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FOREST RESOURCE INFORMATION SYSTEM

Quarterly Report

for the period

1 October 1977 to 31 December 1977

Prepared for

NATIONAL AERONAUTICS and SPACE ADMINISTRATION

Johnson Space Center
Earth Observations Division
Houston, Texas 77058

Contract: NAS9-15325
Technical Monitor: R.E. Joosten/SF5

Submitted by:

The Laboratory for Applications of Remote Sensing
Purdue University
West Lafayette, Indiana 47906

Principal Investigator: R.P. Mroczynski

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16. Abstract

This report documents activities which occured between 1 October and 31 December 1977. This period, Phase I, was primarily designed as a start-up phase to prepare for the project demonstration or Phase II. The tasks involved in this preparation are described in this report.

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FRIS PROJECT SUMMARY

The Forest Resource Information System Project (FRIS) is a cooperative effort between the National Aeronautics and Space Administration (NASA) and St. Regis Paper Co.(STR). Purdue University's Laboratory for Applications of Remote Sensing (LARS), under contract to NASA, will supply technical support to the project.

FRIS is an Application System Verification and Transfer (ASVT) Project funded by NASA. The project is interdisciplinary in nature involving experties from both the public and private sectors. FRIS also represents the first ASVT to involve a large broad base forest industry (STR) in a cooperative with the government and the academic communities.

Purpose

The goal of FRIS is to demonstrate the feasibility of using computer-aided analysis of Landsat Multispectral Scanner Data to broaden and improve the existing STR Forest data base. The successful demonstration of this technology during the first half of the project will lead to the establishment by STR of an independently controled operational forest resource information system in which Landsat data is expected to make a significant contribution. FRIS can be viewed by the user community as a model of NASA's involvement in practical application and effective use of space technology.

Additionally, FRIS will serve to demonstrate the capability of Landsat MSS data and machine-assisted analysis technology to private industry by:

- Determining economic potentials,
- Providing visibility and documentation, and
- The ability to provide timely information and thus serve management needs,

The ultimate long term successfullness of FRIS be measured through future development of remote sensing technology within the forest products industry.

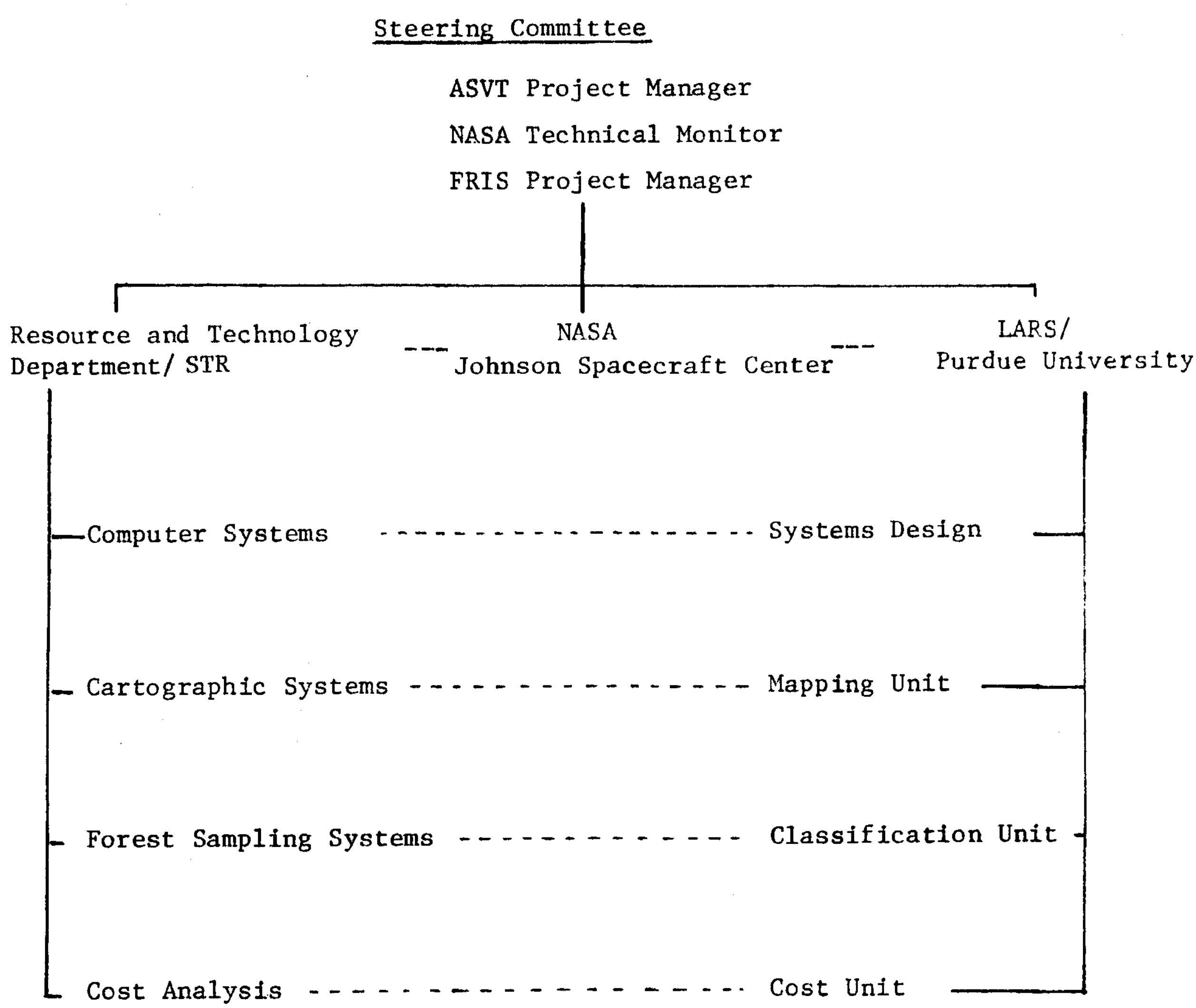
Scope

FRIS is funded as a modular or phasedproject with an anticipated duration of three years. The original project concepts were developed in 1973, and a formal project plan was submitted to NASA by STR in 1976. The project offically began in October 1977 after the signing of a cooperative agreement between NASA and STR; and after the completion of contractual arrangements with Purdue University.

Organization

The organization of FRIS is depicted in the chart that follows. Since FRIS is a cooperative involving three independent agencies, a steering committee consisting of a project manager from each institution was formed to provide for overall guidance and coordination. Operationally, both STR and LARS have project managers and project staff to insure for the timely completion of activities within the project. The NASA technical coordinator monitors project activities and provides a liasion between the STR and LARS staffs. The solid lines on the chart indicate the flow of management responsibility. The dash lines reflect the technical and scientific interchanges between operating units.

FRIS Organization



FRIS Quarterly Report

for the Period

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1.0 Introduction

The material in this report summarizes the activities of the Forest Resource Information System (FRIS) ASVT during the period from 1 October 1977 to 31 December 1977. The first three months of the project were identified as the project startup, or Phase I.

As the name implies, Phase I delt with constructing the foundation upon which subsequent Phases would be built. The objective entering Phase I was:

> To identify, define, develop, procure and/or otherwise prepare people and materials for the Phase II demonstration.

The material which follows describes the activities during the project start-up phase. Results that have accrued from these activities will be detailed where appropriate. However, because of the nature of the Phase I activities, the results are often subjective in nature, reflected more in people's attitudes and feelings than by numerous pages of documentation and profuse graphics.

2.0 Phase I Activities

The principal activities pursued by the staff during

Phase I fall into five major areas. These are:

1. Landsat Data Acquisition and Preparation
2. Preparation of Data Base Source Materials
3. Definitions of Benchmark Evaluation Techniques
4. Collection and Cataloging Reference Data
5. Training Material Development and Scheduling

2.1 Landsat Data Acquisition

The identification and ordering of Landsat data for the FRIS test sites was a top priority task for Phase I. Figure 1 is a schematic indicating the flow of activities associated with acquiring the Landsat data. The goal of identifying, acquiring, and preparing those data prior to beginning Phase II was nearly completed by 30 December 1977.

The FRIS test sites (fig. 2) were identified during the initial Phase of the project (1). These sites represent typical St. Regis land holdings in the southeast. Four sites, located in different physiographic sub-provences in the southeast were selected as replicates in order to test the suitability of classification procedures and results over a large geographic area.

A general description of the test sites follow:

Upper coastal plain/piedmont: This area is characteristized as rugged and highly disected. This physiographic province represents the closet thing to mountainous

Sequence of Acquiring Landsat data for Demonstration

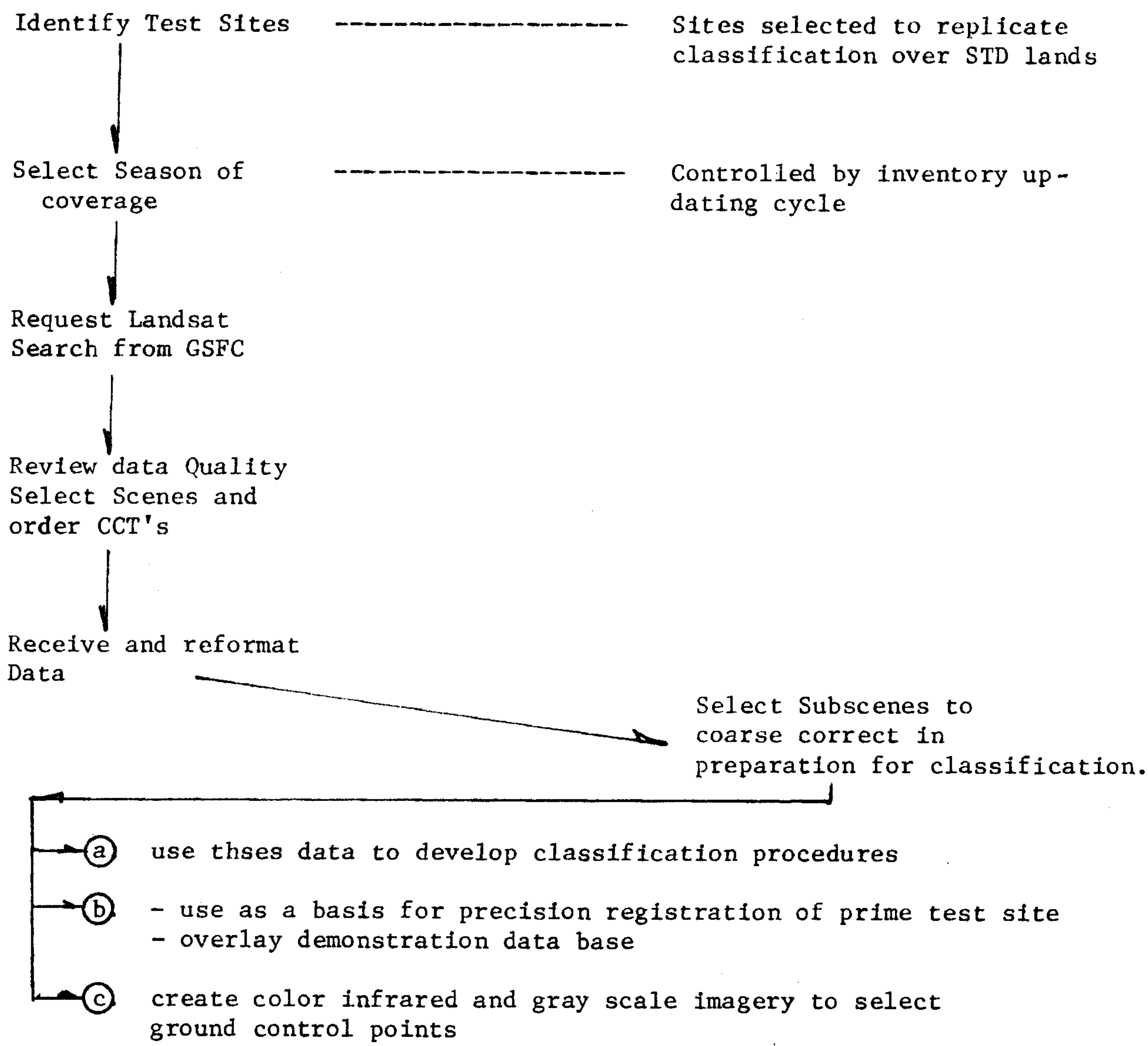

Figure 1. A schematic representation of the selection process and uses of Landsat data for FRIS.

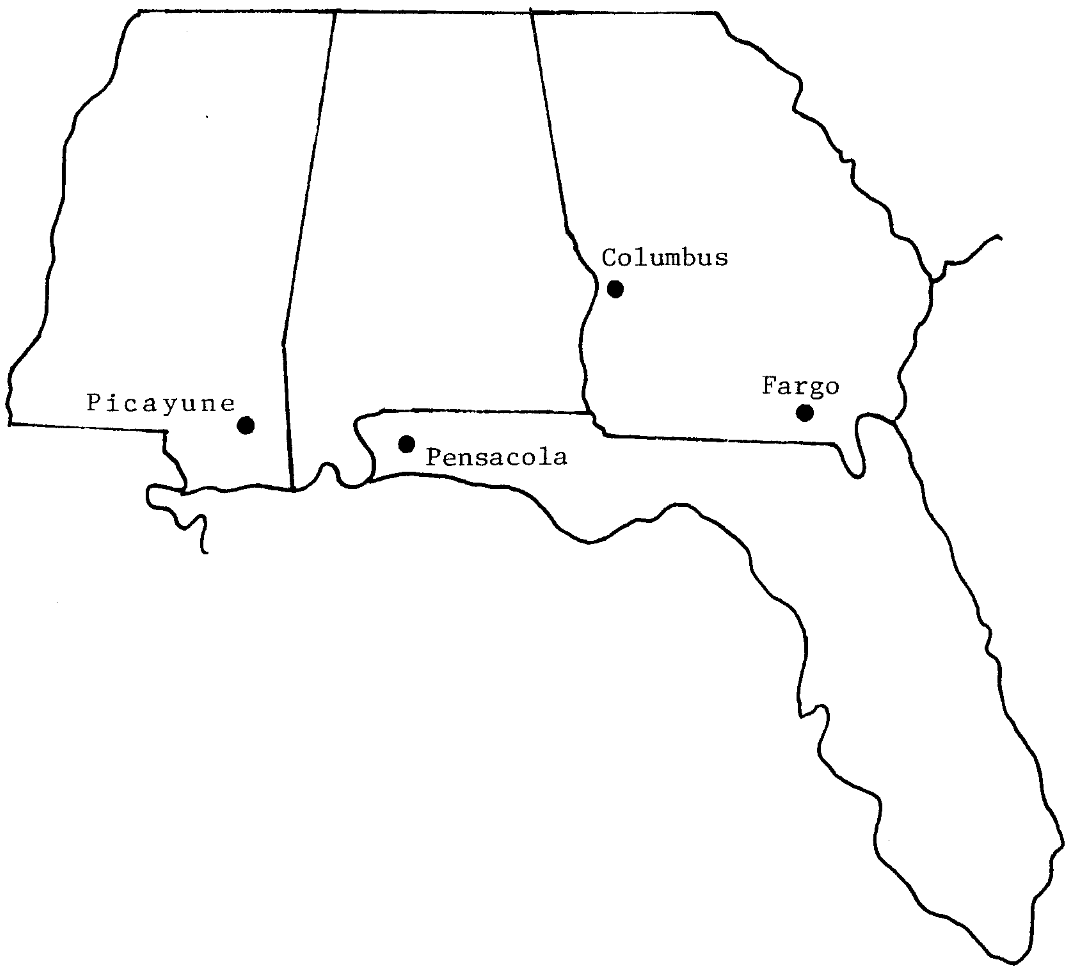

Figure 2. Approximate location of FRIS Test Sites.

terrain found in the southeast. Ranges in relief are wide and forest productivity vary, providing possibly the most difficult challange for the FRIS classification schemes. The test area of approximately 60,000 acres is located in West Central Georgia near the city of Columbus.

Middle coastal plain: This area is composed of gently rolling terrain. The Middle coastal plain falls in a broad area between the Upper coastal plain/piedmont and the Lower coastal plain. A finger of this physiography, a limestone ridge, extends well into central Florida. The test area for the Middle coastal plain lies in southeastern Mississippi, near Slidell, Louisiana, and encompasses approximately 70,000 acres.

Lower coastal plain: This area is of slight relief. The Lower coastal plain appears to be the most uniform area in the region. However, internal soil/moisture relationships are largely influenced by the subterrain hardpan, creating large variations in forest productivity. Because of the generally flat nature of the province, and the wide universallity of conifers, the Lower coastal plain may represent the area of high success in the project. The test area in this province, located close to the community of Fargo in southeastern Georgia consist of 215,000 acres.

Alluvial River Bottom: These areas are called sub-provinces since they occur throughout all the other provinces. In general alluvial bottoms represent the major drainage system of the area. The primary commercial hardwoods occur in the bottom lands, as well as the largest areas of mixed deciduous-coniferous associations. The test area for the alluvial sub-province is located in the Florida panhandle near Pensacola and constitutes some 80,000 acres of the Escambia and Yellow River drainage systems.

In mid October a search was requested through the Goddard Space Flight Center for Landsat data covering these sites. Data was requested for two time windows covering the periods of late fall/early winter, and spring. Table 1 lists the Landsat data, and dates of coverage for the test sites. Dual data dates were ordered to determine if there would be any significant difference between classification results due to seasonality. Previous experience, working with nature resource classifications indicates that spring data appears to yield better classification accuracy. However, to comply with the beginning-of-year inventory up-dating cycle of St. Regis, FRIS inputs are required from either fall or early winter Landsat data. A test will be conducted to determine if seasonal differences in classifications accuracy occurs and if so cause enough problems to warrant a major change in the project plan.

An order was placed with the Goddard Space Flight Center in late October for the data listed in Table 1. Landsat CCT's were first received at LARS by mid-November. These data were subsequently reformatted and subscenes containing the test areas were selected for coarse geometric correction.

These data are now available for analysis and further preprocessing, as will be the case with the Fargo data set. Fargo, which represents the prime data site, will be overlayed with Operating Area and Administrative Unit boundaries.

Table 1. A list of Landsat data according to date and FRIS test site.

Test Site	Date	Scene Id
Pensacola Fl	22 Oct 76	2639-15283
Picayune MI	17 Dec 76	2695-15381
	28 May 77	2857-15305
Columbus GA	21 Oct 76	2638-15225
	7 May 77	2836-15141
Fargo GA	30 Dec 76	2708-15090
	17 Apr 77	2816-15042

Once this data base has been created the Fargo site will become the principal FRIS demonstration site.

2.2 FRIS Data Base

The Southern Timberland Division of St. Regis Paper Co. already has inplace a Management Information System (MIS). This system allows STR personnel to track through time the status of their 1.7 million acres of commercial forest land. In order to be successful, FRIS must integrate Landsat classification results with this management information operating system. A prerequisite to accomplishing this task is to insure that the Landsat data is compatible with the MIS. This interface will most likely occur through a common data base. A unique part of this experiment will be the marriage of the two digitially oriented data bases, the Landsat digital classification file and, the inplace STD operating system. With this requirement FRIS surpasses most Landsat classifications studies in which only maps and tabular statistics of cover classes are the required output.

At the onset of Phase I, STR and LARS Staff were to determine the form of the FRIS data base. Preliminary discussion were centered on raising the Project Staff's awareness regarding the various data formats and requirements expected from FRIS.

From these discussions we were able to determine:

- Necessary input in order to accomplish the demonstration in Phase II. (See Table 2).
- Inputs necessary to develop an optimized (to STR needs) cartographic data base capable of updating management maps as well as interfacing with the MIS. (See Table 2).
- Current limitations in creating digital data bases, especially ones expected to intergrate polygon and grid format data inputs.
- A plan to investigate data base generation systems which are available commercially.

For the purpose of the Phase II demonstration, LARS staff will create a data base consisting of; Administrative Unit (AU) and Operating Area (OA) Boundaries (2). An AU is defined as the base unit on the ground for which STR maintains records. An AU can be of any size, however, it is desirable that they be at least 1,000 acres minimally. They should be easily recognizable on the ground which means that they must be bounded by relatively stable cultural features such as roads, power lines, or rivers. Each AU is then sub-divided into basic management units which are called operating areas. Each OA must meet three criteria to

Table 2. This list represents the various data elements necessary to provide FRIS with an optimum cartographic data base capability. The starred items represent the minimum data base information required which is necessary to complete the Demonstration.

---

* Administrative Unit Boundaries

  - Composite AU's equal ownership boundaries
  - Uniquely coded to sort by state or county designation

* Operating Area Boundaries

  Rights-of-way

  - Railroad
  - Powerline
  - Other ownership

  Highways

  - coded by different haulage classes

qualify as a stand alone measurement unit:

- It must be able to be operated (cut, site prepare, or regenerated) in a years time.
- It must have relatively the same productive capacity.
- It must be able to be operated in the same manner throughout.

Once an AU is subdivided into OA's, the OA then becomes the basic management unit and is handled individually throughout the whole planning system. It is for this reason that the decision was made to digitize the OA boundaries. The AU boundaries will also be digitized. The combination of the AU's by county or other jurisdictional boundary will enable us to recreate STR ownerships on a county or other similar political bases. Figure 3, is a representitive example of the type of material, both AU and OA boundaries, which will be digitized.

2.3 Benchmark Definitions

The ultimate assessment of the success of this project will depend upon St. Regis' implementation of FRIS. Before that decision can be made various component parts of the system must be evaluated as the project matures.

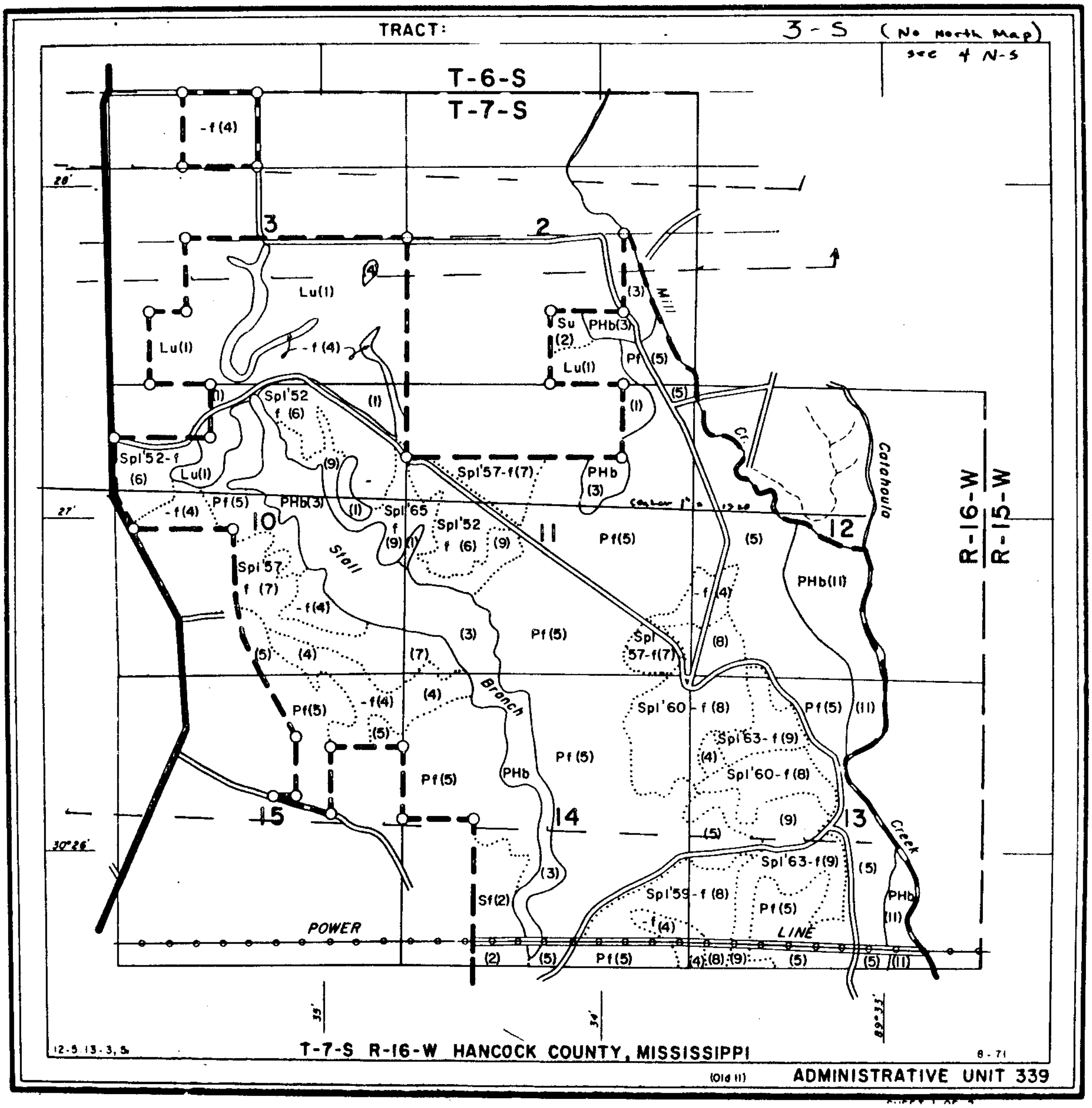

Figure 3. Administrative Unit boundary (heavy dashed line) map for AU 339. The operating Areas are represented by light or dotted lines within the AU boundary.

The evaluation points are defined as benchmarks and will be structured to assist management evaluate remote sensing technology. As the name implies, the benchmarks, will serve as points of reference for comparing existing techniques to this newly applied technology. Obviously, as in the case of Landsat classification, there is no comparable existing technique to compare. In this situation, an attempt will be made to show through cost and classification accuracy studies the relative efficiency of the Landsat Sampling approach compared to current inventory procedures.

Benchmarks for classification accuracy assessment will be determined by statistical criteria. Procedures will be outlined in a document which will identify the approach applied within FRIS to evaluating the classification results. We anticipate a project-wide review of this document together with other evaluation documentations to insure acceptance and understanding of this approach.

In addition to evaluation of classification accuracy, we feel an important departure point for management acceptance of this project will be an evaluation of project costs. Various factors, such as accounting for direct and indirect costs, are involved in computing costs of the application and transfer of this technology. Since costs will be contingent on STR's information requirements, which are presently being defined, no attempt is made to discuss the cost aspects of the project in this report.

2.4 Reference Materials

In the context of this project, reference material include all background information necessary for analysis. Commonly, such items as aerial photos, USGS topographic maps, cover types maps, and any descriptive material related to the test area are considered relevant background material for analysis. Table 3 and associated figures represent the extent of background information available for the FRIS test sites. With this depth of information an analyst will be prepared to make reasonable inferences regarding the composition of the spectral/information class groups which occur in the Landsat data. This is a first and critical step in proceeding to a test site classification. The amount and quality of reference material certainly help improve the probably of developing a good classification. Figure 9 indicates the relationship the analyst will make between the Landsat data and the reference data. Knowledge of the physical characteristics of the scene on the ground is an important analyst input to the classification as indicated in the figure. This input will be provided by STR staff working with LARS Staff during the classification process.

The activity concluded during Phase I dealt primarily with preparation of reference material for the Phase II

Table 3. The reference materials, with example illustrations, available for use during the FRIS Landsat classifications are listed below.

- Administrative Unit and Operating Area Boundary maps (figure 4).
- U.S.G.S. 7½ minute, 15 minute and 1:250,000 scale topographic maps (figure 5).
- County highway maps (figure 6).
- Color infrared, 1:15,840 scale, aerial photographs (figure 7).
- Computer output files, in the form of stand and stock tables and AU Summaries which relate to OA's and AU's within the test sites (figure 8).

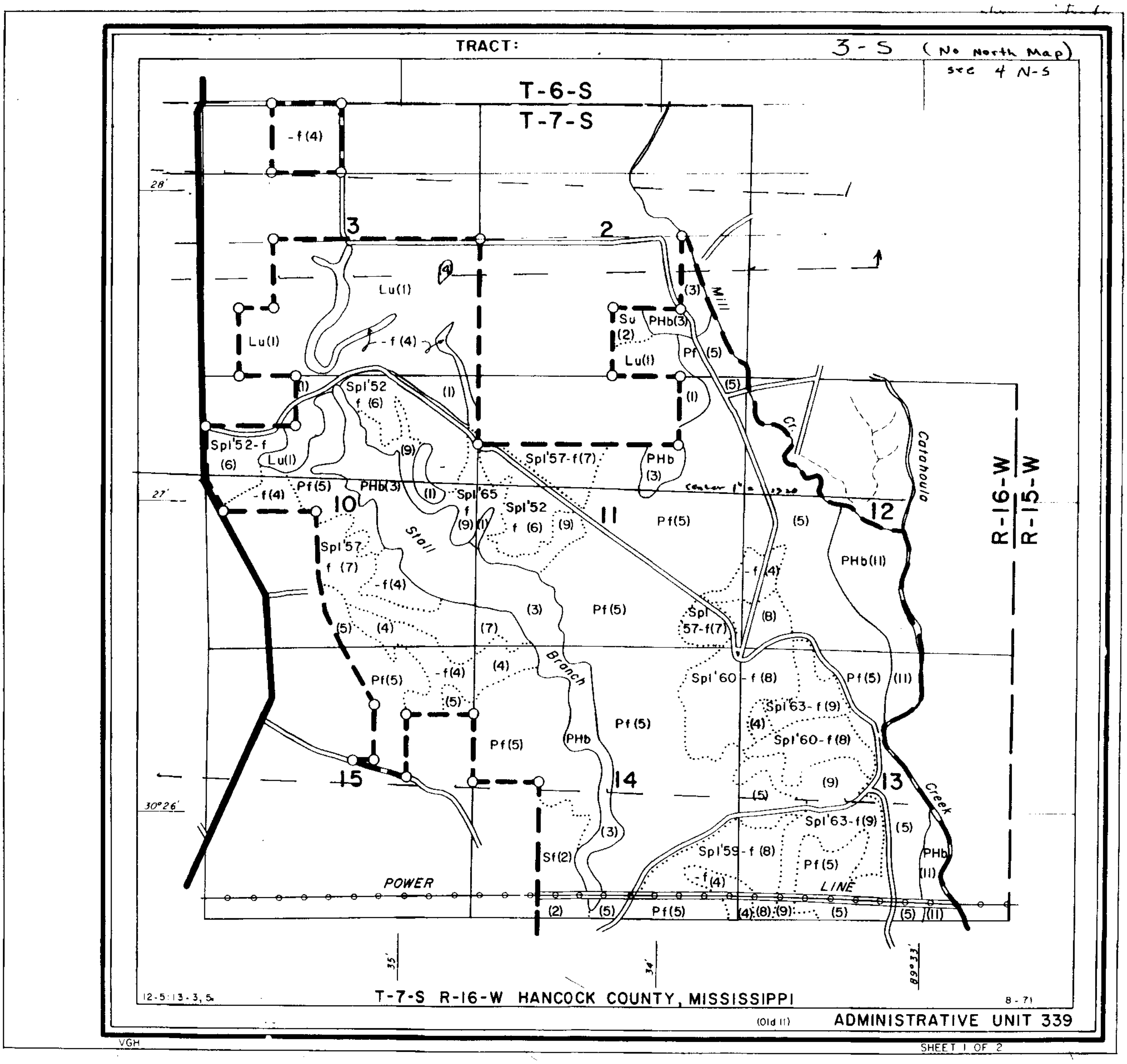

Figure 4. An example of an Administrative Unit and Operating Area boundary map.

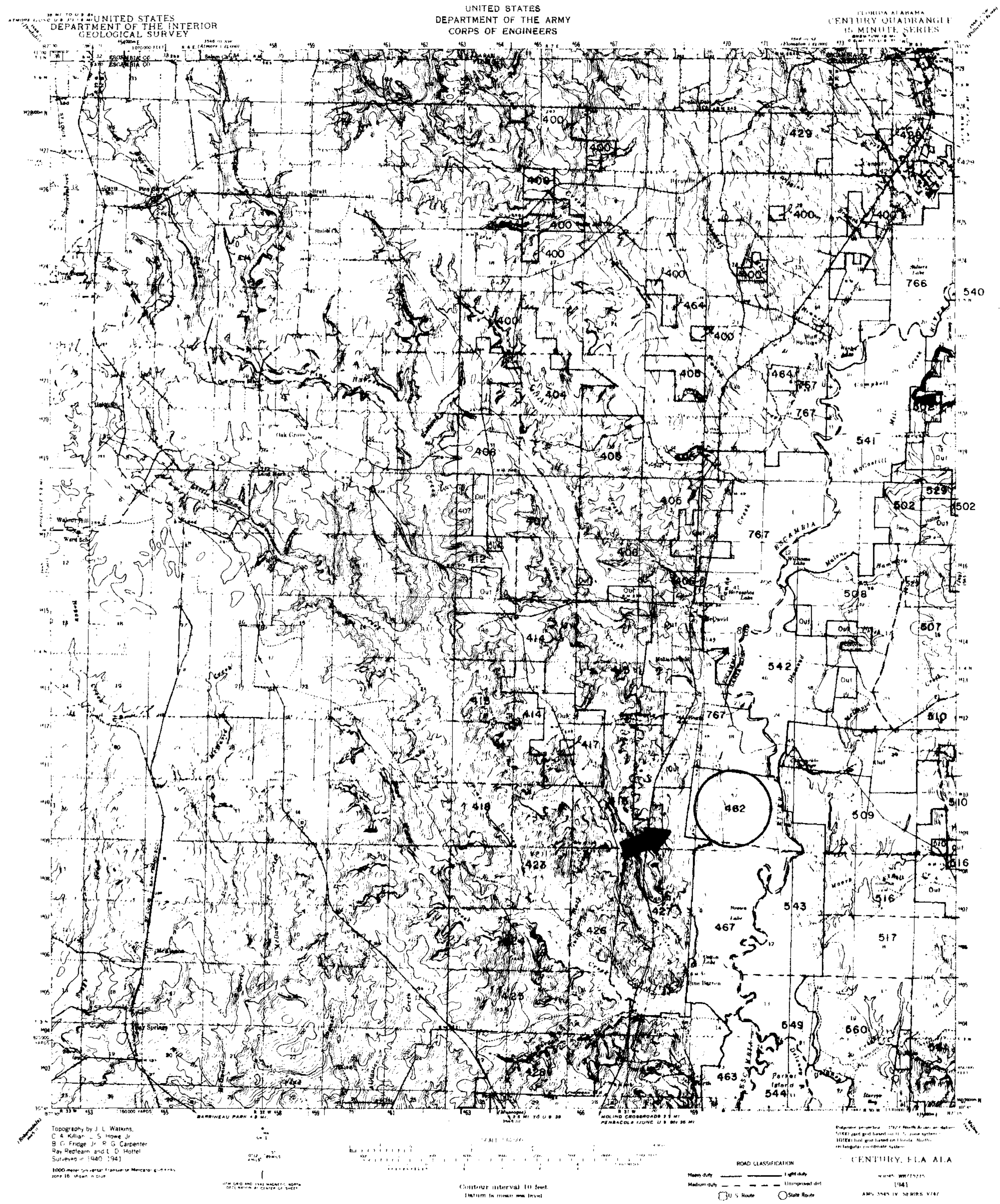

Figure 5. USGS topographic map provide important analysis inputs related to the character of the Earth's surface.

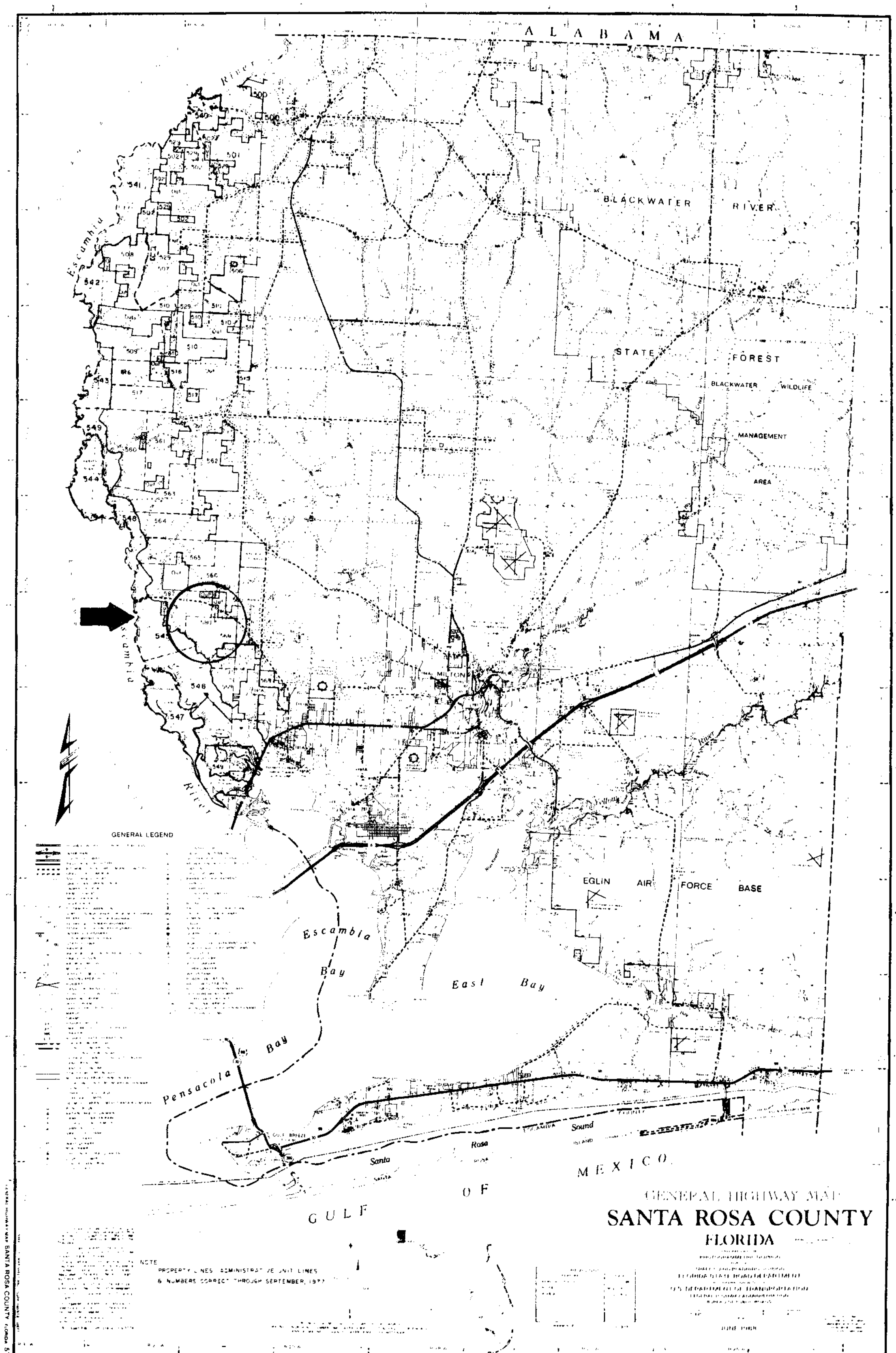

Figure 6. County highway map showing STD controlled lands.

Figure 7. A black-and-white copy of a 1:15840 color infrared resource photograph of the Fargo test site.

OPERATING AREA SUMMARY

FOREST/DISTRICT- MISSISSIPPI
FOREST TYPE- BOTTOMLAND SLASH PINE-HDWD
SIZE CLASS- SMALL PULPWOOD

OWNERSHIP- CASE STUDY
TOPOGRAPHY- COASTAL PLAIN - BRANCH

CORD VOLUMES

SIZE CLASS	PINE CORDS	PINE CD/AC	HARDWOOD CORDS	HARDWOOD CD/AC	CORD
6	157.7	0.452	403.3	1.155	
8-10	293.5	0.841	1178.2	3.376	
SUB-TOTAL	451.2	1.293	1581.4	4.531	
12	77.2	0.221	170.1	0.487	
14-18	376.1	1.078	124.1	0.356	
20-24	0.0	0.0	0.0	0.0	
26+	0.0	0.0	0.0	0.0	
SUB-TOTAL	453.2	1.299	294.2	0.843	
TOTAL	904.5	2.592	1875.6	5.374	

BOARD FOOT VOLUMES

SIZE CLASS	PINE MBF	PINE BF/AC	HARDWOOD MBF	HARDWOOD BF/AC	CYPRESS MBF	CYPRESS BF/
12	11.63	33.33	19.19	54.99	0.0	0.
14-18	117.37	336.30	40.16	115.07	0.0	0.
20-24	0.0	0.0	0.0	0.0	0.0	0
26+	0.0	0.0	0.0	0.0	0.0	0
TOTAL	129.00	369.63	59.35	170.06	0.0	0

STAND TABLE

SIZE CLASS	PINE ST/AC	HDWD ST/AC	CYP ST/AC	TOTAL ST/AC	BASAL AR/AC
REPRO	0.0	23.214	0.0	23.214	0
2	10.714	112.500	0.0	123.214	
4	10.714	105.357	0.0	116.071	
SUB-TOT	21.429	241.071	0.0	262.500	
6	10.913	25.465	0.0	36.378	
8-10	9.863	37.365	0.0	47.228	
SUB-TOT	20.776	62.829	0.0	83.606	
12	0.909	2.728	0.0	3.638	
14-18	2.438	1.258	0.0	3.696	
20-24	0.0	0.0	0.0	0.0	
26+	0.0	0.0	0.0	0.0	
SUB-TOT	3.347	3.986	0.0	7.334	
TOTAL	45.552	307.887	0.0	353.439	

Figure 8. Example of stand and stock table reference output for a FRIS Operating Area. This type of data provide information about the character and composition of sites within the test areas.

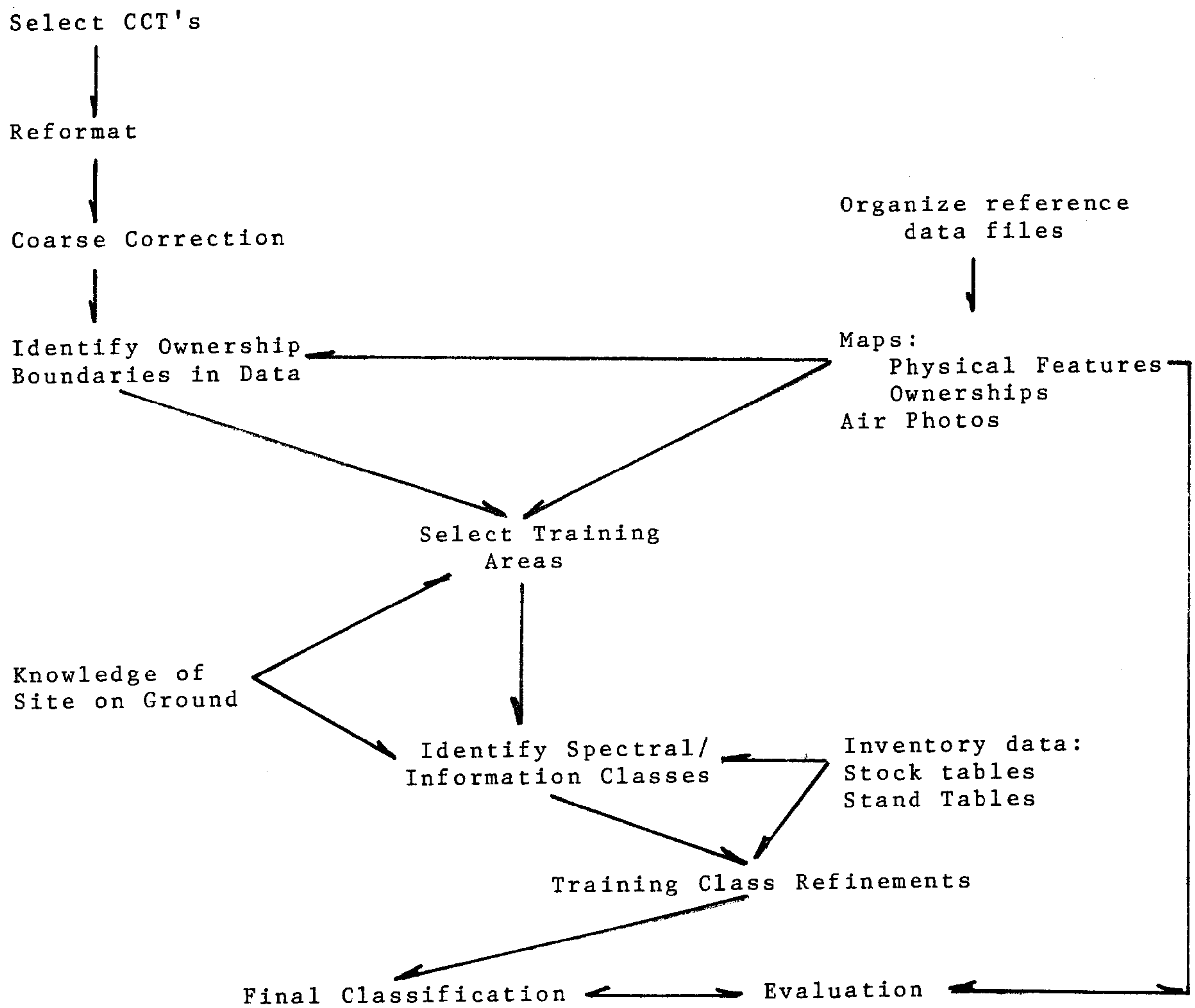

Figure 9. Schematic representation of the interactions of test sites reference data with Landsat data.

demonstration. Although seemingly an insignificant task, the careful cataloging of reference material prior to classification is anticipated to prevent future delays.

2.5 Training

The training emphasis during Phase I was placed on defining the scheduling training activities for Phase II. An important aspect of this ASVT is the transfer of the remote sensing technology to STR Staff. This transfer must occur so that by the end of the project STR staff will have attained the capabilities to independently manipulate FRIS.

Technology Transfer in FRIS will occur at various levels of intensity. The technology may be transfered through:

- Formal (lecture/workshop) presentations
- Hands-on training sessions
- Formal reports and Project Reviews
- Personal interactions
- Symposia and Seminars

Table 4 lists the sequence of training activity anticipated during Phase II. Obviously the material listed does not include telephone conferences, meetings or symposia which are not scheduled activities. The sequence begins with more formal training and proceeds through those activities which could be classed as more informal (eg: hands-on training). The sequence is planned to repeat prior to the beginning of Phase III.

Table 4. Anticipated FRIS Technology Transfer activities during the Phase II Demonstration.

- 2½ day lecture/workshop on the fundamentals of remote sensing and machine-assisted analysis (LARSYS).
- Hands-on classification training at LARS (2-two week periods).
- Project review of Benchmarks and classification procedures (1½ to 2 days).
- Advanced lectures/workshops on FRIS procedures (2½ to 3 days).
- Hands-on experenies
- Project reviews for evaluation of results and recommendations.

3.0 Conclusions

Although Phase I was designed as a Project Start-up Phase certain tangible results occured.

- Landsat data was ordered, received by LARS and preprocessed.
- STR and LARS project staffs became acquainted and preliminary discussion ensued.
- Prime site source maps and reference data was received
- Benchmark criteria were discussed and are being prepared for evaluation.

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