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Data Recorders Speed Forest Surveys[1]

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SUMMARY

Adapting computer and communications concepts to conduct and analyze forest surveys has been undertaken by the Renewable Resources Evaluation Research project of Southern Forest Experiment Station. How data is relayed from the faraway forest site to the unit's base without handwriting one note is described in this study.

Additional keywords: Forest inventory, data capture, telecommunications, data editing and processing, ADP, computer processing.

INTRODUCTION

Forest survey field teams have been cruising plots and writing numbers on tally sheets since 1933. At last, a feasible alternative is available and advancing technology is reducing equipment costs of that alternative. This report describes use of portable data recorders in the Renewable Resources Evaluation Research (RRE) project of Southern Forest Experiment Station.

BACKGROUND

The Renewable Resources Evaluation Research project of the Southern Station is responsible for surveying forest resources in the Midsouth — Alabama, Arkansas, Louisiana, Mississippi, Oklahoma, Tennessee, and Texas. The project constantly remeasures some 26,000 permanent forest plots, each being covered at nearly 10-year intervals. Great quantities of data are generated and must be reduced to tables for analysis and interpretation. And data will increase substantially as RRE units respond to the Resources Planning Act of 1974 and collect information about the nontimber resources.

Although RRE units have sought more efficient ways to deal with the flow of information, virtually all data has continued to go onto tally sheets and then be coded into punch cards. Such cards and accounting machines to "read" them were put into use in the late fifties.

Southern Station RRE shifted to computer processing in the early sixties. Additional progress has come slowly. Until 1976, RRE jobs were submitted via messenger to a remote host computer center. Printed results were obtained the same way. In 1976, the RRE unit installed a group of devices that permitted telecommunications with a host processor and also provided some local computing capability.

The components included a programmable desk top calculator, card reader, printer, and plotter. A disc system was added later to store files and programs. A terminal with dual tape cartridges and another printer were added in 1977 to complete the present hardware.

A perennial problem has been the process of editing tally sheets, punching data cards, and the

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screening for errors introduced by the field cruisers, by misinterpretation of handwritten codes, or by keypunching mistakes. These tally sheets go wherever the plots are, and are exposed to water and insects. All these factors detract from the fidelity and integrity of the resource information.

RRE has investigated several alternatives to tally sheets. Tape recorders and portable card punchers were tried and discarded. The development of data recorders, digital entry models with tape transport, and the solid state memory units led to RRE experiments with the MSI/77 data recorder in 1978. This unit passed tests and adaptations. About half of Southern Station RRE plot information is entered in recorders carried by staff members in the woods and is transmitted via telephone to base facilities in New Orleans.

Data recorders were designed for special inventory needs of supermarkets and warehouses where stock numbers and quantities comprise no more than 12 digits. But RRE researchers operate in terms of 80-column tally sheets, a holdover from days when data was synonymous with punch cards. Experienced cruisers are accustomed to the sheets and can tell at a glance if they have completed all the required items. This posed the problem of how to squeeze the 80-column format into the 12 characters displayed on the data recorder.

The Southern Station RRE answer was to use subscripting. The concept of subscripting variables and recording 1 per record is the key to using the small display for expansive records.

Cruisers normally record their information in numerical form by using codes for items such as crown class, species, and log grade. Through constant use, these codes become second nature to the cruisers. At the present time the number of items recorded on a sample tree ranges from 8 to 34, depending upon the size and quality of the tree. To use data recorders, cruisers must additionally, 1) memorize the subscripts for the 34 items, and 2) record information in a systematic or checklist fashion to ensure notation of all required items.

Utilizing the checklist, which was developed after observing experienced crews operate in the field, the procedure change from tally sheets to data recorders was minimized.

Basically, the routine requires a cruiser, first, to account for all previously tallied trees, one at a time, recording an initial set (A) of information on each of them. Next, A must be entered for all new trees. Recorded data eventually arrives in a long character string with identifiers or signposts for state, county, plot, and sample point. Several trees are commonly recorded at each point so set A is identified by a signpost record denoting point and tree. (FF101 for point 1 tree 1). All subsequent data up to the next signpost belong to set A of point 1 tree 1.

When set A is completed for the first tree, a second signpost denotes the next tree (FF102). Once all trees have set A completed, signpost (FF101) is used again to denote the set B of tree 1 on point 1. Set B is then completed for all trees. The 34 subscripts provide unique reference to each item between signposts and are recorded as field entries. Each record, like the signpost, is a 5-digit number including a 2-digit code for the subscript and a 3-digit code for the variable. Each entry will automatically be followed by the delimeter " + ". A typical example of point-tree information after being recorded and transmitted will appear as:

FF101 + 50144 + 51010 + 53001 + 55011 +
FF102 + 50030 + 51001 + ...

In this case, FF101, which is point 1 tree 1, is followed by the field entry 50144 + (which includes the 2-digit subscript), 50 referring to the variable "azimuth" with a 3-digit value of 144, the " + " denotes the end of the short record and will be automatically inserted after each field entry item when transmitting the data. Subsequent entries of 51010, 53001, and 55011 are included in point 1 tree 1.

FF102 then follows. This signifies point 1 tree 2. It identifies the next tree within the point and is followed by its respective subscripted variables. Zeroing of subscripted variables with null fields is not required. Thus, record length may vary from 1 entry to more than 80 characters; and one may dispense with the magic "80 columns". Actually, the subscripting of variables between signposts could allow random order data entry, if cruisers could remember which items have been entered or not entered.

Although some drawbacks are evident, they are eclipsed by the advantages. Most losses in efficiency stem from the inability to deal with more

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than one tree at a time. Adjacent trees may be tallied simultaneously under the old scheme. Heights are measured by hysometer used at a known distance from the tree. Thus, adjacent trees can be "shot" from the same point. Eliminating this flexibility causes some consternation for the cruisers, but we expect several benefits to accrue. One benefit is removal of the tendency for cruisers recording two trees at one time to get the observations swapped.

An advantage is that the use of a checklist makes it easier to train new cruisers and tends to reduce omissions of required items. Cruisers benefit by having prompt feedback on their recording errors. In this way, errors may be corrected before they become habitual. Some cruisers claim that data entry is faster and easier with the data recorder than with the tally sheet.

On the computing side, the advantages are much more concrete and drawbacks are few. Visual editing of tally sheets and key punching are eliminated. So are the additional errors they introduce. Checking a plot's data as it is received can be automated, as can progress reports and a host of other reports. With tally sheets and card punching, one month could lapse between plot measurement and an editing report to the cruiser. With data recorders, it is possible to complete the editing in a few minutes. In practice this can be accomplished overnight.

The data recorders currently used have a 16,000-character memory capacity. This will ordinarily hold plot data measured over 3 to 4 days. Storing much larger data sets in recorders is technically feasible. In remote locations, up to 3 weeks of information could be stored before transmission. In general however, the risk of losing data sets through physical abuse of the recorder must be weighed against the price of a phone call. Recorders can be damaged by physical abuse such as dropping and by immersion in water. In addition, storing data for extensive periods defeats the advantages of quicker response to field errors. Southern Station personnel prefer to transmit information when the recorders are two-thirds to three-quarters full. This allows a buffer, so that, if transmission is impossible, the cruiser can enter more data and transmit later.

Efforts are aimed at minimizing risk of information loss. To date, transmission of information has suffered little difficulty. Two units did not work when received initially, but were promptly repaired. One failure has occurred, but no information was lost. The greatest risk will come from dropping, immersion, or other abuse of the recorders. This risk is minimized by having conscientious personnel and by regarding data recorders as an advantage — not a burden.

A small acoustic coupler, compatible with the Bell 202S modem, quickly and easily upgrades the data recorder to a portable data terminal. Data is transmitted over the public-switched network at a transmission speed of 1200 bps (bits per second). Transmission mode is asynchronous using a half duplex protocol.

Communications to date have been excellent with data transmitted daily to headquarters from any of seven States. Data integrity is insured by sending two sets of data, which are received on separate tape drives. A comparing feature of the HP2645 CRT terminal then insures that no characters have been altered during transmission by checking character against character, one drive against the other. Transmission errors are few and easily corrected.

After the coded data is received and the tape cartridges are edited on the CRT, it is logged according to field crew leaders and stored on hard disc cartridges. Data is then edited by the project's HP9830 computer system using unique codes in respect to plot, point, and tree variables. At this point, card images are generated to serve as input to the project's standard editing program which checks field data for logical errors. Cruiser errors are then detected and quickly sent back to the field crew leaders. This procedure not only helps to correct recent errors but also alerts cruisers to potentially recurrent errors in successive plots. An interactive program developed for use with the HP9830 system allows the CRT to update disc records easily at any stage of the data set, (including the original coded data file or the card image file). After edits are completed, the final version of the card image file is transmitted to the project's host processor, a UNIVAC 1108, which processes the balance of the computer workload.

Although operations run smoothly under the present arrangements, RRE intends to upgrade the present data acquisition system. The latest MSI models sell for one-third less than our models, possess the ability of partitioning memory into distinct sections or pages, and will soon be offered with LCD (liquid crystal display), which is much easier to see in the sunlight. Further communications capability will improve to the point where error-checking mechanisms are built into the communications protocol. This will allow data recorder transmissions to be automatically received and

verified without operator intervention.

Eventually portable work stations will be placed in the field for each field group leader; who will be responsible for collection of crew data, pre-editing, and final transmission of data to headquarters. This concept would contribute significantly to a more systematic and organized flow of data both from and to the field. Sophisticated hardware can be implemented at nominal cost and each field leader could keep cruisers abreast of any current data collection problems.

CONCLUSION

Data recorders offer several advantages over conventional tally sheets and punched cards. By subscripting variables and using signposts, logical record length may be varied at will. Data entry is easier, sources of human errors are minimized, and time between data capture and processing is cut drastically. Additional benefits that are probable but not yet substantiated include reduced cost, faster data entry, and easier training for new cruisers.

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