

Report on a consultancy to the EC Natural Forest Management and Conservation Project

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Dr. Denis Alder¹
Consultant in Forest Biometrics

Summary

This report describes work to support stock survey, management inventory, permanent sample plots, and tree volume sampling. An enhanced version of the software to support ISSMI (Integrated Stock Survey and Management Inventory) was installed and training given. The software now provides a considerably improved data structure, and provides an integrated mapping module for quick online maps. The report discusses the tree selection for harvesting, protection, and regeneration (seed trees) in terms of the capabilities and algorithms of the software and the practical steps required for implementation. The project will need to devise appropriate species groups for forest management, and then test them with some trials, using ISSMI, to implement tree marking procedures prior to felling, and controls during felling.

Three PSPs were visited and minor comments made in the report on procedures. A revised form is provided in the report to encourage the use of coded notes to identify abnormal or unhealthy trees. An Access database, EPHRU has been designed for data entry, with a demonstration given of its use. A recommendation is made that in the field each tree is fully number with both quadrat and tree number. This will avoid confusion when the plots are re-measured.

A training exercise in tree volume sampling was undertaken at Kalinzu Forest Reserve. A revised form is included in the report, together with explanations on the measurement of forked trees and a description of the sampling distribution. About 2000 trees in all should be measured, of commercial species, but not more than 100 trees of any one species. A table giving the optimum size distribution for the sample is also given. Sampling needs to be continuously monitored to avoid over-sampling of species or size classes.

A general observation in all three areas (ISSMI, PSPs and volume sampling) was that office organisation, allocation of data entry and checking responsibilities, and the logging and archival system for field forms should be given some attention. At the moment tasks are allocated in an *ad hoc* way and compete with revenue collection and GIS work, with no formally organised system of priorities.

¹ E-mail: d-alder@eurobell.co.uk

Background

The assignment described in this report was the third in a series of related short consultancies designed to assist in the development of a combined method of stock survey and management inventory called ISSMI (Integrated Stock Survey and Management Inventory). It also pursues other threads common to the earlier visits, including assistance with permanent sample plot work (PSPs), and with the field sampling procedures required for preparing new volume tables for indigenous forest species.

Itinerary

The consultant arrived in Uganda on the morning of Friday 28th May and departed in the evening of Friday 11th June. Except for the field visits noted below, this time was spent working at the project headquarters in Kampala installing the ISSMI and PSP software, providing training, and report writing.

Two field visits were undertaken. The first, to Budongo Forest Reserve, was made from 30th May to 1st June, to review permanent sample plot work. The second was from 6th-8th June to Kalinzu Forest Reserve to give training in volume sampling and review ISSMI operations, silvicultural trials, and PSP establishment.

Terms of reference

The following points formed the consultant's formally advised terms of reference :

- Install the extended version of the ISSMI software and provide training in its use. Part of the installation procedure will require conversion of data from the preceding version to the amended format.
- Review stock survey and management inventory methods on the ground, to ensure the methods used are consistent with the requirements of the software, and make recommendations for adjustments where necessary.
- Install the PSP data entry system and provide training in its use.
- Review PSP operations on the ground and ensure that they are consistent with intended procedures.
- Review propose procedures for volume sampling in the field and undertake some trial measurements of felled trees as a training exercise.
- Discuss with forestry staff the logical criteria for selection of seed trees and harvest trees applied in ISSMI, the related question of the most appropriate species groups, and the practical questions for controlling felling activities from the basis of the ISSMI tree lists.
- Report on the relative achievement of the above activities and any recommendations or observations relating to them.

It was possible to address and complete all the points in the above list.

Figure 1 Role of ISSMI in planning and control of selection forest

Stock survey and management inventory

An overview of the ISSMI process

Figure 1 shows the various stages in planning and control of harvesting and silviculture as envisaged in conjunction with ISSMI. Some of these steps are already operational, whilst others will be developed and refined over the next one to two years. The software that has been developed and installed during this consultancy is complete and adequate to support all these steps except the final monitoring process.

In the following explanation, the bracketed numbers (1) refer to Figure 1.

Initially (1), stock survey in conjunction with management inventory is done using the ISSMI data forms and methods that have been developed under the earlier consultancies and are now well tested. This aspect of the work can be regarded as complete except for the extension of skills to the districts, so that the operation can be decentralised.

Data entry (2) and checking (3) are done in parallel with field work, with small stock maps being used for quality control (4) whilst work is still in progress. This aspect of the work is operational, but some improvements are needed as discussed on page 12 below.

Once the data has been checked, including the survey co-ordinates of the blocks and sample plots, a data file can be generated (5) for a compartment which gives the co-ordinates for each tree relative to a compartment base point, species, diameter, and stem quality. This can be used by the GIS system to produce a large format stock map overlaid on compartment boundaries, contours, roads, etc. for detailed planning of operations (10). This planning work would be undertaken by the Forest Districts.

The process of silvicultural planning is shown in steps (6) to (8). The ISSMI software produces thematic maps and summary tables showing seed trees, trees to be harvested, and residuals for each block. The selection of these depends on the silvicultural criteria applied, which may be varied experimentally, especially during the early years of application of the system, until a satisfactory result is obtained that balances conservation, stand improvement and production needs. The development of this process of silvicultural planning probably represents the next goal for the EC Forestry Project.

Once an appropriate selection of harvest and seed bearing trees has been made, then two parallel activities can take place. On the ground, the harvest and seed trees need to be distinctively marked (9). At the same time, a process of planning and consultation will take place in the district forestry office to allocate blocks to particular millers (10) and take into consideration community needs.

Felling operations will be supervised using lists of trees and A4-sized blocks maps produced by the ISSMI software (11). After completion of felling, an inventory of stumps will be carried out as a cross-check on the supervisory work, using an independent, headquarters-based team (12). This will be intended to minimize and deter possible malpractice or collusion during the supervision of exploitation.

The ISSMI software

Overview of software capabilities and design

The ISSMI software comprises a Microsoft Access database, an Excel-based program for drawing maps of single blocks, a secondary Access database called ISSMILIB that supports the database management options described below, and a Windows library called ISSMIMAP.DLL which can be attached to the ISSMI database to provide thematic mapping functions. Generally, simply copying the Access file is sufficient to provide a data entry capability. Full installation is required for all parts of the system to work, and is described in Appendix A.

The software provides the following functions:

- *The merging or extraction of data to another ISSMI database.* This supports the distributed data processing model described below, and is designed to facilitate splitting of data entry work up among a number of computers and operators, and the ultimate devolution of data processing to District offices.
- *Entry and editing of stock survey and inventory plot data.* Supporting this is a species list, which may be edited as needed, and lists of coded notes used in the field. Simple reports list data as entered, for checking purposes.
- *Specification of silviculture,* by allocation of species groups to species, and silvicultural criteria to species groups. A summary report shows the effect of any particular combination of criteria at the compartment level.
- *Thematic mapping.* Simple maps of compartments or selected groups of blocks can be produced on screen or copied to other Windows applications. The separate Excel mapping program can also produce a formatted block map designed for field checking of data. The software can also output the tree co-ordinate data as a file. This may be used for high quality mapping, overlaid on other geodata by a GIS system.
- *A variety of formats for stand tables,* which incorporate information from the inventory plots to show the distribution of trees across size classes. The stand tables can show tree numbers, basal area or volume, and may be in simple or cumulative form. The resultant tables can be output to Excel to produce histograms of stand structure. This is essentially a tool for forest management and silvicultural analysis. The tables can be produced for a whole compartment or a listed group of blocks.
- *A check list of seed and harvest trees by stock numbers.* This list is designed as a control tool to supervise tree marking and exploitation.

The distributed data processing model

The ISSMI software was designed so that copies could be made and data entered separately onto each copy. These separate data sets could then be merged as needed. The suggested arrangement ultimately would be to have a master file at Forestry headquarters, with a local version in each district. Figure 2 shows the concept.

However, this method can also be used to subdivide data processing tasks. The local copies are used to enter data from different forms by different operators. When the data has been checked and edited, then it can be merged back to the master file.

The extraction process can take data for a selected compartment to provide an initial set of data for training or local application. The merging process adds all new records from the subsidiary database, but does not copy any edits onto pre-existing records. Edits on the local database can only affect those records which are unique to it. Those which are also held on the master file will not be updated when the data is merged.

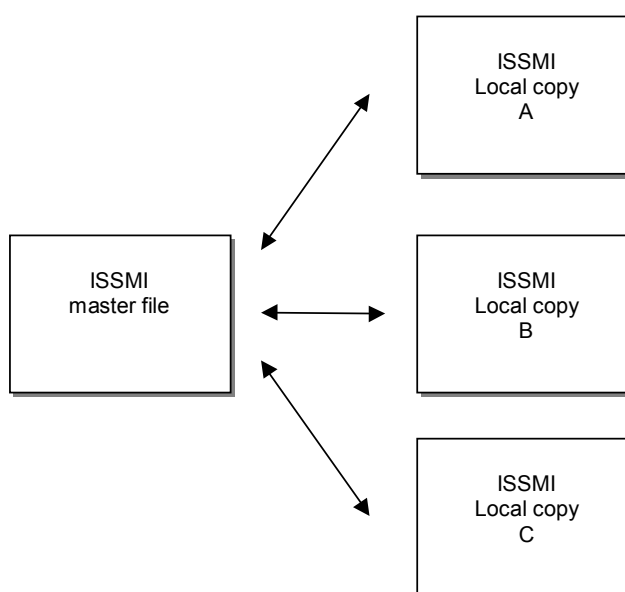


Figure 2 The distributed processing model for ISSMI

Stock survey and inventory plot data entry

As with the first edition of the ISSMI program, the new version has as a core function the editing and entry of data. The forms used are essentially identical to the earlier version, although there have been some internal changes, as described in the consultant's previous report. Blocks and plots are now uniquely identified in the system by fields which can be related obviously to the source of origin. For example, Block 35 of compartment 34, Kalinzu FR, has the identifier Kal-34-35. The plot at the SW corner of this block is identified as Kal-34-35-SW.

This change has several consequences compared with the use of arbitrary sequence numbers, as in the earlier edition. It is now impossible to enter the same data twice, as the system will reject the block or plot header with an error message if it already exists. If the forest, compartment, block or plot locations are edited, then the identity field is modified by ISSMI to reflect the change.

Species codes are now also uniquely keyed in the species list. Entering a code not in the list will cause an error message, although it is possible to immediately enter a new species if this is actually necessary.

Two report formats have been added to print block or inventory plot data in a format similar to that used on the field sheets. This is designed to facilitate data checking.

The ISSMI mapping module is also a powerful checking tool. Blocks or plots which have no co-ordinates will not appear on the map. Blocks with incorrect co-ordinates

will appear in the wrong place. Sample plots are shown on the map, and this allows their entry and co-ordinate positions to be checked visually.

A progress report summarises all the data held in an ISSMI database and can also be used as a management control on data entry.

Using the version of the ISSMI software provided in February 1999, the consultant found that the project staff had entered data for some 11,000 trees and 106 blocks since the previous visit in February 1999, but only one inventory plot had been entered. This implies that there is now a backlog of some 400 inventory plots which require entry.

Use was clearly being made in the field of the single block maps produced by the Excel ISSMIMAP program, but some confusion had crept into the nomenclature of compartments, especially in Lwamunda, where data was variously assigned to compartment 1, 1A, 1B, 01B.

Unless inventory plot data is entered at the same time as stock survey data, it will not be possible to develop a system that allocates yields on a correct silvicultural basis. There is obviously a perception at the moment that stock survey is important whereas inventory plots are not. This needs to be corrected and both aspects given equal priority. The present backlog of data needs to be brought up to date.

Specification of silviculture

Three interlinked types of information control silviculture in ISSMI, as shown on page 10. The first, in the species table, is the species group to which each species is assigned. The second is the table of species groups, which defines key criteria such as the minimum felling limit, and the importance given to the group as potential harvest or seed trees. The group may also be designated as protected, in which case it will not be harvested, irrespective of any other criteria. The species group table also selects the colours and symbols used for the group on maps.

The final table is that of Silvics. This allows a number of different silvicultural regimes to be created. Each regime may be named, and is characterised by the number of seed and harvest trees per hectare, and weights used in scoring trees for selection as harvest or seed trees.

The Silvics form has an action button which applies the selected regime to a particular compartment. When this is done, a field in the *StockTrees* table of the database is filled in with codes to designate each tree as a harvest tree, a seed tree, or a residual.

This scheme is an interim one. It does not take account of information on advance growth provided from the inventory plots, nor does it use the coded notes to identify abnormal trees.

The thematic mapper

The thematic mapper will operate when ISSMI is fully installed in accordance with Appendix A. If it does not start, or produces an error message, please refer to that Appendix, especially in relation to the registration procedure in Windows 95.

The first view produced by this system is of blocks, with trees shown as dots. Seed trees are shown in red, harvest trees in blue, and residuals in green. If no selection has been applied, all trees are shown in green.

If blocks are missing, although in the data, then either coordinate, block size, or strip width data is missing for the block. If the block appears incorrectly placed or overlaps other blocks, then one or other of the above fields is incorrect. If trees are crowded to one side of the block, while the other is empty, the sweep width is wrongly entered.

Inventory plots are shown as small circles, and should appear near the corners of each block. If they are missing, either coordinate or size information has not been entered, or data for the entire plot is absent.

Selecting a block or group of blocks with the mouse and clicking the Zoom button will produce an enlarged diagram. This can show stock numbers, and symbols or colours for species groups according to options checked at the base of the screen form. This diagram can be printed for field use, either directly, or better by importation to Word as a diagram. For the latter, the Copy button is used to copy the map to the windows clipboard.

In addition to the linked mapping program, the Excel mapping program remains effective and produces detailed maps of single blocks. There are two versions of this program. The original one was ISSMIMAP.XLS; this is not fully compatible with the new version of ISSMI. A second version, called ISMI2MAP.XLS, will work with the new version. The operation of both programs is identical.

An example of thematic mapper output is included in the consultant's report for May 1999. An example for the Excel-type block map is given in the February 1999 report.

Stand tables

Stand tables can be produced in several format. The dialog screen that initiates stand table production is shown opposite to indicate the combination of options available.

The stand table can cover a whole compartment (with the keyword *All* in the Blocks field) or a selection of blocks given as a list (eg. 33,34,43,44).

The dialog box is titled "ISSMI stand table options". It contains the following elements:

- Forest:** A dropdown menu with "Kalinzu" selected.
- Compartment Blocks:** A dropdown menu with "34" selected and a text field with "All".
- Variable for table:** Three radio buttons: "Trees per ha." (selected), "Basal area per ha.", and "Volume per ha."
- Diameter classes:** Three input fields: "from" (10), "by" (20), and "to" (90), all followed by "cm".
- Checkboxes:** "Cumulative values" and "Area totals" are both checked.
- Buttons:** "Cancel" and "OK".

The variable summarised may be tree numbers, basal area, or bole volume. The diameter classes can be varied, although a lower limit below 10 cm is not meaningful

since this is the smallest size sampled. The classes can be conventional or cumulative. In a cumulative table, the values are shown for trees 10 cm and above, 30 cm and above, 50 cm and above etc. In a conventional table, they are shown by classes 10-30, 30-50, 50-70, etc.

The figures may also be shown as averages per ha or as totals for the selected area. The per ha figures will only be correct for blocks which fall entirely within the forest reserve. If edge blocks are included which are partially outside, then the area is overestimated, and the per ha means consequently lower than the true average figures.

The resulting table can be printed, exported to Word, or exported to Excel. In the latter, the data can be presented graphically.

It is important to note that the stand table will only be correct for trees below 50 cm if the inventory plots have been entered into the database. The sampling percentage is shown on the stand table heading, and should normally be close to 5%. It is important to check through the thematic mapper and work progress reports that inventory plots have been entered before using the stand table for analysis.

An example of this report is included in the consultant's report for May 1999.

Check list of trees for marking and monitoring

The check list report is given for each compartment. Its intended purpose is to be used for marking trees as seed trees and for harvesting; and also for controlling these operations. An example of this output is given in the consultant's report for May 1999.

Tree selection and marking

Method of tree selection

The system for selecting trees for harvesting or for reservation as seed trees is illustrated on the diagram overleaf. Each species in the species list is assigned to a species group, of which there can be any number. They are designated by serial numbers from one upwards (zero should not be used).

The *Species groups* form allows the minimum felling diameter, the relative weighting as a commercial or seed bearing species, and the protection status to be set. Trees below the minimum diameter are not considered for harvesting, nor are those with a protected status. The weightings are used in scoring trees for selection, and should be values on a scale 0-5. However, a zero value indicates that the species is either non-commercial (under the *Felling* category) or should never be selected as a seed bearer (under the *Seed Tree* category). This form also gives a name to the group, which should be more meaningful than those in the example, and allows symbols and colours to be selected for the ISSMI mapper.

As a guide line, major commercial species should have felling and seed tree weights of 5. Minor species can be 3, and others zero. Protected species should only include those for which strict conservation is required.

Linkages among various files used to specify silviculture

Group	Description	Harvest	Selection weighting		Protected	Map symbol	Map colour
		Min. diam	Felling	Seed trees			
1	Group 1	50	5	5	No	Star	Red
2	Group 2	50	5	3	No	Triangle	Blue
3	Group 3	50	2	0	No	Circle	Cyan
4	Group 4	50	0	0	No	Diamond	Green
5	Group 5	50	0	0	No	Square	Brown
6	Group 6	50	0	0	No	Square	Brown

The *Species groups* form designate minimum diameters, the importance of the species (on a scale 0-5) for harvesting or seed trees, and whether they are strictly protected. Mapping colours and symbols can also be set.

Code	Group	Botanical name	Volume eqn.
250	2	Diospyros abyssinica	A
251	2	Diospyros mespiliformis	A
252	2	Dombeya bagshawei	E
253	2	Dombeya goetzenii	E
254	2	Dombeya mukole	E
255	2	Drypetes spp.	D
456	4	Ehretia cymosa	U
256	2	Ekebergia canpensis	U
257	2	Ekebergia senegalensis	U
459	4	Elaeodendron buchananii	U
460	4	Elaeophorbia drupifera	U

Silvic	Allowable cut Maximum N/ha	Seed trees Required N/ha	Harvest trees criteria weights			Seed trees criteria weights		
			Species	Quality	Size	Species	Quality	Size
Standard	10	10	1	-1	1	2	2	1

Record: 1 of 1

The *Species list* can be edited to change the group in which a species occurs.

The *Silviculture* form indicates how many trees per ha should be harvested or reserved as seed trees. It also gives the relative importance of species, stem quality and tree size in scoring trees for selection in either category. The *Apply* button does the tree allocation for a particular compartment.

The *Silviculture* screen form determines the total number of trees per ha to be felled, and the number to be reserved as seed trees. It also has some general weights which determine the relative importance of species, stem quality and diameter class in scoring trees for felling or selection as seed bearers.

The *Apply* button on the *Silviculture* form applies the criteria that have been set to a given compartment to make the tree selection. Once the selection is made, it is stored permanently in the database, and does not need to be repeated for that compartment unless it is desired to test the effect of different tree selection criteria.

Formula for scoring trees

For harvested or seed trees, there are three values that can be set by the user:

- W_k Weight for species group k
- W_g General weight for the species group attribute
- W_q Stem quality weight
- W_d Tree diameter weight

For each tree, the following values are given by the data:

- K The species group number, which depends on the tree species
- Q Stem quality, which is scored 1 to 5.
- D Diameter class, which is coded as (1) 50 to 59 cm, (2) 60 to 69 cm, (3) 70 to 79 cm, (4) 80 to 89 cm, (5) 90 cm or more.

The stem quality weight W_q or the tree diameter weights W_d can be entered as negative values. The negative value is used to indicate to the software that the order of scoring is reversed, so that quality 5 is scored as 1, quality 4 as 2, etc. This effectively reverses the importance of the value, so that the worst or smallest stems would be selected in preference to the largest or best.

The formula to score each tree is then:

$$S = W_k.(W_g + W_q + W_d)$$

where S is the score.

Once scores have been calculated for each tree, the list is sorted from largest to smallest, and the designated number of trees per ha selected from the top down.

The use of the species group weight W_k outside the bracket ensures that species group will always be the priority factor in selection. The relative balance between W_g , W_q and W_d determines the importance of diameter and quality as selection factors.

Practical application of tree selection

The tree selection process, either for harvesting or as seed trees, has not yet been implemented in practice. The following steps are suggested for application, which should be modified in the light of experience:

- *Formulate meaningful species groups.* The species groups currently in ISSMI are arbitrary and were set up purely to test the software. Species groups should include Mahoganies, strongly accepted commercial species, weakly or regionally commercial species, marginal or potential species, species of ecological or conservation importance, and other species. This grouping needs to be based on an analysis of actual patterns of use and marketing.
- *Determine appropriate levels of allowable cut and seed tree retention.* The consultant suggests that harvest levels should be limited to 15 trees/ha or less, and 10 seed trees per ha should be specified.
- *Set the weights for species groups, stem quality, and diameter.* The author suggests that species group weights should be 5 for commercial species, 3 for marginal species, and zero for non-commercial species. The quality and diameter weights should initially be around 1 or 2, with negative values for harvest quality so that there is a tendency to select poorer trees for felling, and retain better ones.
- *Make a selection on a compartment using ISSMI, and print the check list of seed and harvest trees, together with maps for blocks on a suitable scale showing the stock numbers.* The latter will be clearest if printed in colour.
- *Mark the trees on the ground.* The consultant suggests an S for seed trees and an X for harvest trees. Residuals should not be marked. White emulsion can be used as the paint marks do not need to persist more than one or two years. The marks should be painted at approximately breast height on the north side of the tree.
- *Organise and supervise felling.* There are a number of practical aspects to this, related to measurement of products and collection of fees, and some further co-ordination of the information system in this area will be useful in future.
- *Cross-check stumps* and provide a return of actual stock numbers felled and the stock numbers of trees severely damaged during felling. Forms and data handling procedures for this activity will need to be devised at a later date.

Recommended further developments

Office procedures

The following recommendations are made for immediate implementation:

- A register should be kept showing forms received (stock survey or inventory plot), forest, compartment, block, date received, date entered, date checked, with signature of the responsible officer.
- Forms should be filed in box files by forest and compartment.
- A master copy of ISSMI should be maintained on one computer in the network. This should be name *ISSMI2 (master file)*
- Subsidiary copies can be made to other computers to speed up data entry. These should be given distinct names to avoid confusion.
- ISSMI data entry should be prioritised to ensure that forms handed in are completely entered and checked within one week, with block maps and data lists returned to the field for checking by the end of that time. If this cannot be accomplished by existing staff, then an additional person should be employed.

This process should also include checking that block and plot co-ordinates are correct with reference to the field maps.

- The ISSMI master file should be backed up internally daily and before any merge operations to incorporate data from the subsidiary files. External backups to ZIP disks should also be made daily.
- It is extremely important that inventory plots are entered in tandem with block data.

Software development

The consultant can envisage a number of areas in which ISSMI will need improvement, but he suggests that this process should be driven by the demands of users, with an upgrade perhaps being specified in six months time after there has been extensive experience and use of this preliminary system.

Tree selection and marking

It is recommended that the procedures described on page 11 in the section **Practical application of tree selection** are followed through. The final stage, of carrying out stump and damage surveys, will however probably need to be co-ordinated with an upgrade of the software so that this functionality can be added.

Evolution of methods for tree selection

The consultant envisages that in future, tree selection will be related to a calculation of allowable cut that will take into account the advance growth data from the inventory plots. However, this more complete and fully sustainable method of yield calculation does not need to be implemented until all stages of the field operations and the basic data processing provided by the present version of ISSMI are fully operational. It is an activity which should be associated with the general upgrade of the ISSMI software in some six months time.

Installation of data entry software

As described in the consultant's previous report, an Access database has been designed for the permanent sample plot data called EPHRU. This is an acronym for EditIng of PSPs for the High forest Region of Uganda. A copy of this database was installed on the ISSMI computer in the directory C:\DATA-A\PERMANENT SAMPLE PLOTS, and a demonstration given of its use.

However, there did not appear to be much awareness in the office of the PSP data. Perhaps because of the lack of software, no data has so far been entered, and consequently no one appears to have an assigned task in this area. There is a need now to address this organisational aspect and clear the backlog of data.

Observations on field visits

The consultant visited two plots in Budongo Forest Reserve on 31st May to review procedures for the new plots. These were plots N10/2 and N7/2.

The following points were noted:

- Where the normal point of measurement is not 1.3 m, then it is often being placed in an area that is insufficiently above buttresses or fluting, so that it will be necessary to move it again in a few years. When not possible to measure at 1.3 m, the normal standard is to place the POM one metre above the convergence of buttress. On some fluted trees, it is not possible to see any definite convergence within the lower 4.5 m reachable with a ladder, and in this case, the best site for measurement (with least concavity around the stem) should be chosen.
- Trees are being numbered only with the within-quadrat tree number. Experience has shown the consultant that after some years, this system will be confusing as trees die, new recruits are added, and internal quadrat boundaries become more ambiguous. It is recommended that each tree bears a unique number for the whole plot to avoid these problems¹. Given that currently, a within-quadrat number is used, this can be prefixed with the quadrat number. For example, tree six on quadrat 17 should be labelled 17-6. This uses more paint initially, and is slower, but avoids much confusion at re-measurement.
- It is important to keep painted numbers as neat as possible by using paint brushes in good condition. Hardened brushes need to be replaced, and workers need to be made responsible for proper cleaning and maintenance of brushes at the end of each day. Narrow brushes (eg. 3/4") should be supplied. These are details but they have significant consequences for the legibility of numbering, the work rate, and the consumption of paint.
- The coded notes are not being sufficiently used, principally because the list is not available to staff in the field whilst enumerating the plots. A consequence is that many malformed or abnormal trees have no coded note, giving a misleading impression of the status of the tree. A new PSP form is given in Appendix B

¹ See Alder, D; Synnott, TJ (1992) Permanent sample plot techniques for mixed tropical forests. Department of Plant Sciences, University of Oxford, Tropical Forestry Papers 25, p.62.

which shows the coded notes on the form. This should help to correct this problem.

Apart from these points, the work appeared to be going well. At another PSP visited, in Kalinzu FR compartment 27, work was underway demarcating a new plot. It was noted that the cutting of internal boundaries was too enthusiastic, with a strip about one metre wide being completely cleared. This will disturb the future pattern of recruitment, and should be avoided. If trees are individually numbered, as recommended, then there is no need to have heavy or semi-permanent internal quadrat lines.

GPS positions were taken at the three plots visited. It was found easy to read the GPS under the canopy, but required several minutes. Remaining in one spot for two hours, the estimated position was found to wander over an ellipse about 100 by 150 m. It is recommended that GPS positions be recorded for all PSPs, with readings taken at the plot centre (quadrat 25) . This will assist mapping and relocation of plots.

The following, in latitude and longitude, are the positions recorded:

Plot	Latitude	Longitude
Budongo N7/2	1° 46' 12" N	31° 31' 50" E
Budongo N10/2	1° 47' 29" N	31° 31' 57" E
Kalinzu cpt. 27	0° 23' 17" S	30° 5' 45" E

These are quoted to the arc second, which is about 31 m on the ground at the equator. The instrument used was a Garmin III GPS.

Recommendations

Office procedures and responsibility

A senior officer needs to be made responsible for the PSPs, including the collation of forms from the field, oversight of field work, and control of data entry and checking. This need not be a sole responsibility, but is a substantial one that will increase as the number of plots and the body of data builds up. Eventually, this officer should receive short-course training in PSP analysis. A single data entry staff should support this officer, again with a clearly scheduled job description including entry and checking of PSP data.

As with the ISSMI data, a proper archival and storage system for the forms is required.

Reprinting of field forms

Appendix B gives a revised field form for PSPs designed to provide easier reference to coded notes in the field. Existing forms in use should be collected and withdrawn, to be replaced by the new form as soon as possible.

Numbering of trees

It is recommended that each tree has painted on a number which includes the quadrat number, such as 1-1 (quadrat 1, tree 1) or 25-6 (quadrat 25, tree 6). This rule should apply to all new plots, with existing plot numbers re-painted in the full form when the plots are maintained and re-measured.

To facilitate clear and neat numbering, $\frac{3}{4}$ " paint brushes should be used which are maintained in good condition. White spirit or kerosene for cleaning and spare brushes should be part of the consumable cost of operations.

As has been previously emphasised, only good quality thick oil paint should be used.

Coded notes

The coded notes need to be fully used. Once the forms have been re-printed as suggested above, it is recommended that monitoring visits pay attention to the use of the coded notes. No tree that is malformed, damaged or difficult to measure should lack an explanatory note.

Position of POM

It is recommended that in general, where a good measurement cannot be made at 1.3 m, the new POM should be set at one metre above any buttress or deformity of the stem if at all possible within the reach of the ladders used.

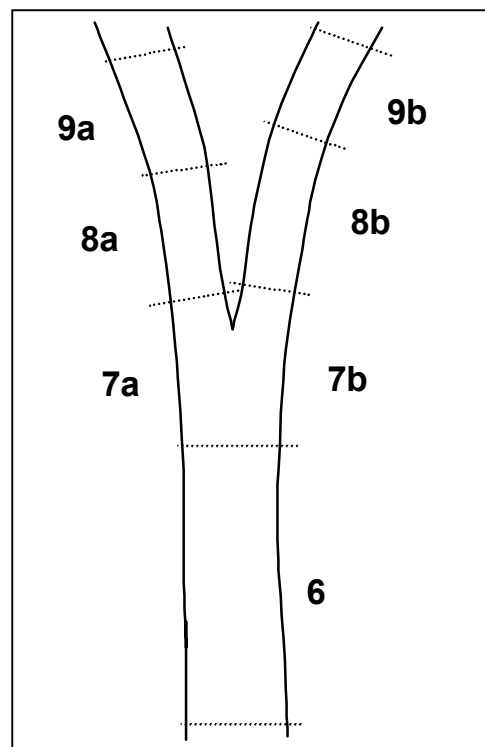
Tree volume sampling

Training in field sampling

A training exercise was undertaken in Kalinzu Forest Reserve, Compartment 34, on 7th and 8th June to use the volume sampling forms (see Appendix C). Three trees were measured completely. A number of others which were prepared were inaccessible during the training period but were due to be measured later. Once a tree has been felled, measurement requires about 30 minutes per tree.

Several points were discussed during the training exercise:

- The diameter measurement at 1.3 m (DBH) or above buttress (DAB) should mimic the measurement normally made on a standing tree. The 1.3 m is measured from the ground, and includes therefore the stump height.
- The top of the first section should be substantially below the DBH or DAB, and should include only the cut stump itself, and any unconvertible butt log including a severely buttressed section or aerial root system.
- Sections of sound log should be measured in lengths of about 4 m, but this distance can be shortened if there are practical difficulties in getting a tape under the tree at the 4 m point.
- Abnormal sections, including bent or twisted parts of the bole, those with forks, side branches or swellings, or sections with defects such as splits or rot should be measured separately, and may be short lengths of 1 m or less. The codes shown on the volume sampling form (Appendix C) should be applied to any defective section.
- When the tree is forked and contains useable logs above the fork, then each branch of the forked section should be measured separately. This is illustrated in the diagram to the left with a tree that forks in section 7. The length of each side is measured independently and recorded on the form as section 7a or 7b. Then the logs above are measured normally, but numbered 8a, 9a or 8b, 9b, etc. depending on which side of the fork they are from.
- Measurement should stop at the point of crown break, if there are no useable logs above, or at the top of the last merchantable log if the upper part of the bole is defective, or at a minimum diameter of 20 cm if the stem continues slender and straight.
- Trees which are completely defective should not be measured or included in the sample.



Data entry and analysis methods

The consultant has not designed an Access form for input of the volume tree sample, as he believes that it is a useful and necessary exercise for project staff to develop this themselves. As with the stock survey, inventory sample plot, and PSP data input forms, a one-to-many form should be developed. The following are the main steps which should be followed:

- Design two tables in Access. One should contain the information on the form header, and should include an *Autonumber* primary key called *TreeNo*, for example.
- The second table should include the *TreeNo* field, a section number, section length, top diameter, and coded note.
- The Relationships dialog in Access should be used to link the *TreeNo* field between the two tables, using the *Enforce referential integrity* option.
- The *Form Wizard* can then be used build a preliminary one-to many form whose formatting and layout can be modified in the forms design screen.

Help and further information on these processes can be obtained using the Access Help screens.

The consultant will provide a prepared form for the volume input if requested, but believes an effort should be made to undertake this relatively simple task independently, as an essential training exercise.

At a later date, when a substantial amount of data has been accrued and cross-checked, then assistance can be given with calculation of tree volumes, and guidance provided on the fitting of tree volume equations using Excel. The normal procedure will be to calculate a table of tree net and gross volumes, together with species and tree diameter. This summary information can then be exported to Excel for regression analysis.

Monitoring of sampling

It will be important as work progresses to monitor the localities, species and site classes sampled to avoid over-sampling.

The overall objective will be to measure 2000 trees. Each species should not have more than 100 trees. The samples should be split between three distinct sites for each species. However, some species may have localized distributions which do not allow this. The size distribution for each species sample should be approximately as follows:

Diameter class (cm)	30-40	40-50	50-60	60-70	70+
Number of trees	5	10	20	30	35

A manual tally will need to be made weekly of forms completed, species, locality, and tree diameters. The leaders of the volume teams will need to be given clear

instructions on which species and size classes should no longer be sampled at each location.

The sampling should always avoid trees of excessively bad form, which are substantially unusable, or trees which are so fluted as to be unmeasurable. Selected trees should be those which would be of normal commercial interest, in terms of stem quality and species.

Conclusions and recommendations

Summary of recommendations

ISSMI

- *Some attention needs to be given to office organisation and responsibilities.* A single officer should be responsible for data entry, storage, quality standards (checking data, correcting the species list and coded notes, etc.) and ensuring that standards for turnaround of data and reports are met. He or she should be assisted by a single data entry person. The consultant's view is that existing arrangements do not define responsibilities clearly, and staff with duties in GIS work and revenue collection cannot simultaneously cope with managing the ISSMI data.
- *The tree selection process needs to be worked through on a trial basis.* This requires use of the selection procedures in the software, after deciding appropriate species groups and numbers for harvested and retained trees, and experimenting with the weighting methods for tree size and quality. It then involves physically marking trees on the ground for either harvest or as seed trees, and following up during and after felling.

PSPs

- *Office responsibilities for the control of the PSP data, its entry and checking, need to be assigned.* The workload of data entry personnel should be assessed to see if additional staff need to be employed.
- *The PSPs forms should be reprinted, using the model in Appendix B.* Existing forms in circulation should be withdrawn. The main objective is to ensure fuller use of coded notes.
- *All trees should be numbered with both quadrat and tree number, separated by a short hyphen, eg. 17-5 for tree 5 in quadrat 17.*
- *More care should be taken in locating of POM when not at 1.3 m.* It should be at least a metre above the convergence of buttresses if possible.

Volume sampling

- *An effort should be made to design an Access input form for the volume data, using the same one-to-many principle exemplified by the ISSMI and PSP data forms.* If difficulty is experienced, the consultant can provide a ready-made format, but he feels that this is an important exercise to attempt.
- *The data must be monitored weekly as it is collected to balance the distribution of sites, species and size classes in accordance with the criteria set out on page 18.* This again requires that a responsible officer is assigned, who should also manage and direct data entry and archival of forms. Field crews will require frequent updating of their instructions to ensure that the balance of sampling is maintained.

Summary of current status of operations

ISSMI

To date some 13,000 trees have been stock surveyed and entered in the computer using the ISSMI package. Approximately 400 ha of forest have been surveyed. The system needs to be further developed, especially in its application to and control of selection silviculture, which is the *raison d'être* of the method. However the basic feasibility of both the operational and software aspects have been demonstrated.

PSPs

The plots which have so far been established on the ground are well demarcated and clearly numbered and marked. Data entry has yet to be started, but some basic software has been provided for this purpose with this assignment. Future re-measurements will provide the critical test for the standard or work, since it is at that point that errors in measurement and species identification may become apparent.

Volume sampling

The volume sampling work has been started, and training given in the field. Depending on the resources allocated, it may take six months to a year to achieve the 2000 tree recommended sample, at which point a complete analysis and review of volume equations in current use should be undertaken. However, it will be desirable after some three months to check both field methods and data entry, to avoid any serious deviation from the necessary standards. At that time, a preliminary analysis should be made.

Topics for future biometric inputs

There are a number of areas where future specialist inputs may be required, in relation to the improvement and extension of ISSMI, software for analysing PSP and tree volume data, other growth and yield studies and strategic estimates of allowable cut in natural forest and plantations, systems analysis of data processing needs and organisation, and training in more advanced database and Excel skills. However, the consultant believes that these issues should be driven by a clearly emergent demand rather than the consultant's suggestions, otherwise a circular process of self-perpetuating consultancies arises.

General conclusions

This assignment leaves the ISSMI work, the PSP studies, and the tree volume sampling all well placed to continue without major limitations of technique or application. It is desirable now that a period of several months at least elapse with good use being made of the existing facilities, and with field sampling being fine tuned to a smoothly functioning operation, before any further modifications or elaborations of technique or software are undertaken.

Denis Alder (Dr.)
Oxford, 18th June 1999

Appendix A : Installation of ISSMI

Files required

ISSMI consists of the following files:

ISSMI2.MDB	The main database. This may be renamed as needed.
ISSMILIB.MDB	A program in Access/VBA to manage the data extraction option. This <u>must not</u> be renamed.
ISMI2MAP.XLS	Excel program compatible with Issmi2 to draw block maps
ISSMIMAP.DLL	The mapping program configured as a Windows Dynamic Link Library (DLL)

With the exception of the DLL file, these need only be copied to a suitable target directory for installation. However installing the DLL file requires several steps, which are detailed below.

System requirements

Access 97

ISSMI requires that Access version 97 or later is fully installed, especially components relating to Visual Basic for Applications.

Excel 97

To run the ISMI2MAP.XLS module, Excel 97 must also be installed. When ISMI2MAP is run, the *Enable Macros* options must be selected on the start-up screen.

Visual Basic

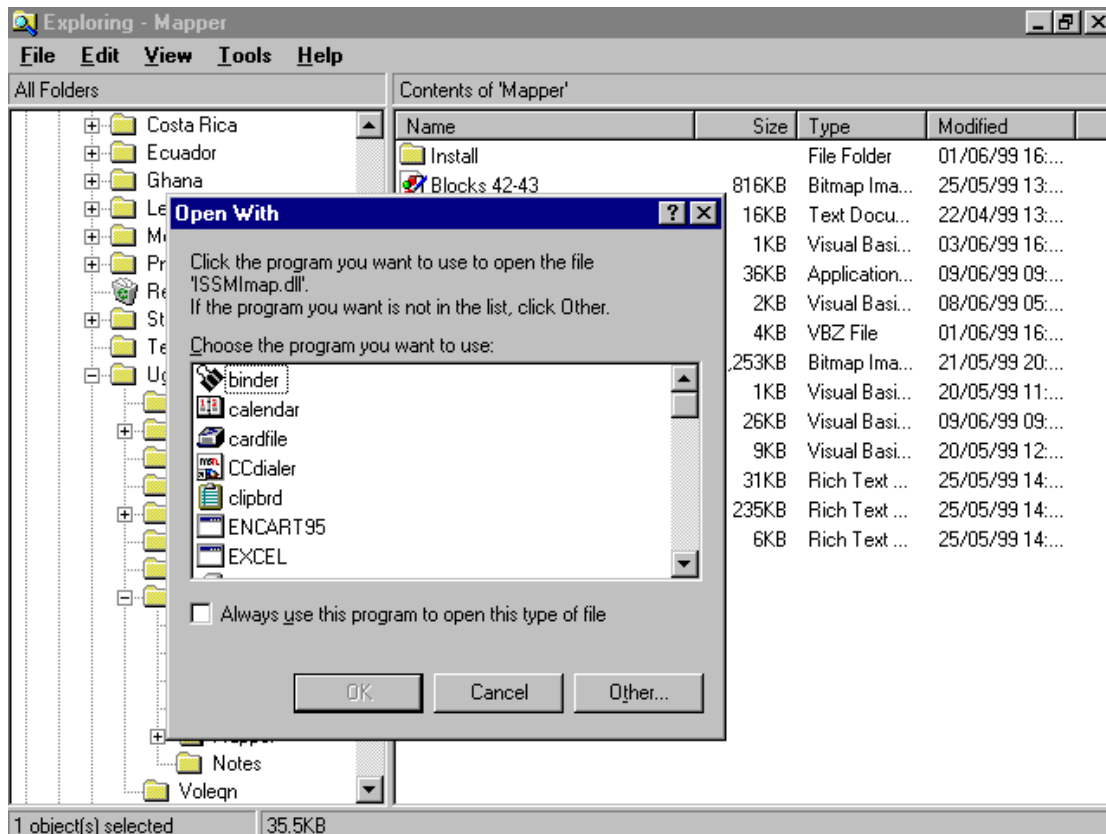
To run ISSMIMAP.DLL, some files are required from the Visual Basic system which are not a normal part of Microsoft Office and may not be on the target machine. To install them, the files found in the directory C:\DATA-A\STOCKMAPPING\ISSMI2\MAPPER\INSTALL of the ISSMI computer should be copied to a temporary directory on the target machine (eg. C:\~INSTALL) and then the program SETUP.EXE run. The default options should be selected and the required files will be added to the system. After this is done, the temporary directory and its contents can be deleted.

Installing ISSMIMAP.DLL

Registering ISSMIMAP.DLL with Windows 95

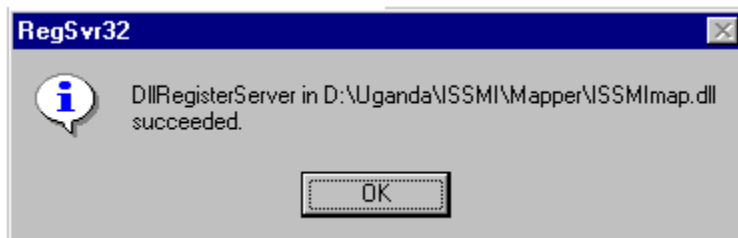
Before trying to run ISSMI2 for the first time, the ISSMIMAP.DLL file must be registered with the system. This is best done using the Windows Explorer, which can be configured to automatically register any DLL file simply by clicking on it.

Open the Windows Explorer, and find the file ISSMIMAP.DLL, which should be in the same directory as the ISSMI2.MDB file. Double click on it. If the Explorer has not already been set up to register a DLL, a dialog as shown below will appear. Click on the Other button and find the file REGSVR32.EXE in the C:\WINDOWS\SYSTEM



directory. Click on it, and check the box marked *Always use this program to open this type of file*.

Afterwards, you should see the message opposite.



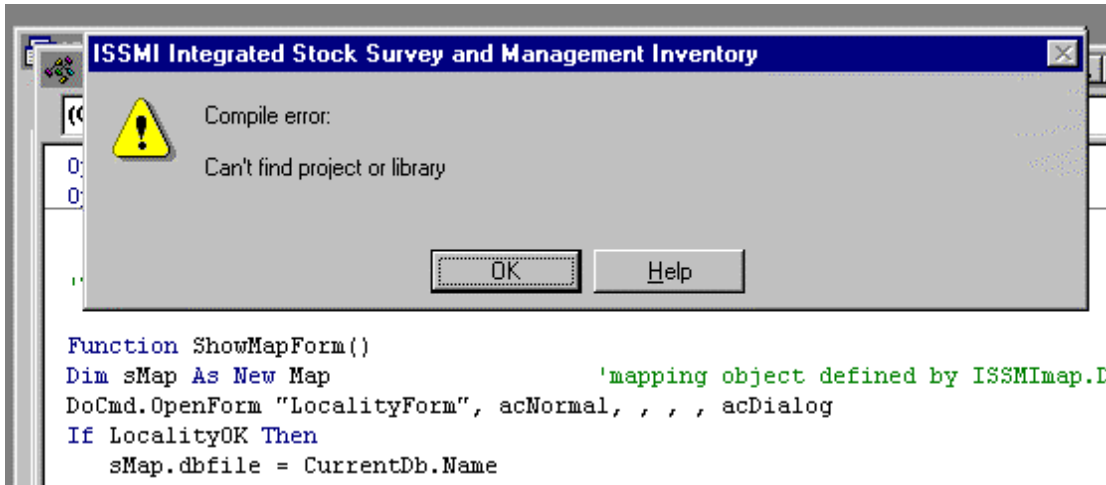
The system will now be configured to register a DLL automatically by clicking on it from the

Explorer, giving a message similar to that shown. The first part of the above process should not need to be repeated.

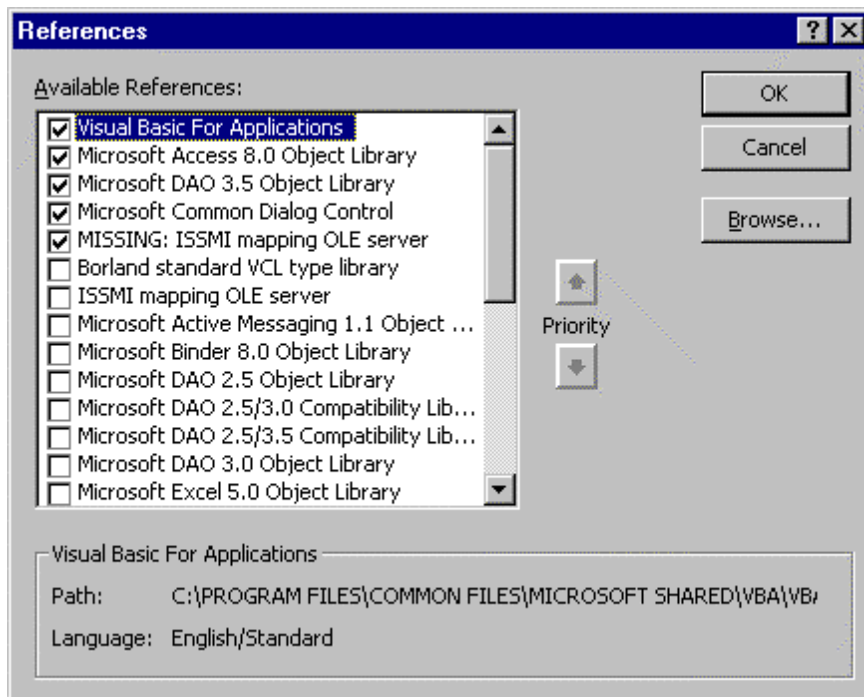
Setting the correct reference to ISSMIMAP in Access

Although ISSMIMAP will now be registered with Windows 95, it still may not be possible for the Access database ISSMI2 (or whatever it may be called) to use it. Test this by starting the ISSMI2 database and selecting the **Reports / Mapping** option from the menu. If an error message such as that shown below appears, then some further steps are required to complete the installation.

- Firstly, select the **Tools / ISSMI design** menu option. From the standard menu bar, select **Window / Unhide**, and select the **Database** window.
- Click on the **Modules** tab, and double click on the module *Mapping*.

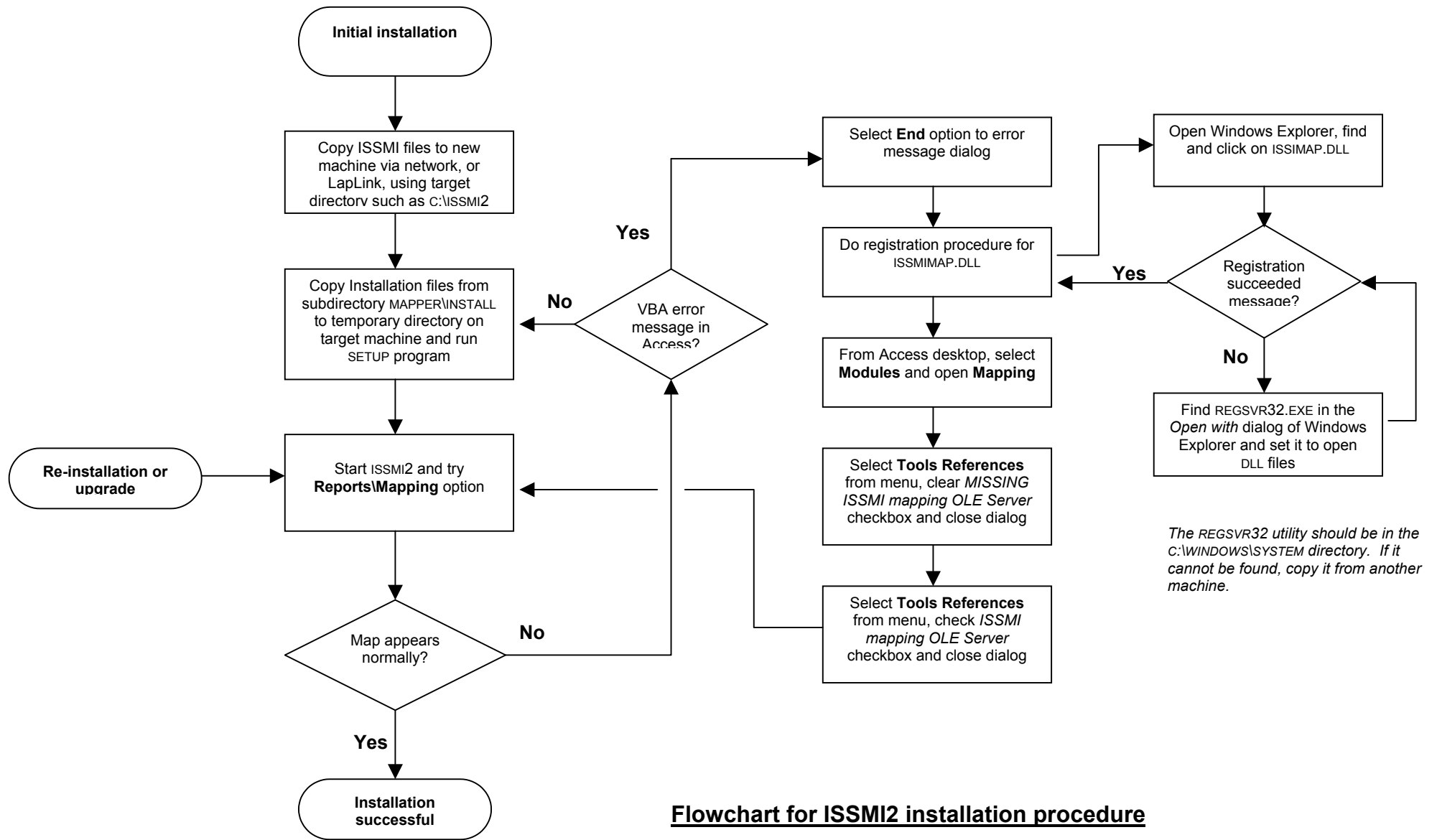


- Then select the menu bar **Tools / References**. The screen shown below will appear. Clear the check box which says *Missing : ISSMI mapping OLE server* and close the dialog.
- Repeat the process, selecting again the menu bar **Tools / References**. Search for the box labelled *ISSMI mapping OLE server* and select it. Close the dialog box, and close the open module.
- Restart ISSMI by closing it in Access and then re-opening it. The mapping function can now be tested and should operate normally.



Flow diagram for installation

Exactly how the installation will go on a given computer depends on several uncertain factors relating to the history of the system. The following flowchart serves as a guide map for the appropriate steps to follow.



Appendix B : Permanent sample plot forms

The form overleaf should be photocopied or printed in as many copies as required.

It is recommended that existing forms be withdrawn from use as soon as possible.

Permanent sample plot enumeration form											Sheet	of		
PSP No.		Forest			Block			Compartment		Enumeration date				
OIC enumeration team				General observations and site codes							Old PSPs only: Last meas. Year			
(1) Quad No.	(2) Tree No	(3) Species			(4) Code	(5) Diam	(6) Alt. Diam	(7) POM	(8) Crown Illum.	(9) Coded notes/remarks		(10) Old No.	(11) Old Diam	

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Coded notes for tree condition.

Tree form and measurement quality

DU Diameter unreliable - measurement cannot be made accurately.

FB Fluted bole – bole is fluted and cannot be well measured.

MF Malformed – tree very crooked, bent over, twisted

MS Multiple stems – forked above POM

OD Optical diameter measurement – large high buttress trees measured by Relascope

Damage and health indicators

BS Broken stump – tree broken off in mid or lower bole

BT Broken top – crown completely broken off

CD Crown damage – major branches broken, crown partially lost

CI Climber infestation – competing with tree crown

DB Dead bark – areas of bark loss exposing dead cambium

EX Excrescences – large bumps or woody growths from bole of tree.

FD Fire damage – charred wood or bark.

FU Fungi – fruiting bodies of fungi on stem or buttress.

LD Logging damage – tree has been damaged during logging.

LT Leaning tree – tree partially uprooted or leaning from the vertical

RB Rotten buttress – Base of tree largely rotten

RT Rotten timber – rotten branches, hollows etc. on main bole

ST Strangled tree – Tree largely dominated by strangler

DF Defoliation – tree has no foliage

Dead or missing tree indicators

DT Dead tree – tree clearly dead, but standing

LS Logged stump – sawn or axe-cut stump

NT No tree – Tree completely missing

TF Tree fallen and on ground.

Other factors

DC Diameter change – new POM adopted

FW Flowering – tree is in flower

IN Ingrowth – a recruit tree not previously measured.

US Uncertain species – identification given is best guess.

Appendix C : Tree volume form

The form overleaf should be photocopied or printed in as many copies as required.

It is recommended that existing forms be withdrawn from use as soon as possible.

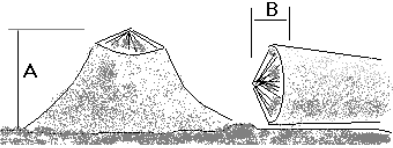
Volume tree measurement form				Officer-in-charge	Measurement Date	
Forest		Forest block		Cpt.	Block No.	Stock No.
Diameter (cm)	POM (m)	Species name			Code	
Section	Length (m)	Top diameter (cm)	Defect code			
0			Stump – see note			
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
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25						

Block and stock no: *If the sample tree has a stock number, stock survey block and tree stock number must be recorded here. For sample trees below 50 cm, or in areas not stock surveyed, these fields should be left blank.*

Diameter & POM: *The point of measurement is conventionally 1.3 m above ground or 1 m above buttress. If it cannot be reached before felling, mark a reference point, eg 2 m above ground and measure from that after felling, adding reference height to record POM.*

Diameter should be measured to the nearest whole cm.. Height of POM should be measured in m to two decimal places, eg. 1.55 m.

Stump section. *Measurement length as A+B in diagram below, and top diameter as the base section of the first log.*



Defect codes: *Each section which is not a useable log should have a defect code entered, from the following:*

FD *Felling damage – splitting or breakage.*
FK *Forked section*
BR *Section containing a lateral branch*
DH *Decay, holes, hollows, large bumps etc.*
MF *Malformed, twisted, curved, fluted, etc.*

General points:

- *Do not measure trees with multiple stems or extensive longitudinal splitting after felling.*
- *Sound sections of good log can be measured in lengths of 3-5 m.*
- *Defective sections can be as short as necessary, eg. 0.5 or 1 m.*
- *Continue measuring up to the point of crown break.*