, J.E., ORTIZ BLAS, T., ESCALONA LUTTIG, I. and REYES GARCÍA, A. (2000). La Selva Seca Oaxaqueña en el Contexto Internacional: Una recopilación de información para la elaboración de propuestas. Resource materials for participants at Project Training Workshop, 30-31 Aug, 2000, Oaxaca, Mexico. Spanish. 30 copies. Overseas Development Institute, London. UK [Field] (Factsheet)
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Informal workshop report	ZELAYA, R., BARRANCE, A.J. and GORDON, J.E. (2000). Ayuda Memoria: Taller de Maduración del Proyecto CUBOS. Informal workshop proceedings of Project maturity workshop, held at Escuela Agrícola Panamericana, Zamorano, Honduras, 3-5 July, 2000. 40pp. Overseas Development Institute, London. (Informal workshop report)
Workshop	BARRANCE, A.J. and GORDON, J.E. (2000). Taller de Maduración del Proyecto CUBOS. Escuela Agrícola Panamericana, Honduras. 3-5 July. [Maturity workshop involving 15 representatives of NGOs and Government agencies from 4 Mesoamerican countries] Spanish. (Workshop)
Workshop	BARRANCE, A.J., GORDON, J.E., GONZALEZ, M.A. and PADILLA, E. (2000): Como Integrar el Desarrollo Rural y la Conservación de la Diversidad de Arboles en el Bosque Seco Tropical Mesoamericano; Lecciones de un proyecto de investigación multidisciplinaria. Hotel Roma, Panama City. 5 September. [Training workshop involving 25+ participants at the Annual Congress of the Sociedad Mesoamericana para la Biología y la Conservación]. Spanish. (Workshop)
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Electronic database	CUBOS (undated) Database of species and sites surveyed by CUBOS in Oaxaca and Southern Honduras (in prep) http://www.mesoamerica.org.mx/

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APPENDIX 1 KEY FOR ASSIGNING SPECIES WEIGHTINGS

1. Endemic to the seasonally dry forests of the pacific coastal plain and foothills of Mesoamerica

  2. Endemic to Oaxaca OR to southern Honduras
    3. Not abundant in disturbed vegetation **Cat A**
    3. Abundant in disturbed vegetation and widespread along coast BUT not in a taxonomically isolated group or economically important genus **Cat B**

  2. Not endemic to Honduras or Oaxaca
    4. Occurring in 2-4 Mexican States or C.A. countries:
      5. In economically important genus OR taxonomically isolated AND not common in disturbed vegetation **Cat A**
      5. Not in economically important genus and not taxonomically isolated OR very common in disturbed vegetation **Cat B**
    4. Occurring in more than 4 states:
      6. Found in not more than 8 states/countries
        7. In economically important genus OR taxonomically isolated AND not common in disturbed vegetation **Cat B**
        7. Not in economically important genus AND not taxonomically isolated OR very common in disturbed vegetation **Cat C**

      6. Found in more than 8 states/countries
        8. In economically important genus OR taxonomically isolated AND not common in disturbed vegetation **Cat C**
        8. Not in economically important genus AND not taxonomically isolated OR very common in disturbed vegetation **Cat D**

1. Not endemic to the seasonally dry forests of the pacific coastal plain and foothills of Mesoamerica

  9. Occurring in 4 or fewer Mexican States or C.A. countries
    10. In economically important genus OR taxonomically isolated AND not common in disturbed vegetation **Cat C**
    10. Not in economically important genus AND not taxonomically isolated OR very common in disturbed vegetation **Cat D**
  9. Occurring in more than 4 states
    11. Under no significant threat from direct exploitation **Cat D**
    11. Under threat throughout its range from non-sustainable exploitation **Cat C**

APPENDIX 2: SPECIES OF CONSERVATION CONCERN IN THE STUDY AREA

OAXACA

∗ CATEGORY A (including possible new species):

Carlowrightia sp. nov. ACANTHACEAE
Achatocarpus oaxacanus Standl. ACHATOCARPACEAE Mature forest fragments, occasionally fallows.
Licania sp. nov CHRYSOBALANACEAE
Trixis silvatica B.L.Rob. & Greenm. COMPOSITAE Mature forest fragments.
Jatropha alamani Muell.Arg. EUPHORBIACEAE Mature forest fragments and fallows.
Jatropha sympetala Standl. & Blake EUPHORBIACEAE Mature forest fragments and fallows
Jatropha sp. nov. EUPHORBIACEAE
Manihot oaxacana D.J.Rogers & Appan Black. EUPHORBIACEAE Mature forest fragments and fallows.
Caesalpinia coccinea G.P.Lewis & J.L.Contr. LEGUMINOSAE-CAESALPINIOIDEAE Forest fragments and edges.
Mimosa albida Humb. & Bonpl. ex Willd. var. ***pochutlensis*** R.Grether LEGUMINOSAE-MIMOSOIDEAE. Disturbed forest fragments
Zapoteca tehuana H.M.Hern. LEGUMINOSAE-MIMOSOIDEAE. Mature forest fragments.
Lonchocarpus sp. nov. LEGUMINOSAE-PAPILIONOIDEAE
Bunchosia discolor Turcz. ex Char. MALPIGHIACEAE Mature forest fragments.
Megastigma sp. nov. RUTACEAE
Thouinia, (undescribed species), SAPINDACEAE
Castela retusa Liebm. SIMAROUBACEAE. Mature forest fragments.
Waltheria conzatii Standl. STERCULIACEAE. Fallow.

∗ CATEGORY B:

Sapranthus foetidus (Rose) Saff. ANNONACEAE Jalisco, Guerrero & Oaxaca. Mature forest fragments and fallows.
Bourreria purpusii Brandgee BORAGINACEAE Jalisco & Oaxaca. Mature forest fragments.
Forchhammeria lanceolata Standl. CAPPARIDACEAE Oaxaca & Guererro. Mature forest fragments and fallow.
Bucida wigginsiana Miranda COMBRETACEAE Guererro Oaxaca. Mature forest fragments.
Trixis pterocaulis B.L.Rob. & Greenm. COMPOSITAE Jalisco, Colima & Oaxaca. Mature semi-deciduous forest fragments.
Acalypha liebmannii (Muell.Arg.) Lundell EUPHORBIACEAE Oaxaca, Guerrero. Disturbed seasonal oak forest.
Caesalpinia hughesii G.P.Lewis LEGUMINOSAE-CAESALPINIOIDAE Oaxaca, Guererro & Colima. Forest fragments and edges.
Brongniartia bracteolata Micheli LEGUMINOSAE- PAPILIONOIDAE Oaxaca & Chiapas. Mature forest fragments, occasional fallows and farmland.
Lonchocarpus emarginatus Pittier LEGUMINOSAE-PAPILIONOIDAE Oaxaca & Chiapas. Mature forest fragments.
Lonchocarpus longipedicellatus Pittier LEGUMINOSAE-PAPILIONOIDAE Jalisco, Guererro & Oaxaca. Mature forest fragments.
Hibiscus kochii Fryxell MALVACEAE Guererro, Oaxaca. Mature forest fragments.
Eugenia salamensis Donn.Sm. var. ***rensoniana*** (Standl.) McVaugh MYRTACEAE Oaxaca Guatemala & Costa Rica. Mature forest fragments.
Guettarda galeottii Standl. RUBIACEAE Sinaloa, Nayarit & Oaxaca. Fallows.
Randia cinerea (Fernald) Standl. RUBIACEAE Oaxaca & Guererro. Fallows.
Recchia mexicana Moc. & Sessé SIMAROUBACEAE Oaxaca & Jalisco. Mature forest fragments, occasional fallows.
Physodium oaxacanum Dorr & Barnett STERCULIACEAE Oaxaca & Chiapas.
Triumfetta heliocarpoides Bullock TILIACEAE Guererro & Oaxaca. Seasonal oak forest.
Aloysia chiapensis Moldenke VERBENACEAE Oaxaca & Chiapas. Solar.

∗ CATEGORY C:

Achatocarpus mexicanus H.Walter ACHATOCARPACEAE Chiapas & Oaxaca -not limited to Pacific dry forest. Mature forest fragments.

Lagrezia monosperma (Rose) Standl. AMARANTHACEAE Jalisco, Michoacan, Colima, Guererro & Oaxaca. Mature forest fragments.

Actinocheita filicina (DC.) F.A.Barkley ANACARIACEAE Guererro, Oaxaca, Chiapas & Puebla – not limited to Pacific dry forest. Disturbed forests and farmland.

Bursera aptera Ramirez BURSERACEAE Guererro, Oaxaca, Puebla & Morelos- not limited to pacific dry forest. Mature forest fragments.

Bursera instabilis McVaugh & Rzed. BURSERACEAE Nayarit, Jalisco, Michoacan, Colima, Guererro & Oaxaca. Mature forest fragments.

Capparis angustifolia Kunth CAPPARIDACEAE Guererro & Oaxaca. Mature forest fragments.

Bucida macrostachya Standl. COMBRETACEAE Oaxaca, Chiapas, Belize, Guatemala, Honduras & Nicaragua. Mature forest fragments, occasional fallows.

Chromolaena glaberrima (DC.) R.M.King & H.Rob. COMPOSITAE Oaxaca- not limited to Pacific dry forest. Principally oak forest.

Montanoa tomentosa Cerv. ssp. ***microcephala*** (Sch.Bip.) V.A.Funk COMPOSITAE Oaxaca -not limited to Pacific dry forest. Principally seasonal oak forest.

Verbesina oaxacana DC. COMPOSITAE Oaxaca -not limited to Pacific dry forest. Fallows.

Croton axillaris Muell.Arg. EUPHORBIACEAE Oaxaca, Chiapas, San Luis Potosí, Tamaulipas, Guatemala Nicaragua Costa Rica. Mature forest fragments.

Croton ramillatus Croizat EUPHORBIACEAE Guererro Oaxaca Veracruz- not limited to Pacific dry forest. Mature forest fragments.

Croton septemnervius McVaugh Jalisco Guererro Oaxaca -not limited to Pacific dry forest. Mature forest fragments and fallows.

Casearia williamsiana Sleumer FLACOURTIACEAE Honduras -not limited to Pacific dry forest. Disturbed forest fragments.

Samyda mexicana Rose FLACOURTIACEAE Jalisco, Guererro, Oaxaca, Veracruz -not limited to Pacific dry forest Mature forest fragments.

Gyrocarpus mocinnoi Espejo HERNANDIACEAE Guererro, Chiapas, Oaxaca, Puebla & Guatemala. Mature forest fragments and fallows.

Hyptis tomentosa Poit. LABIATAE Oaxaca, Chiapas, Veracruz -not limited to Pacific dry forest. Mature forest fragments, fallows and farmland.

Caesalpinia mollis (Kunth) Spreng.-LEGUMINOSAE-CAESALPINIODEAE -not limited to Pacific dry forest.

Cynometra oaxacana Brandegee LEGUMINOSAE-CAESALPINIODEAE Jalisco, Colima, Guererro, Oaxaca & Chiapas. Mature forest fragments.

Calliandra hirsuta (G.Don) Benth. LEGUMINOSAE-MIMOSOIDAE Guererro, Oaxaca, Chiapas, Puebla -not limited to Pacific dry forest. Farm land.

Havardia campylacanthus (L.Rico & M.Sousa) Barneby & J.W.Grimes LEGUMINOSAE-MIMOSOIDAE Michoacan, Guererro, Oaxaca Belize, Nicaragua & Honduras. Forest fragments and farmland.

Mimosa eurycarpa B.L.Rob. Michoacan, Colima, Oaxaca -not limited to Pacific dry forest. Mature forest fragments.

Mimosa robusta R.Grether LEGUMINOSAE-MIMOSOIDAE: Farmland.

Indigofera platycarpa Rose LEGUMINOSAE-PAPILIONOIDAE Guererro Oaxaca Pue Mor –not limited to Pacific dry forest Mature forest fragments.

Lonchocarpus constrictus Pittier LEGUMINOSAE-PAPILIONOIDAE Jalisco, Michoacan, Colima, Guererro & Oaxaca. Mature forest fragments and occasionally forests.

Platymiscium lasiocarpum Sandwith LEGUMINOSAE-PAPILIONOIDAE Jalisco Michoacan Guererro Oaxaca -not limited to Pacific dry forest. Mature forest fragments

Abutilon grandidentatum Fryxel. MALVACEAE Oaxaca, Chiapas -not limited to Pacific dry forest. Mature forest fragments.

Hibiscus peripteroides Fryxell Oaxaca, San Luis Potosí -not limited to Pacific dry forest. Reverine forest.

Torrubia macrocarpa Miranda Oaxaca Mature forest fragments, occasionally farmland.

Chiococca filipes Lundell Oaxaca, Chiapas & Honduras -not limited to Pacific dry forest. Seasonal oak forest.

Randia nelsonii Greenm.RUBIACEAE Sinaloa, Michoacan Oaxaca & Veracruz -not limited to Pacific dry forest. Mature forest fragments.

Rondeletia deamii (Donn.Sm) Standl. RUBIACEAE Oaxaca, Guatemala, Honduras & Nicargua - not limited to Pacific dry forest. Forest fragments and farmland.
Heliocarpus occidentalis Rose TILIACEAE Guererro & Oaxaca. Mature forest fragments.

<u>HONDURAS</u>

∗ CATEGORY A:

None

∗ CATEGORY B:

Leucaena salvadorensis Standl. LEGUMINOSAE-MIMOSOIDAE El Salvador, Nicaragua & Honduras. Disturbed forest fragments and farmland.
Eugenia hondurensis Ant. Molina MYRTACEAE Honduras & Nicaragua. Disturbed forests and farmland.
Grajalesia fasciculata (Standl.) Miranda NYCTAGINACEAE Guatemala ELS Honduras Nicaragua. Disturbed forest and farmland.
Guettarda deamii Standl. RUBIACEAE Guatemala, El Salvador, Honduras Nicaragua. Disturbed forest fragments.

∗ CATEGORY C:

Persea caerulea (Ruiz & Pav.) Mez LAURACEAE El Salvador, Honduras Nicaragua Costa Rica & Panama. Disturbed forest fragments.
Casearia williamsiana Sleumer FLACOURTIACEAE Honduras, Nicaragua -not limited to Pacific dry forest. Disturbed forest fragments.
Mimosa panamensis (Benth.) Standl. LEGUMINOSAE-MIMOSOIDAE Honduras & Panama -not limited to Pacific dry forest Farmland
Bunchosia guatemalensis Ndzu MALPIGHIACEAE Chiapas, Guatemala & Honduras -not limited to Pacific dry forest. Disturbed forest fragments.
Randia pleiomeris Standl. RUBIACEAE Guatemala, El Salvador & Honduras -not limited to Pacific dry forest. Disturbed forest fragments and farmland.
Rondeletia deamii (Donn.Sm) Standl. RUBIACEAE Oaxaca, Guatemala, Honduras & Nicaragua - not limited to Pacific dry forest. Forest fragments and farmland.
Trigonia rugosa Benth. TRIGONIACEAE Guatemala El Salvador, Honduras & Nicuargua -not limited to Pacific dry forest Disturbed forest fragments.

∗ IUCN Categories:

Vulnerable
Bombacopsis quinata (Jacq.) Dugand. BOMBACACEAE Disturbed forest fragments, occasionally farmland.

Endangered:
Guaiacum sanctum L. ZYGOPHYLLACEAE Disturbed forest fragments.

APPENDIX 3 COMPLETE GHI (BIOQUALITY) SCORES IN DESCENDING ORDER FOR FOREST AND COMMUNITY DIVERSITY SURVEYS

Code	Area: Vegetation	Community	GHI
279	Oaxaca: Forest	(forest survey)	385.7
284	Oaxaca: Forest	(forest survey)	283.3
177	Oaxaca: Forest	(forest survey)	274.3
178	Oaxaca: Forest	(forest survey)	244.7
285	Oaxaca: Forest	(forest survey)	232.3
277	Oaxaca: Forest	(forest survey)	202.5
175	Oaxaca: Forest	(forest survey)	200.0
271	Oaxaca: Fallow	El Limón	180.0
242	Oaxaca: Forest	La Jabalina	162.2
258	Oaxaca: Forest	(forest survey)	161.5
214	Oaxaca: Forest	(forest survey)	159.4
257	Oaxaca: Forest	Petatengo	156.0
230	Oaxaca: Forest	La Jabalina	150.0
266	Oaxaca: Fallow	El Limón	150.0
286	Oaxaca: Forest	(forest survey)	150.0
278	Oaxaca: Forest	(forest survey)	141.7
281	Oaxaca: Forest	(forest survey)	140.6
250	Oaxaca: Milpa	Petatengo	140.0
255	Oaxaca: Milpa	Petatengo	139.3
229	Oaxaca: Forest	La Jabalina	139.0
231	Oaxaca: varios	La Jabalina	128.6
283	Oaxaca: Forest	(forest survey)	121.9
282	Oaxaca: Forest	(forest survey)	117.4
216	Oaxaca: Forest	(forest survey)	114.7
212	Oaxaca: Forest	La Jabalina	107.1
218	Oaxaca: Forest	La Jabalina	96.8
217	Oaxaca: Forest	La Jabalina	90.9
263	Oaxaca: Fallow	El Limón	90.9
219	Oaxaca: Fallow	La Jabalina	89.2
209	Oaxaca: Forest	(forest survey)	87.1
264	Oaxaca: Fallow	El Limón	85.7
223	Oaxaca: Fallow	La Jabalina	81.8
173	Oaxaca: Forest	(forest survey)	81.1
176	Oaxaca: Forest	(forest survey)	80.0
267	Oaxaca: Fallow	El Limón	75.0
280	Oaxaca: Forest	(forest survey)	75.0
265	Oaxaca: Fallow	El Limón	70.6
256	Oaxaca: Pasture	Petatengo	69.2
239	Oaxaca: Forest	(forest survey)	61.8
221	Oaxaca: Forest	La Jabalina	60.0
254	Oaxaca: Frutal	Petatengo	60.0
172	Oaxaca: Forest	(forest survey)	60.0
226	Oaxaca: Fallow	La Jabalina	58.5
153	Honduras: Forest	(forest survey)	55.8
269	Oaxaca: Solar	El Limón	54.5
179	Oaxaca: Forest	El Limón	52.9
210	Oaxaca: Forest	(forest survey)	52.9
240	Oaxaca: Forest	(forest survey)	52.5
114	Honduras: Solar	San Juán	45.0
211	Oaxaca: Forest	La Jabalina	44.1

Code	Area: Vegetation	Community	GHI
127	Honduras: Forest	San José las C.	42.9
236	Oaxaca: Milpa	La Jabalina	41.4
30	Honduras: Orchard	Agua Zarcas	37.5
15	Honduras: Solar	San José las C.	37.5
133	Honduras: Forest	(forest survey)	37.5
171	Oaxaca: Forest	(forest survey)	37.5
150	Honduras: Forest	(forest survey)	36.6
120	Honduras: Coffee	San Juán	36.4
222	Oaxaca: Forest	La Jabalina	36.4
237	Oaxaca: Milpa	La Jabalina	36.0
118	Honduras: Fallow	San Juán	33.3
40	Honduras: Forest	Agua Zarcas	31.6
241	Oaxaca: Forest	La Jabalina	31.6
123	Honduras: Fallow	San José las C.	30.8
48	Honduras: Milpa	Agua Zarcas	30.0
148	Honduras: Forest	(forest survey)	30.0
61	Honduras: Fallow	Agua Zarcas	29.3
149	Honduras: Forest	(forest survey)	29.3
164	Honduras: Forest	(forest survey)	28.6
268	Oaxaca: Fallow	El Limón	26.1
81	Honduras: Milpa	Los Coyotes	25.0
84	Honduras: Solar	Los Coyotes	25.0
131	Honduras: Forest	(forest survey)	25.0
235	Oaxaca: Fallow	La Jabalina	25.0
137	Honduras: Forest	San Juán	24.0
68	Honduras: Solar	Los Coyotes	24.0
80	Honduras: Solar	Los Coyotes	23.7
154	Honduras: Forest	Los Coyotes	23.5
47	Honduras: Milpa	Agua Zarcas	23.1
78	Honduras: Milpa	Los Coyotes	23.1
132	Honduras: Forest	(forest survey)	22.5
135	Honduras: Forest	(forest survey)	22.5
143	Honduras: Forest	(forest survey)	22.5
5	Honduras: Pasture	San José las C.	22.2
63	Honduras: Solar	Agua Zarcas	21.4
91	Honduras: Milpa	Los Coyotes	21.4
140	Honduras: Forest	(forest survey)	21.4
228	Oaxaca: Fallow	La Jabalina	21.4
71	Honduras: Solar	Los Coyotes	20.9
151	Honduras: Forest	(forest survey)	20.9
10	Honduras: Fallow	San José las C.	20.0
23	Honduras: Solar	San José las C.	20.0
86	Honduras: Milpa	Los Coyotes	20.0
147	Honduras: Forest	(forest survey)	20.0
225	Oaxaca: Fallow	La Jabalina	20.0
155	Honduras: Forest	Los Coyotes	18.8
112	Honduras: Milpa	San Juán	17.6
88	Honduras: Milpa	Los Coyotes	17.6
83	X	Los Coyotes	17.6
252	Oaxaca: Milpa	Petatengo	17.6

Code	Area: Vegetation	Community	GHI
249	Oaxaca: Pasture	Petatengo	17.6
169	Oaxaca: Forest	(forest survey)	17.6
72	Honduras: Solar	Los Coyotes	16.4
33	Honduras: Pasture	Agua Zarcas	16.2
73	Honduras: Milpa	Los Coyotes	16.2
261	Oaxaca: Fallow	Petatengo	16.2
215	Oaxaca: Forest	El Sanjon	15.8
93	Honduras: Milpa	Los Coyotes	15.6
144	Honduras: Forest	(forest survey)	15.4
31	Honduras: Solar	Agua Zarcas	15.0
134	Honduras: Forest	(forest survey)	15.0
213	Oaxaca: Forest	La Jabalina	15.0
141	Honduras: Forest	San José las C.	14.6
4	Honduras: Milpa	San José las C.	14.3
74	Honduras: Milpa	Los Coyotes	14.1
26	Honduras: Milpa	Agua Zarcas	13.6
11	Honduras: Fallow	San José las C.	13.6
1	Honduras: Pasture	San José las C.	12.2
9	Honduras: Pasture	San José las C.	12.0
89	Honduras: Solar	Los Coyotes	12.0
70	Honduras: Solar	Los Coyotes	11.8
54	Honduras: Solar	Agua Zarcas	11.1
122	Honduras: Milpa	Agua Zarcas	10.3
160	Honduras: Forest	Agua Zarcas	9.7
67	Honduras: Pasture	Agua Zarcas	9.7
262	Oaxaca: Fallow	Petatengo	9.7
53	Honduras: Milpa	Agua Zarcas	9.1
270	Oaxaca: Forest	El Limón	9.1
276	Oaxaca: Forest	(forest survey)	9.1
158	Honduras: Forest	Los Coyotes	8.1
163	Honduras: Forest	(forest survey)	8.1
119	Honduras: Coffee	San Juán	7.9
2	Honduras: Milpa	San José las C.	7.7
167	Honduras: Forest	(forest survey)	7.5
168	Honduras: Forest	(forest survey)	7.5
152	Honduras: Forest	(forest survey)	7.5
161	Honduras: Forest	(forest survey)	7.0
37	Honduras: Pasture	Agua Zarcas	6.8
138	Honduras: Forest	San Juán	6.7
105	Honduras: Milpa	San Juán	6.5
35	Honduras: Fallow	Agua Zarcas	5.8
76		Los Coyotes	4.0
94	Honduras: Forest	San Juán	0.0
136	Honduras: Forest	San Juán	0.0
98	Honduras: Forest	San Juán	0.0
99	Honduras: Forest	San Juán	0.0
101	Honduras: Forest	San Juán	0.0
95	Honduras: Coffee	San Juán	0.0
96	Honduras: Coffee	San Juán	0.0
107	Honduras: Coffee	San Juán	0.0

Code	Area: Vegetation	Community	GHI
108	Honduras: Coffee	San Juán	0.0
109	Honduras: Coffee	San Juán	0.0
121	Honduras: Orchard	San Juán	0.0
115	Honduras: Orchard	San Juán	0.0
116	Honduras: Orchard	San Juán	0.0
117	Honduras: Orchard	San Juán	0.0
104	Honduras: Milpa	San Juán	0.0
97	Honduras: Pasture	San Juán	0.0
106	Honduras: Pasture	San Juán	0.0
102	Honduras: Solar	San Juán	0.0
103	Honduras: Solar	San Juán	0.0
110	Honduras: Solar	San Juán	0.0
111	Honduras: Solar	San Juán	0.0
113	Honduras: Solar	San Juán	0.0
50	Honduras: Forest	Agua Zarcas	0.0
38	Honduras: Orchard	Agua Zarcas	0.0
44	Honduras: Orchard	Agua Zarcas	0.0
52	Honduras: Orchard	Agua Zarcas	0.0
58	Honduras: Orchard	Agua Zarcas	0.0
39	Honduras: Fallow	Agua Zarcas	0.0
41	Honduras: Fallow	Agua Zarcas	0.0
42	Honduras: Fallow	Agua Zarcas	0.0
51	Honduras: Fallow	Agua Zarcas	0.0
55	Honduras: Fallow	Agua Zarcas	0.0
57	Honduras: Fallow	Agua Zarcas	0.0
62	Honduras: Fallow	Agua Zarcas	0.0
27	Honduras: Milpa	Agua Zarcas	0.0
29	Honduras: Milpa	Agua Zarcas	0.0
32	Honduras: Milpa	Agua Zarcas	0.0
46	Honduras: Milpa	Agua Zarcas	0.0
56	Honduras: Milpa	Agua Zarcas	0.0
59	Honduras: Milpa	Agua Zarcas	0.0
64	Honduras: Milpa	Agua Zarcas	0.0
45	Honduras: Pasture	Agua Zarcas	0.0
65	Honduras: Pasture	Agua Zarcas	0.0
66	Honduras: Pasture	Agua Zarcas	0.0
28	Honduras: Solar	Agua Zarcas	0.0
34	Honduras: Solar	Agua Zarcas	0.0
36	Honduras: Solar	Agua Zarcas	0.0
43	Honduras: Solar	Agua Zarcas	0.0
49	Honduras: Solar	Agua Zarcas	0.0
60	Honduras: Solar	Agua Zarcas	0.0
146	Honduras: Forest	San José las C.	0.0
124	Honduras: Forest	San José las C.	0.0
126	Honduras: Forest	San José las C.	0.0
142	Honduras: Forest	San José las C.	0.0
18	Honduras: Fallow	San José las C.	0.0
19	Honduras: Milpa	San José las C	0.0
125	Honduras: Milpa	San José las C	0.0
13	Honduras: Milpa	San José las C	0.0

Code	Area: Vegetation	Community	GHI
3	Honduras: Pasture	San José las C.	0.0
16	Honduras: Pasture	San José las C.	0.0
20	Honduras: Pasture	San José las C.	0.0
22	Honduras: Pasture	San José las C.	0.0
6	Honduras: Solar	San José las C.	0.0
7	Honduras: Solar	San José las C.	0.0
8	Honduras: Solar	San José las C.	0.0
14	Honduras: Solar	San José las C.	0.0
17	Honduras: Solar	San José las C.	0.0
21	Honduras: Solar	San José las C.	0.0
24	Honduras: Solar	San José las C.	0.0
12	Honduras: Solar	San José las C.	0.0
79	Honduras: Forest	Los Coyotes	0.0
156	Honduras: Forest	Los Coyotes	0.0
157	Honduras: Forest	Los Coyotes	0.0
85	Honduras: Fallow	Los Coyotes	0.0
92	Honduras: Milpa	Los Coyotes	0.0
69	Honduras: Pasture	Los Coyotes	0.0
75	Honduras: Solar	Los Coyotes	0.0
77	Honduras: Solar	Los Coyotes	0.0
82	Honduras: Solar	Los Coyotes	0.0
87	Honduras: Solar	Los Coyotes	0.0
90	Honduras: Solar	Los Coyotes	0.0
145	Honduras: Forest	(forest survey)	0.0
162	Honduras: Forest	(forest survey)	0.0
165	Honduras: Forest	(forest survey)	0.0
166	Honduras: Forest	(forest survey)	0.0
139	Honduras: Forest	(forest survey)	0.0
203	Oaxaca: Forest	El Sanjon	0.0
180	Oaxaca: Coffee	El Sanjon	0.0
194	Oaxaca: Coffee	El Sanjon	0.0
184	Oaxaca: Coffee	El Sanjon	0.0
208	Oaxaca: Coffee	El Sanjon	0.0
181	Oaxaca: Orchard	El Sanjon	0.0
190	Oaxaca: Orchard	El Sanjon	0.0
191	Oaxaca: Orchard	El Sanjon	0.0
197	Oaxaca: Orchard	El Sanjon	0.0
202	Oaxaca: Orchard	El Sanjon	0.0
187	Oaxaca: Orchard	El Sanjon	0.0
205	Oaxaca: Orchard	El Sanjon	0.0
207	Oaxaca: Orchard	El Sanjon	0.0
195	Oaxaca: Milpa	El Sanjon	0.0
192	Oaxaca: Pasture	El Sanjon	0.0
198	Oaxaca: Pasture	El Sanjon	0.0
201	Oaxaca: Pasture	El Sanjon	0.0
186	Oaxaca: Pasture	El Sanjon	0.0
182	Oaxaca: Solar	El Sanjon	0.0
183	Oaxaca: Solar	El Sanjon	0.0
188	Oaxaca: Solar	El Sanjon	0.0
189	Oaxaca: Solar	El Sanjon	0.0

Code	Area: Vegetation	Community	GHI
193	Oaxaca: Solar	El Sanjon	0.0
196	Oaxaca: Solar	El Sanjon	0.0
199	Oaxaca: Solar	El Sanjon	0.0
200	Oaxaca: Solar	El Sanjon	0.0
185	Oaxaca: Solar	El Sanjon	0.0
204	Oaxaca: Solar	El Sanjon	0.0
206	Oaxaca: Solar	El Sanjon	0.0
220	Oaxaca: Milpa	La Jabalina	0.0
232	Oaxaca: Milpa	La Jabalina	0.0
234	Oaxaca: Solar	La Jabalina	0.0
224	Oaxaca: Solar	La Jabalina	0.0
233	Oaxaca: Solar	La Jabalina	0.0
238	Oaxaca: Solar	La Jabalina	0.0
227	Oaxaca: Milpa	El Limón	0.0
274	Oaxaca: Solar	El Limón	0.0
273	Oaxaca: Solar	El Limón	0.0
275	Oaxaca: Solar	El Limón	0.0
272	Oaxaca: Solar	El Limón	0.0
247	Oaxaca: Frutal	Petatengo	0.0
246	Oaxaca: Fallow	Petatengo	0.0
243	Oaxaca: Milpa	Petatengo	0.0
260	Oaxaca: Pasture	Petatengo	0.0
244	Oaxaca: Pasture	Petatengo	0.0
245	Oaxaca: Solar	Petatengo	0.0
251	Oaxaca: Solar	Petatengo	0.0
253	Oaxaca: Solar	Petatengo	0.0
248	Oaxaca: Solar	Petatengo	0.0
170	Oaxaca: Forest	(forest survey)	0.0
174	Oaxaca: Forest	(forest survey)	0.0
259	Oaxaca: Forest	(forest survey)	0.0