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2. NASA/BLM APPLICATIONS PILOT TEST (APT)

PHASE II FINAL REPORT

VOLUME III

TECHNOLOGY TRANSFER)

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ESL INCORPORATED
Sunnyvale, California

NASA/BLM APPLICATIONS PILOT TEST (APT)

PHASE II FINAL REPORT

VOLUME III

TECHNOLOGY TRANSFER

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NASA/BLM APT: PHASE II

FINAL REPORT

VOLUME III: TECHNOLOGY TRANSFER

1. INTRODUCTION.

1.1 Overview of Objectives.

The primary objective in Phase II was the demonstration of the integration of remote sensing technology with existing techniques for producing a vegetation type map and vegetation productivity estimates. A parallel objective was the transfer of this technology to BLM personnel to promote the implementation and utilization of the procedures and techniques within the BLM operations framework. The technology being demonstrated emphasized the integration of quantitatively-based remote sensing data while maintaining consideration of cost-efficiency in the implementation of the overall design. The technology transfer expanded on this emphasis with particular attention on further developing the understanding, on the part of BLM, of approaches to inventories that integrate multiple data sources given various resource information objectives. Specifically, any considerations based on the candidate approaches were focused on sampling strategies and analyses of the costs of data collection as specified by those strategies.

Information requirements and the timing and precision required for that information were the major elements to be considered in developing sampling strategies. The cost analyses examined fixed budget vs. precision desired and also fixed budget vs. allocation of effort for single or multiple parameter inventories. Combining sampling strategies with cost information, the following factors needed to be optimized to achieve cost efficiency of inventory design: plot size, number of plots,

1.1 -- Continued.

cluster size, number of levels of data and sample selection methods. The technology transfer activities during Phase II were focused on developing an understanding of these concepts within BLM as well as keeping project participants informed on the progress of the technology demonstration of these concepts (see Volume II of this final report).

1.2 Overview of Approach.

The technology transfer portion of Phase II was divided into three parts consisting of a planning session, workshops (two) and project status reviews (four). The planning session was held at the outset of the project to familiarize project participants with the full scope of the work to be performed and to establish a milestone schedule (Section 2.0). The two workshops were held to provide "hands-on" instruction for project participants in specific Phase II technology areas and utilized actual project data (Section 3.0). The four project status reviews were held periodically through the life of the project to maintain continuity in reporting on interim results, to resolve any problems that occurred and to update the project schedule as necessary (Section 4.0).

The remainder of this document contains materials presented at the various sessions described above and memos describing significant results from each. (A complete training syllabus covering project planning, data collection and data analysis as it relates to the technology demonstrated during this APT is scheduled to be produced under Phase III of this program and should be available in mid-1981.)

2. PLANNING SESSION.

The objective of this session was to familiarize all project participants with the expecced flow of tasks over the life of the Phase II effort. The project flow chart in Appendix I, Vol. I of the final report was presented at this time. Also, the two training courses were discussed and finalized as to scope, content and dates. A preliminary set of milestone dates was established to be used in monitoring progress on the numerous aspects of the Phase II effort.

Lyndon B. Johnson Space Center

SF5/78-253	DATE October 10, 1978	INITIATOR SF5/K.Hancock:cmg:10/10/78:2214	2

TO: Distribution

CC:

FROM: SF5/Kenneth J. Hancock

SIGNATURE Kenneth J. Hancock
Kenneth J. Hancock

SUBJ: Minutes of the Phase II Planning Session, October 3-4, 1978, at ESL

The meeting was chaired by Brian Fine, ESL Project Manager. See enclosed attendance roster. He introduced the ESL team members and made a brief statement about the ESL effort followed by BLM/Arizona, BLM/DSC, and NASA/JSC. Bill Bonner mentioned a general note of interest in that at the BLM State Associate Directors meeting last month, a decision was made to make a recommendation to the BLM W.O. that Landsat be used for stratification to satisfy the BLM SVEM manual requirements. Further BLM/DSC was asked to provide a plan for a 10-million acre planning unit for an operational phase by the end of FY80.

Anticipated Ground Data/Large Scale Photo Requirements

Brian gave the anticipated LSP/ground requirements: 135 range ground plots; 45 forest/woodland plots; and a maximum of 200 flight lines (each with 10-18 photo plots) based on 10-15 strata levels at Levels II/III. This contrasts with an estimated 800-1000 ground plots without LSP in the range strata to get 20/3% as per the ESL original proposal transmittal letter.

UCB Planning Model

Randy Thomas discussed the Planning Model at UCB which determines number of samples, sample size and samples per stratum. The Planning Model has software documentation (FORTRAN); however, the user documentation is incomplete but usable by an experienced operator. These will be provided under the contract.

Technology Transfer

The discussion centered on the two training courses, field and data analysis, and the high cost of users How-To Manuals. As for the training, Bill Bonner said consideration should be given to three points:

1. Can Arizona support the training?
2. Is it worth the cost and commitment?
3. Is i[illegible]quate?

Ken Moore made the decision that the training should occur as planned with instructor notes and handouts as the only documentation. Attendees will be: 4 from Arizona; 2 from Denver Service Center and 1 from JSC with 2 ESL instructors. Documentation will be considered for Phase III with a decision to be reached for either instructor manuals or user How-To Manuals. The field training course will be held at St. George, Utah from June 11-15, 1979. The Data Analysis course will be conducted at the ESL facility from November 12-16, 1979, recognizing that November 12 is a holiday.

Output Products

Gary Gnauck opened with a discussion on the possibility of ESL providing the output products as color off-set prints at an additional expense of approximately $2-3K for each product (3 required). This is an option and not a scheduled product.

Ji ls brought up the point about the scale accuracy that was requested, i.e., not a distance between points but 2% positional error from the map position, 413 feet. This statement was provided to BLM by USGS. ESL has the actio ck on their capability to provide this accuracy.

The q n of imbedding the admin boundaries in the negative was brought up by Mike as it was inadvertently left out of the rewritten output Products Section pro y BLM and used to price out the contract by ESL. BLM will accept a separate / oundaries overlay with grid tics for registration the same as on the negative ' will provide JSC with a description and are prepared to transfer funds to NAS ne cost, estimated by ESL to be about $1500 total cost including G&A, overhead

Ken Moor ested estimates in acres and pounds as well as hectares and kilograms. Ga ich said ESL would provide this at no additional cost although the RFP cal ed ctares and kilograms only.

Changes to W

Sect 2

Scen) l for classification will be the August 26, 1977, Landsat, the same c e: cessed for BLM by EROS Data Center. Add this scene to the lis

Sect 3.

Add Ir or Admin boundaries overlay for 1:250,000 product only. Statement by BLM. This will be added as a change later.

Sectic 3. nge to read:

Tw il tapes for the entire Arizona Test Site shall be provided in a for pa the equipment to be delivered to BLM.

inal spectral classification
acre smoothed data used to generate the output product
ier 3.1.1.1 (1)

Section 3.1.3 Change sentence to read:

"Statistical confidence statements will be made for these estimates using regression techniques."

Axies definitions are X: The proportion of LSP plots in each flight line in each strata as determined from pixel by pixel Landsat grouped classification. Y : The proportion of LSP plots in each flight line in each strata as determined from photo interpretation/ground data collection. (Definitions provided by Mike Garratt).

Section 3.2.1.1 (1) Change to read:

Total ground vegetation cover (in % cover)

Section 3.2.1.1 (3) and (4)

Asterick and add: Point in time, not corrected for seasonal or annual variations.

Section 3.2.2 (4) Define mortality:

Mortality is defined as the number of fallen and standing dead trees. Mortality does not require confidence levels.

Phase II Flow Chart

The flow chart events and dates were discussed in detail. Brian will have the chart drafted and sent to BLM and JSC. He will also pick off the critical events and these will be used as milestones for the bimonthly reports. One critical issue to be resolved is the specs for the LSP to be contracted for by BLM. The Planning Model was to provide the specs in March 1979; however, BLM needs them for their RFP by November 1978 to assure a contract to fly the LSP during the summer of 1979. BLM will send ESL a set of the specs used for the 1976 LSP and they will be reviewed to see if they will suffice except for scale as the present thinking is that a larger scale (1:750) will be required. An interim scale could be included in the RFP with the final scale to be negotiated.

Another critical item was the Phase II Peer Review as to when it should be held and what is the purpose. Ken Hancock explained that plans were to hold a review along the lines of the NFAP Ten-Ecosystem Workshop held at JSC in September 1978. The purpose is to brief outside technical personnel on the ASVT procedures and techniques and get their reactions and inputs. This would both advise others in the field of how the ASVT is being accomplished and get their inputs and recommendations. The recommended date for the review is December 1978.

Phase Reviews and Training

Dates were established for the reviews and training to be held at the same time to reduce travel expenses. Reviews were scheduled as follows:

Review I - January 8, 1979, at ESL after the classification is completed and prior to running the Planning Model.

Review II - June 11, 1979, at St. George during the field training (June 11-15) after the LSP has been flown and while the first ground plots are being selected.

Review III - September 17, 1979, at St. George.

Review IV - November 12, 1979, at ESL during the data analysis training (November 12-16) and data screening of the LSP and ground data.

A Final Review was scheduled for February 1980 to be held at Denver and hosted by DSC with a majority of the review presented by the user, Arizona, and DSC.

Overall the Planning Session was very successful and ESL is to be commended for the excellent effort that was put forth to assure its success.

Distribution:
BLM/DSC M. Garratt
BLM/Arizona K. Moore
ESL/B. Fine
HB/G. Nixon

The following paragraphs are included in copies of the minutes to ESL and BLM/DSC only.

Management and Support

The Phase II contract was discussed in that it in reality it is a "fixed price" contract as there are no more funds available. ESL pointed out that they would closely monitor the expenditures and there was no allowance for changes as this would increase fund requirements. JSC and BLM acknowledged and agreed that any changes affecting cost would be offset by eliminating some other task.

The possibilities of another subcontractor for field data collection and issuing a subcontract for LSP photointerpretation was discussed. The present subcontractor for field data collection is Range Resources, Inc. The new subcontract being considered is Resource Inventory Services, a company formed by Jim Nichols when he became a consultant to ESL. JSC and BLM pointed out that the selection of a subcontractor was an ESL decision; however, consideration should be given to the fact RRI has experience and a favorable past performance whereas RIS is an unknown factor although we were all aware of Jim Nichols capabilities. ESL acknowledged this and will be choosing a subcontractor for field data collection in the near future. ESL is weighing the advantage of doing the LSP photointerpretation in-house and further developing their own capability vs. going contract with RIS.

Bill asked what were the tasks that Jim Nichols, as a consultant, and UCB would be involved with. Jim will be concerned with technical review of the classification, allocation of samples, estimation procedures, technology transfer, the four reviews and the peer review. UCB will be involved in planning model runs, training on ground data collection techniques, estimations Q.C. task, and the reviews tied to the two training courses.

Bimonthly Reports

The bimonthly report format was agreed to as the one presented by Ken Hancock (example enclosed). The milestones to be included in the report will be picked from the flow chart by Brian. In the written portion of the report each task will have comments even if its says "no work on this task during the reporting period". The first reporting period ends January 1, 1979, with subsequent reports every other month through January 1, 1980. Reports are due by the fifteenth of the month.

Final Report

ESL expressed the desire to begin the structure of the report as soon as possible. BLM and JSC were asked to give comments on the Phase I Final Report as to its suitability for the Phase II report and recommend changes and the level of detail desired.

Phase I Output Products

The letter from JSC procurement on revised output products was discussed. ESL has completed the three products JSC considered as not meeting requirements of the Statement of Work, i.e., the July 10, 1975, color negative 1:250,000; the UTM grid for the August 1, 1976, black and white negatives; and the Area A August 1, 1976, black and white negatives. Ken Hancock advised ESL not to take action on costing out the other items as Bill Bonner had said the Alaska people did not agree with this satisfying their requirements. Alaska is sending Denver a letter on their assessment of what products they require. Bill and Ralph Marker will travel to JSC to discuss and resolve the differences. As a result of these discussions another letter will be sent to ESL by JSC procurement. With a bit of luck, this may put the Phase I output products to bed.

ATTENDANCE LIST

PHASE II PLANNING SESSION - 3 & 4 OCTOBER 1978

Name	Phone	Organization
Stephen DeGloria	415/642-2351	University of California
William J. Bonner	303/234-5673	BLM - Denver Service Center
Jim Nichols	408/279-4124	Resource Inventory Service (ESL consultant)
Randy Thomas	415/642-2351	University of California
Dwayne Sykes	801/628-1691	BLM - Arizona Strip District
Mike Garratt	303/234-5673	BLM - Denver Service Center
Ken Hancock	713/483-2204	NASA - Johnson Space Center
George A. Nixon	713/483-3751	NASA - Johnson Space Center
Gary E. Gnauck	408/734-2244	ESL Incorporated
John Littlewood	408/734-2244	ESL Incorporated
Brian T. Fine	408/734-2244	ESL Incorporated
Joel B. Dye	408/734-2244	ESL Incorporated
Sandra Hawley	408/734-2244	ESL Incorporated
Ken Moore	801/628-1691	BLM - Arizona Strip District
Randy Thomas		University of California/Berkeley

ARIZONA MILESTONES

Task	Start	Finish
RADIOMETRIC CORRECTIONS	Oct 16	Oct 18
GFE: August '77 Landsat Scene Tapes	Oct 16	
GEOMETRIC CORRECTIONS	Oct 19	Nov 16
CONTROL POINT SELECTION & GEOMETRIC MODEL PREP	Oct 23	Nov 8
GFE: Topo & Highway Maps (Admin. Boundaries)	Oct 23	
DIGITIZING	Oct 30	Nov 16
GFE: LSP '78 Transect Maps	Nov 9	
INITIAL (ISA) CLASSIFICATION	Nov 17	Dec 12
GFE: All '78 LSP & Annotated Photos	Nov 21	
BLM Personnel		
FINAL SCENE CLASSIFICATION	Dec 13	Jan 10, '79
INITIAL CLASS DESCRIPTIONS	Dec 13	Jan 25
GFE: PI Data from '78 Photography	Dec 13	
STRATIFICATION	Jan 11	Jan 25
LSP ALLOCATION (UCB)	Jan 26	Mar 9
LSP SELECTION	Mar 12	Mar 22
LSP COLLECTION	May 1* June 1**	June 30
GFE: Slides	June 1*/Jul 1**	
ACREAGE ESTIMATES	Mar 23	Dec 31
GROUND ALLOCATION & SELECTION	Jun 1 Jun 11*	July 15
GFE: Prints	Jul 11**	

* Desert/Range
** Woodland/Forest

Task	St	Finish
GROUND DATA COLLECTION	Jun 11	Oct 5
Training (DLM Personnel)	Jun 11-15	
PHOTO INTERPRETATION	Jun 18	Oct 5
DATA ENTRY	Aug 31	Oct 17
DATA SCREENING	Oct 18	Oct 30
DATA ANALYSIS	Nov 1	Dec 31

Review	January 8, 1979	at ESL	
	June 11, 1979	at St. George	
	September 17, 1979	at St. George	
	November 12, 1979	at ESL	
Training Course	May 21-25, 1979	at St. George	- Field Training
	Nov. 12-16, 1979	at ESL	- Data Analysis
Phase II Review	Dec. 11-13, 1978	at JSC, Houston	

BI-MONTHLY REPORT DISCUSSION

I. LANDSAT PROCESSING % Complete % Resources Used

Subtopics - Preprocessing; Stratification; Digitizing; Classified training; Classification; Area determination

II. MULTISTAGE PROCESSING % Complete % Resources Used

Subtopics - LSP sample allocation/selection; Ground sample allocation/selection

III. DATA COLLECTION % Complete % Resources Used

Subtopics - Ground data collection; LSP interpretation

IV. PRODUCTIVITY ESTIMATION % Complete % Resources Used

Subtopics - Rangeland strata parameter estimates and accuracies; Forest/woodland stand parameter estimates and accuracies

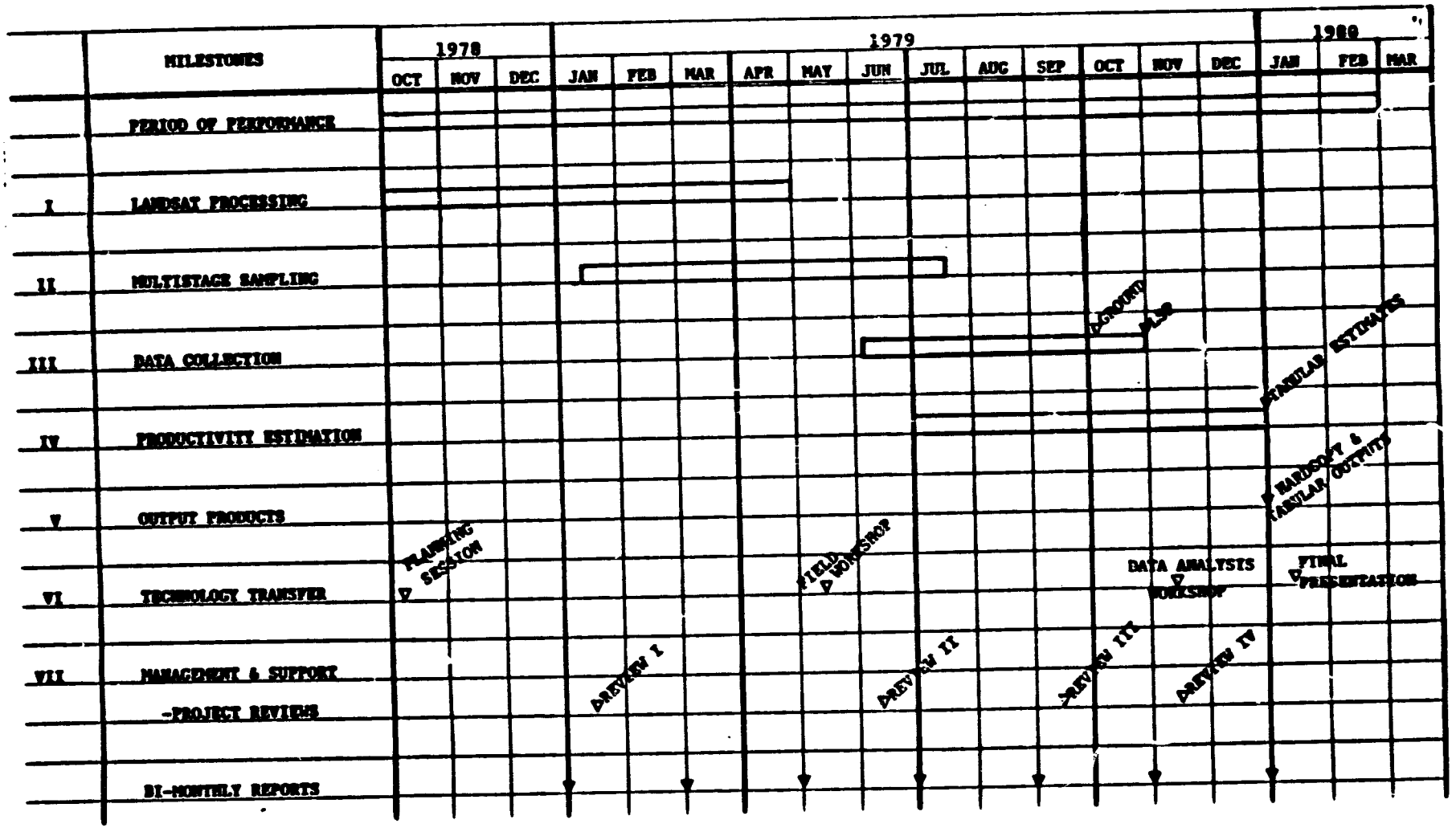
V. OUTPUT PRODUCTS % Complete % Resources Used

Subtopics - Landsat hard copies; Tabular output; Rangeland forage production estimates; Forest/woodland production estimates; Final report

VI. TECHNOLOGY TRANSFER % Complete % Resources Used

VII. MANAGEMENT & SUPPORT % Complete % Resources Used

Subtopics - Reports; Phase II reviews



3. SEMINARS/"HANDS-ON" INSTRUCTION.

There were two training courses given to BLM-Arizona personnel during Phase II: Multistage Sampling-Field Workshop and the Data Analysis Workshop.

3.1 Multistage Sampling-Field Workshop, May 21-25, 1979.

This week long workshop/seminar covered the sample allocation, data collection and data analysis procedures used on the project. Participants in the course stated afterwards that the objectives were, in general, satisfied. The most frequent comment, however, was that of having a much greater appreciation for the complexity of resource inventory programs such as Phase II.

3.2 Data Analysis Workshop, November 13-16, 1979.

The objective of this course was to familiarize program participants with the procedures and techniques to be followed in reducing the data collected during Phase II to produce the vegetation map and the productivity estimates. The most significant result of the course was the grouping of the 117 Landsat spectral classes into 14 Arizona vegetation framework Level III categories performed by the attending BLM-Arizona personnel.

The week long workshop/seminar will cover the sample allocation, data collection and data analysis procedures being used on the project. The objectives of the session are:

(1) the development of a thorough, practical understanding of sample allocation procedures used on the project and the justification for the procedures

(2) to introduce and develop, from a practical standpoint, the statistical procedures and estimators being used on the project

(3) to further develop understanding of the optimization procedures being used with an emphasis on the factors that must be considered when designing an inventory and mapping project

(4) to further the understanding of the data sources being used on the project, including: a) the information extraction procedures, b) relative level of accuracy and precision of each data source, c) relative cost of acquisition and data extraction for each source, and d) the risk associated with the use of data from each source

(5) to prepare the attendees for the data analysis workshop to be held at ESL in October 1979.

To further develop the understanding of the data types being used in the project, the aerial photography, ground data and Landsat data from the project will be used to demonstrate the concepts essential to the inventory and mapping project. This will include the attendees actually

completing photo interpretation of the aerial photography, the collection of supporting ground data, the analysis of the data collected, the presentation of the results in a graphical format, and the interpretation of the meaning and importance of the results. During the week there will be 11 major sections covered:

(1) the review of the project status and work to be completed by the BLM, NASA, and ESL

(2) the review of the sampling, statistical and remote sensing terms and concepts that relate to the resource inventory and remote sensing project

(3) the development of a set of project objectives and the selection of statistical confidence statements that will meet the objectives of a project

(4) the development of categories from Landsat, aerial photography and ground, and the analysis of the relationship of the categories developed (contingency analysis)

(5) the use of Landsat, terrain data and aerial photography to stratify an area, the objectives, uses and advantages of stratification and the associated numerical analysis

(6) the application of multiphase sampling (double sampling), its uses, limitations, assumptions and numerical analysis in resource inventories

(7) multistage sampling (cluster sampling), its uses, limitations, assumptions and numerical analysis in resource inventory

(8) the optimization of data collection and analysis with emphasis on what to collect, how much of it to collect and where to collect it (get the most for the dollar, or getting what you want for the least dollars)

(9) the sample allocation procedures used on the project and the results of that allocation

(10) the application of the field data collection procedures being used on the project

(11) review, wrap-up and preview.

In addition to the above sessions, the personnel presenting the material will be available in the evening to assist those who are interested in more thoroughly developing the material covered during the day and to complete work begun during the day in photo interpretation and data analysis.

In preparation for the week, each attendee should thoroughly read and understand the reference material provided in the package, paying particular attention to the following:

> The Mean and What It Means (1, F. Freese, Elementary Statistical Methods for Foresters, p. 3), Standard Deviation (1, p. 4), Coefficient of Variation (1, p. 5) Confidence Statements (1, p. 11), (2, pp. 1-4), (3, pp. 1-3), Correlation Coefficients (1, p. 7), Sample Size Calculations (1, p. 12), (2, pp. 1-4), "T" Level of Confidence (2, pp. 1-4).

These items will be used liberally during the week from a practical standpoint rather than a theoretical one. Therefore it is not necessary to understand the mathematical statistics associated with the terms, but rather to develop an intuitive feel for the meaning of the terms. Each attendee should bring the following items:

(1) clipboard
(2) pocket stereoscope
(3) an engineer's scale (6")
(4) 10 sheets of 1/10th ruled graph paper
(5) magnifying loupe
(6) calculator (simple one will do; statistical one would be better)

Session 1 - Review of Project Status and Work to be Completed.

ESL will present: (1) the digital processing completed to date, (2) sample allocation completed, (3) photo acquisition, (4) ground data collection, (5) photo interpretation, (6) statistical analysis, (7) output products, and (8) final report.

NASA will present current status of the earth resources program, the ASVT program, and future spacecraft capabilities.

BLM will present the status of their program, their computer system acquisition in Denver and current projects.

Session 2 - Review of Statistical and Sampling Terminology.

Objective.

The objective of this session will be to review the terminology essential to the completion of the remote sensing based inventory demonstration project and to establish basis for the material that follows in the remainder of the course.

Elements.

(a) Statistical terms:

- o mean
- o standard deviation
- o coefficient of variation
- o standard error of the estimate
- o confidence bounds
- o analysis of variance
- o regression analysis
- o contingency analysis
- o correlation coefficient

(b) Sampling terms

- o simple random sampling
- o systematic sampling
- o multistage sampling (cluster sampling)
- o multiphase sampling (double sampling)
- o sampling proportional to size
- o sample size calculation

Remarks.

This will not be a theoretical development. Instead, it will be based on practical examples from this or related projects. The attendees will be expected to participate in this and the following sessions in a seminar fashion, by bringing their backgrounds and experience to bear on the subjects at hand. The discussions will emphasize the advantages, assumptions, and limitations of the statistical, sampling and remote sensing material from a pragmatic viewpoint. An evening session is planned to provide additional time and interface with the instructors to assist those who feel weak on particular sampling, estimation and remote sensing points.

Session 3 - Developing Inventory & Mapping Objectives, Data Requirements and Confidence Statements.

Objectives.

This session will be a review of the elements of planning a resource inventory and mapping project.

Elements.

(a) Project planning outline

(b) Levels of precision and accuracy defined

(c) Confidence statements appropriate to the project objectives

(d) Effects of confidence statements on cost

Schedule.

(a) Introduction of terminology and concepts

(b) Critical review by attendees of BLM's Resource Inventory Note No. 9, "Some Basic Considerations When Sampling Small Woodlands," by B. S. Ashley

(c) Attendees do precision and confidence statements for each level of inventory required by the Bureau

(d) A review of the effects of the confidence statements on the budget required.

Remarks.

The attendees should thoroughly review Resource Inventory Notes BLM No. 9, "Some Basic Considerations When Sampling Small Woodlands" prior to the session. The ideas of confidence bounds and probability statements in the Resource Inventory Note should be put in context to the attendee's particular inventory and mapping problem prior to the session to allow their full participation in the seminar.

Session 4 - Development of Categories and the Analysis of Categorized Information From More Than One Source.

Objective.

Introduction of the students to the concept of nonmeasurable attributes (categories), and the analysis of the relationship between attributes that have been put into categories, and the application and interpretation of the resulting analysis.

Elements.

(a) Introduction of the objectives of the analysis of categorized data (contingency analysis)

(b) Definition of categories (classifications)

(c) Contingency tables (what the numbers mean)

(d) Likelihood values

Schedule.

(a) Instructor's introduction of the concepts and terms

(b) Review of the classification framework in terms of categories associated with the project

(c) The attendees using large scale aerial photography and a verbal key to place points into categories from the classification framework

(d) The analysis of the data from the attendees' interpretation

(e) The meaning of contingency analysis to the ASVT project

Equipment Required.

(a) large scale aerial photos (provided)
(b) stereoscope
(c) verbal photo interpretation key and color chip
(d) data sheet (provided)
(e) calculator
(f) a true identification of the cover types at each point on the ground

Session 5 - Stratified Sampling and Estimation.

Objective.

Develop the concepts of stratified sampling and estimation and develop an understanding of the objectives, applications, advantages, assumptions and limitations of stratified sampling. Bring the use of Landsat, aerial photos and ground data into the context of stratified sampling.

Elements.

(a) Objectives of stratified sampling

(b) Terminology and notation associated with stratified sampling

(c) Analysis of variance procedures (ANOVA)

(d) Selecting stratification criteria

(e) Sample size and allocation optimization

Schedule.

(a) Introduction to the stratification process

(b) Attendees to use 1:30,000 photography to stratify an area of the project

(c) Place known plots into strata based on the attendees' interpretation of the 1:30,000 photography

(d) Numerical analysis of the plot data

(e) Interpretation of the significance of the results of the stratification

(f) Application of stratified sampling to the project (high altitude photo, Landsat, conventional photography and large scale photography)

Equipment.

(a) 1:30,000 stereo pair of the area to be stratified
(b) stereoscope
(c) overlay showing location of sample points
(d) raw data from the sample points
(e) summary data sheet
(f) calculator.

Session 6 - Multiphase Sampling (Double Sampling).

Objective.

Development of a working knowledge of the basic applications of multiphase sampling, its advantages and disadvantages. Introduce the associated terminology and assumptions for multiphase sampling.

Elements.

(a) The objectives of multiphase sampling

(b) Basic terminology for multiphase sampling

(c) Regression and ratio estimators

(d) Scatter diagrams

(e) Distribution of error

(f) Parameters (SSR, SSE, R^2, A, B, and E)

(g) Sample size estimation

(h) Bias associated with ratio estimation

(i) Sample selection

(j) Quality control in multiphase sampling.

Schedule.

(a) Introduction to basic concepts

(b) Example of the application through the use of double sampling with large scale photography

(c) Analysis of the relationship between photo and ground measurements from the photo interpretation completed in the workshop

(d) Significance of the results

(e) Applicability to this project.

Equipment.

(a) Large scale aerial photos of the plots to be interpreted
(b) Data sheet
(c) Pocket stereoscope
(d) Calculator
(e) Graph paper.

Session 7 - Multistage Sampling (Plot Size & Cluster Size Determination).

Objective.

Further the development of the concepts of sampling error and measurement error through large scale photo interpretation. The development of multistage sampling concepts including cluster size determination and travel cost estimation.

Elements.

(a) Measurement error

(b) Sampling error

(c) Plot size

(d) Replacing plot size with increased number of plots

(e) Autocorrelation concepts

(f) Tradeoffs of measurement cost versus travel cost.

Schedule.

(a) Introduction of concepts and objective of multistage sampling

(b) Photo interpretation at varying plot sizes

(c) Numerical analysis of results

(d) Plotting of results

(e) Development of relationship to project

Equipment.

(a) Large scale aerial photos
(b) Stereoscope
(c) Data sheet
(d) Graph paper
(e) Calculator.

Session 8 - Optimization of Inventory and Mapping.

Objective.

Develop a basic understanding of sample optimization procedures relevant to the remote sensing project for rangeland, woodland, and forest.

Elements.

(a) Plot size

(b) Number of plots per cluster

(c) Number of clusters per strata

(d) Travel cost

(e) Measurement cost

(f) Stratification cost

(g) Correlation coefficients

(h) Autocorrelation

(i) Isoproduction functions

(j) Isocost functions

(k) Expansion paths

Schedule.

(a) Objectives of optimization: fixed budget vs. fixed precision

(b) Terminology

(c) Basic optimization model

(d) Review of data from project and from seminar

(e) Sample allocation optimization

Equipment.

(a) Graph paper
(b) Calculator.

Session 9 - Project Sample Allocation Procedures and Results.

Objectives.

To thoroughly review the sample allocation procedure used on the project, the specific parameters used and assumptions considered.

Elements.

(a) Review of the planning model procedure

(b) Review of the facts pertinent to this sample optimization

(c) Review of plot size and measurement procedures from previous sessions of the seminar

(d) Review the results of the allocation for this project

(e) Review of expected results, given the sample optimization used

Schedule.

(a) Review of the elements

(b) Actual planning model runs

Remarks.

Facts to be presented include:

(a) Cost of each element

(b) Probability levels and allowable errors used or expected

(c) Parameters to be estimated in the project

(d) Correlation of coefficients used

Session 10 - Review and Demonstration of Field Procedures.

OBJECTIVES

Review and discussion of use of ground data within project.

ELEMENTS

(a) Comparison with SVIM methodology

(b) Range-related ground data collection procedures

(c) Woodland-related ground data collection procedures

(d) Forest-related ground data collection procedures

(e) Practical experience in using large-scale aerial photography (LSP) to navigate to and locate plot on ground

(f) Actual collection of ground parameters for analysis

SCHEDULE

(a) Discussion of ground data collection procedures with respect to project

(b) Field trip for LSP navigation and ground data collection demonstration

EQUIPMENT

(a) Cupboard

(b) Pocket stereoscope

(c) Field data forms (to be provided)

Session 11 - Review and Wrap-Up.

Objectives.

(a) Review and answer outstanding questions

(b) Preview remainder of project

(c) Preview next training session and assign a study to be completed prior to that session

1979

SIGN-UP LIST

NASA/BLM ASVT Training Course

May 21-25

1.	George Ramey	Range Conservationist	Arizona State Off.
2.	John R. Morgart	" "	Arizona Strip Dist.
3.	Ralph (Cub) Wolfe)	" "	" " "
4.	L. D. Walker	" "	" " "
5.	Dwayne Sykes	Wildlife Biologist	" " "
6.	*Ken C. Moore	Area Mgr., Shivwits	" " "
7.	Robt. (Bob) Davis	Forester	" " "
8.	Thomas R. Costello	"	DSC - D-234
9.	Paul Cuplin	Fisheries Biologist	" D-234
10.	Ed Work	Physical Scientist	" D-440
11.	Lorin Schwartz	" "	" D-440
12.	Ken Hancock	NASA Technical Monitor	JSC - Houston, Tx.
13.	Jim Nichols	Res. Inven. Service	San Jose, Ca.
14.	Mike Gialdini	Proj. Mgr., ESL	Sunnyvale, Ca.

*Ken Moore attended only part-time.

Ariz. Dist. Office (Main) 673-3545
Ariz. Dist. (Areas) 628-1691 (Four Seasons)

A G E N D A

DATA ANALYSIS WORKSHOP

13-16 November 1979

Tuesday, 13 November

1. Photo Interpretation Review

   Procedures used in photo interpretation

   Attributes being measured/estimated

   - Relate these attributes to those measured on the ground.

2. Stat Review

   Review basic statistical terminology and concepts:

   - Mean
   - Standard deviation
   - Coefficient of variation
   - Standard error of the estimate
   - Confidence bounds
   - Analysis of variance
   - Regression analysis
   - Contingency analysis
   - Correlation coefficient
   - Simple random sampling
   - Systematic sampling
   - Multistage sampling
   - Multiphase sampling
   - Sampling proportional to size

   Present the basic framework for connecting these concepts into an estimator.

Wednesday, 14 November

3. Present the use of ANOVA and contingency analysis for generating class descriptions.

   Sources of data:

   - Photo interpretation
   - DTD
   - Landsat classification

   Verification procedure

4. Hands on experience working with the data

   Percent cover estimates → class description → menu

   DTD - Landsat classification contingency table
   DTD menu

   Review of actual class description results (% cover)

5. Evaluation of preliminary aggregations of computer classes and generation of new aggregations (as necessary) based on class description results with the use of the IDIMS color display (Part 1 - Range).

Thursday, 15 November

6. Present the use of photo/ground regression in the estimation procedure.

7. Review the impact of the correlation coefficient on sample size (using actual data if available) required to reach desired accuracy.

8. Evaluation of preliminary aggregations (Part 2 - woodland and forest)

Friday, 16 November

9. Estimation procedures for range resources

   Review range production estimators

   Intuitive explanation of the production estimation

   Review the quantities to be estimated and accuracy "specifications"

10. Estimation procedures for forest and woodland resources

   Review forest and woodland production estimators

11. Wrap-up and review

   Need to have color selection and names for each class to be displayed on the final output products

4. PROJECT STATUS REVIEWS.

The objectives of these periodic reviews were to present progress to date on the Phase II effort and identify and resolve any problems noted or anticipated. The four in-progress reviews were held in January, June, September, and November, 1979. These reviews were considered extremely valuable in maintaining involvement in the project by all BLM, NASA and contractor participants. Coupled with the training course, the reviews provided an excellent means of exchanging information on the project: its objectives, the procedures, the problems encountered and their solutions and the results.

A final project review was held on 29-30 May 1980 to present the accomplishments and results of Phase II to a larger audience than that addressed at the status reviews. In the words of the NASA Project Manager for this APT, "Overall, I considered the Phase II Final Review as a successful culmination of a very rewarding and productive project. The success can be directly attributed to the cooperation and determination of the people involved from both BLM and the contractor."

U.S. Government

MEMORANDUM

Lyndon B. Johnson Space Center — NASA

REPLY TO:	DATE	INITIATOR	SHEET
SF5/79-21	January 18, 1979	SF5/KJHancock:cmg:1/18/79:2204	1

TO: Memo for Record

CC

FROM: SF5/Kenneth J. Hancock

SIGNATURE

Kenneth J. Hancock

SUBJ: Phase Two Project Status Review No. 1

DATE: January 8, 1979

LOCATION: ESL Incorporated, California

ATTENDEES:

R. Marker, BLM/DSC
W. Bonner, BLM/DSC
M. Garratt, BLM/DSC
D. Sykes, BLM/ASD
R. Davis, BLM/ASD
C. Wolf, BLM/ASD
G. Nixon, NASA/JSC
K. Hancock, NASA/JSC
S. Howley, ESL
G. Gnauck, ESL
B. Fine, ESL
J. Nichols, ESL Consultant
R. Thomas, UCB

DISCUSSION:

The status was repoted by B. Fine following the enclosed agenda and the format of the Bimonthly Report.

I. Landsat Processing

- Radiometric Corrections - complete
- Debanding - complete
- Control point; 90 C.P. selected and transformation complete
- Digitizing - 80% complete
- Classification and training -

  First classification completed December 1 using 1978 LSP (120 flight lines). These flights did not include Ponderosa Pine and Agriculture but training was included for these classes. Preliminary names were assigned to the 92 clusters from 4 IMU's. Entire scene classified December 18 using 73 classes.

- Digital Terrain Data - data being unpacked considering using bilinear method; however, Jim Nichols suggested nearest neighbor because of nature of data and cost. It was stated that EDC used cubic convolution.

ACTION No. 1: ESL decision on method to be used for unpacking digital terrain data.

II & III. Multistage Processing

- ESL will be discussing with UCB the need to run the Planning Model, techniques, inputs and outputs to model prior to forwarding the LSP data for input to the Planning Model.

- PI of 1978 LSP - this was to be completed by the BLM contractor in December 1978; however, the date has slipped to January 19, 1979. The effect of this is that any slack in the follow-on tasks has been eliminated and there is no more room for slips or remarks. This delays the ESL due date of digitized data to UCB from January 26 to mid-February.

- LSP for 1979
  BLM specifications complete; RFP to be issued by mid-February; award April 1; collection to begin May 1 in low desert and range areas; low desert and range plotted and delivered by June 1; forest plotted and delivered by June 15.

  ESL will select flight lines by mid-March and deliver maps for contractor by May 1.

- Jim Nichols explained his recommended methodology for determining forest and woodland production using line length and trees intersect instead of total area count of trees. He thinks the UCB Planning Model can give the line lengths for the different forest and woodland cover classes.

- ESL will have Range Resources Inc. under contract by February 15 to the field data collection.

IV. Technology Transfer

- The Peer Review was cancelled by Ken Hancock. Plans are to plan for a management review for the Fall 1979 and include the Phase I field work and evaluation being done by BLM/Alaska.

ACTION NO. 2: BLM/DSC and NASA/JSC will look into having management meeting around October time frame.

ACTION NO. 3: ESL will have May 21-25 Training Session Agenda to NASA and BLM by May 7.

ACTION NO. 4: NASA/JSC will get list of attendees to ESL by April 23.

VII. Management and Support

ACTION NO. 5: ESL will have Final Report outline and draft of Section 1, Landsat Data Processing, to NASA/JSC by February 28. The next Section, Allocation should be in draft July - August period.

ACTION NO. 6: NASA/JSC and ESL will establish dates for draft of each Section of Final Report and rates to be reviewed and returned to ESL by March 30.

- The initial Bimonthly Report has been drafted and should be mailed shortly.

COMMENT: The status report presented by ESL was very satisfactory. The progress was fairly readily tracked by using the flow charts that were drafted from the ESL chart presented at the Planning Session.

Agenda for Multistage Sampling Phase II

Contract Review - January 8, 1979

Progress reports and discussions of scheduling problems for the following topics:

I. Landsat Processing
   1. Preprocessing
   2. Stratification
   3. Digitizing
   4. Signature derivation
   5. Classification

II. Multistage Processing
   1. Effect of delay of PI of '78 LSP by Virtual Image
   2. BLM Contract schedule for collection of '79 LSP
   3. BLM LSP specifications
   4. LSP flight line allocation schedule
   5. BLM purchase order for prints of LSP

III. Multistage Processing
   1. LSP flight line allocation
   2. LSP specifications and collection

IV. Technology Transfer
   1. Cancellation of Peer Group Review
   2. Plans for May 21 - 25, 1979 training

V. Final Report
   1. Draft outline

U.S. Government

MEMORANDUM

Lyndon B Johnson Space Center — NASA

REFER TO:	DATE	INITIATOR	ENCL
SF5/79-152	June 11, 1979	SF5/K Hancock/TM: 4735	*

TO: Memo for Record

cc: SF5/ O. G. Smith
BLM/DSC/ Ed Work
BLM/Arizona Dwayne Sykes
ESL/ Mike Gialdini

FROM: SF5/ K. J. Hancock

SIGNATURE: Kenneth J. Hancock

SUBJ:

Phase II Project Status Review No. 2

Location: St George, Utah

Attendees:

Ed Work, BLM/DSC	Mike Gialdini, ESL
Ken Moore, BLM/Arizona	Joel Dye, ESL
Dwyane Sykes, BLM/Arizona	Len Zuras, ESL
Cub Wolfe, BLM/Arizona	Randy Thomas, UCB
John Morgart, BLM/Arizona	Ken Hancock, JSC

Discussion:

Ed Work gave a brief resume of the status of the Idaho Test Site Project. There have been 350 flight line allocated with 10 plots per flight line. The flight lines are two kilometers in length and require three wide angle photos per stereo pair. The photography and P. I. work is contracted out to Jim Nichols, Resource Inventory System. The photography is now being flown and the P. I. is schedule to be completed by November 1979. Ground data collection begins in July with two persons from BLM/DSC and four from BLM/Idaho. The digital classification is to be done by EROS Data Center.

The project status report was reported by ESL and their subcontractor, UCB, following the enclosed agenda (Enclosure 1).

1. Landsat Data Processing Results (Enclosure 2).

* Classification and Class Descriptions - Spectral classes determined through clustering of four ISA (Intensive Study Areas), 512 x 512 in size, resulting in an initial 83 clusters. As a result of assigning these clusters to 26 summary categories, confusion was noted in high and low desert. BLM/Arizona provided ESL an elevation strata mask for the two desert categories on a 1:250,000 topo map. Using the elevation data for reassignment of spectral classes where "confusion" existed resulted in 117 clusters and 27 summary categories. Although the results are tentative, this demonstrates the possible value of using elevation as a means of elimination spectral confusion.

* Digitizing - GCP's (Ground Control Points) have been digitized as well as all administration boundaries.

* Digital Terrain Data - ESL encountered problems with mosaicing the 1° blocks of elevation data from the DMA digital tapes. As much as 600' difference in elevation was encountered in the overlap area of the 1° blocks. Because of this the task of determining elevation, slope and aspect of each pixels has been delayed until more information can be found out about the DMA tapes.

2. Sample Allocation (Enclosure 3) - Randy Thomas briefed the UCB planning Model for sample allocation and the results obtained for the Arizona Test Site following the enclosed outline.

3. Sample Selection Results (Enclosure 4) - Joel Dye briefed the ESL procedures for selection of samples, i.e., flight lines. The results are enclosed showing both the Planning Model results and the ESL results. Note that the Planning Model called for only 114 flight lines (PSU's) whereas the ESL results show 200. The 200 flight lines are based on the maximum afforded by the BLM budget and the total that will be flown.

Action Items

1. A discrepancy, or difference in the method used, arose from discussion on flight line (PSU) selection. The UCB allocation of flight lines was based on plurality of pixels of a given cover type in a PSU, i.e., a PSU had to contain more pixels of a given cover type than the other cover types to be considered for allocation. The ESL method of PSU selection was based on the total number of pixels in the project area, i.e., all pixels of a given cover type were numbered from one to the total on pixels in the class and then a random number generator was used for selection of flight lines-- thus all pixels of a given cover type had an equal probability of selection. Considerable discussion followed. Since the total number of flights lines to be flown is 200 whereas the Planning Model gave a requirement of 114, the effects of the selection criteria should have little or no effect on this project; however, if additional flight lines had not been planned for the Arizona project there could have been a possible problem.

ESL and UCB took the action to discuss this subject and forward their evaluation to JSC by July 16, 1979. This task is not to entail a detail study.

2. ESL delivered a draft of section 2.1.4 Class Description of the Final Report and a revised copy of the report Outline incorporating the changes recommended by JSC, and BLM. The review by BLM is to be completed by June 30 along with the other section delivered by ESL on May 11, 1979.

3. Copies of the BLM SVIM (Soil Vegetation Inventory Method) forms are enclosed (Enclosure 5). ESL plans to modify these forms as necessary, with the consent of BLM, to accommodate the ground data collection. ESL will forward copies of the modified forms to JSC after necessary changes have been agreed to by BLM.

NASA/BLM APT

PHASE II

PROJECT STATUS REVIEW

11 JUNE 1979

AGENDA

LANDSAT DATA PROCESSING RESULTS	M. GIALDINI, ESL
SAMPLE ALLOCATIONS - SURVEY PLANNING MODEL RESULTS	R. THOMAS, U.C.B
SAMPLE SELECTION RESULTS	J. DYE, ESL
CURRENT OPERATIONS, SESSION WRAP-UP	M. GIALDINI, ESL

NOTE: GENERAL DISCUSSION OF KEY ISSUES IS WELCOME ANY TIME DURING THE SESSION.

LANDSAT PROCESSING RESULTS

- CLASSIFICATION
- CLASS DESCRIPTIONS
- DIGITIZING
- DIGITAL TERRAIN DATA

CLASSIFICATION

- INITIAL RAW CLASSES
- INITIAL SUMMARY CLASSES
- FINAL RAW CLASSES
- FINAL SUMMARY CLASSES

CLASS DESCRIPTIONS

- 1978 LSP PHOTO INTERPRETATION
- ANOVA ON PI RESULTS BY SUMMARY CLASS

DIGITIZING

- CONTROL POINT NETWORK AND EVALUATION
- TRANSFORMATIONS
- ELEMENTS DIGITIZED

DIGITAL TERRAIN DATA

- EVALUATION OF ADJOINING 1^{0} BLOCKS
- INTENDED USE OF DATA

SAMPLE SELECTION RESULTS

- PROCEDURES FOR SELECTION

  PROBABILITY PROPORTIONAL TO AREA - WOODLAND

  EQUAL PROBABILITY - RANGE AND FOREST

- PLOTTING PSU'S TO MAPS

BBC INTERIM FORM 1731-1
MAY 1979

U.S. DEPARTMENT OF THE INTERIOR

BUREAU OF LAND MANAGEMENT

SOIL VEGETATION INVENTORY METHOD

*******-SVIM-*******

TRANSECT DATA SHEET

RECORD TYPE . . . . . (1) V 1

FORMAT CODE . . . . . (2) D

BLM ADMIN UNIT (ST/DI/RA/PU). (3) |_|_|_|_|_|_|_|_|_|

ALLOTMENT . . . . . (4) |_|_|_|_|_|

PASTURE . . . . . (5) |_|_|

SITE WRITEUP AREA (SWA) . . . (6) |_|_|_|_|

TRANSECT NUMBER . . . . . (7) |_|_|

COMPARISON AREA . . . . . (8) |_|

DATE (YYMMDD) . . . . . (9) |_|_|_|_|_|_|

ACTION CODE (A,D) . . . . . (10) |_|

(11) AERIAL PHOTO |_____|

(12) RECORDER |_____|

(13) GROUND COVER DATA		(14)	(15) PLANT LIST			SOIL FACTOR ITEMS	(16)
BASAL	DOT COUNT	HITS	SYMBOL	SYMBOL	SYMBOL		RATING
BARE GROUND						SOIL MOVEMENT	
PERISTENT LITTER . .						SURFACE LITTER . . .	
NON-PERSISTENT LITTER						SURFACE ROCK	
GRAVEL (2mm - 3") . .						PEDESTALLING	
COBBLE (3" - 10") . .						FLOW PATTERNS	
STONE (> 10") . . .						RILLS	
BEDROCK						GULLIES	
						(17) SOIL SURFACE FACTOR TOTAL .	

(18) LEVEL OF TRANSECT HIT					(19) HITS	(18) LEVEL OF TRANSECT HIT					(19) HITS
BASAL	CANOPY 1	CANOPY 2	CANOPY 3	DOT COUNT		BASAL	CANOPY 1	CANOPY 2	CANOPY 3	DOT COUNT	

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DSC INTERIM FORM 1731-1 (CONTINUED)

(18) LEVEL OF TRANSECT HIT					(19) HITS
BASAL	CANOPY 1	CANOPY 2	CANOPY 3	DOT COUNT	

GENERAL INSTRUCTIONS FOR V1

(1) DE 3529 RECORD TYPE - Preprinted on form.
(2) DE 3579 FORMAT CODE - Preprinted on form.
(3) DE 0003 BLM ADMINISTRATIVE UNIT - Enter Administrative State Code(alpha) and the District, Resource Area and Planning Unit numbers.
(4) DE 0968 ALLOTMENT - Enter designated RMAS 4 character number.
(5) DE 3905 PASTURE - Enter pasture number, blank if none; (must be unique within Allotment).
(6) DE 3507 SITE WRITUP AREA - Enter SWA number.
(7) DE 3508 TRANSECT - Enter Transect number.
(8) DE 3572 COMPARISON AREA - If data is from Comparison Area enter "C", otherwise leave blank.
(9) DE 6618 DATE - Enter Date of data collection (Yr.Mo.Day).
(10)DE 7350 ACTION CODE - Enter "A" to Add new data; "D" to Delete existing data.
(11)DE 6525 RECORDER - Enter Recorders initials.
(12)DE 5713 AERIAL PHOTO - Enter Photo-ID or Map Identifier.
(13)DE 3526 GROUND COVER DATA - Record Dot Counts by Basal Categories.
(14)DE 3527 HITS - Record total number of hits for each basal category (use section to left for dot count tally). See SVIM Manual 1731, Illustration 8, for diagramatic sketches of step point data and recording procedures. When a hit is duplicated on a transect it can be dot counted rather than making a new entry.
(15)DE 2646 PLANT LIST - Record other plant species observed but not encountered on pace transect.
(16)DE 4817 SOIL FACTOR ITEMS - Enter a value for each item as determined for Site Writeup Area. This is the recorded rating from the required soil surface factor form. See BLM Manual 7322.11B.
(17)DE 4818 SOIL SURFACE FACTOR TOTAL - Record SSF total. This is an optional entry item.
(18)DE 3526 LEVEL OF TRANSECT HITS - Enter appropriate ground cover and/or plant symbol encountered at each level. See SVIM Manual 1731 for diagramatic information.
(19)DE 3527 HITS - Record total number of Hits. Use column to left for Dot Count tally.

WORK AREA/REMARKS

BBC INTERIM FORM 1731-6
MAY 1979

U.S. DEPARTMENT OF THE INTERIOR

BUREAU OF LAND MANAGEMENT

SOIL VEGETATION INVENTORY METHOD

*******-SVIM *******

WEIGHT ESTIMATE AND VEGETATION CHARACTERIZATION

RECORD TYPE . . . . . (1) V 2

FORMAT CODE . . . . . (2) D

BLM ADMIN UNIT (ST/DI/RA/PU). (3) |_|_|_|_|_|_|_|_|_|

ALLOTMENT . . . . . (4) |_|_|_|_|

PASTURE . . . . . (5) |_|_|

SITE WRITEUP AREA (SWA) . . . (6) |_|_|_|_|

TRANSECT NUMBER . . . . . (7) |_|_|

DATE (YYMMDD) . . . . . (8) |_|_|_|_|_|_|

ACTION CODE (A,D) . . . . . (9) |_|

PLOT SIZES:

TREES & SHRUBS (10) |_| 1/100 |_| 1/200

GRASSES & FORBS (11) |_| .96 |_| 1.92 |_| 4.80 |_| 9.60 |_| 19.20 |_| 48.00 |_| OTHER_____ Specify

PLOTS TO BE CLIPPED AND/OR CHARACTERIZED

	1	2	3	4	5	6	7	8	9	10
CLIP:										
CHAR:										

WEIGHT ESTIMATE DATA									VEGETATION CHARACTERIZATION						
(12) PLOT NO.	(13) PLANT SYMBOL	(14) AVE AVAIL	(15) AVE PHEN	(16) AVE UTIL	(17) ESTIMATED WEIGHT IN GRAMS HT1	HT2	HT3	HT4	(18) AVE HEIGHT	(19) AVE CROWN DIAM.	(20) AGE CLASS	(21) FORM CLASS	DOT COUNT	(22) NUMBER CHARID	(23) NOT CHARID

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DSC INTERIM FORM 1731-6 (continued)

WEIGHT ESTIMATE DATA									VEGETATION CHARACTERIZATION						
(12) PLOT NO.	(13) PLANT SYMBOL	(14) AVE AVAIL	(15) AVE PHEN	(16) AVE UTIL	(17) ESTIMATED WEIGHT IN GRAMS WT1	WT2	WT3	WT4	(18) AVE HEIGHT	(19) AVE CROWN DIAM.	(20) AGE CLASS	(21) FORM CLASS	DOT COUNT	(22) NUMBER CHARZD	(23) NOT CHARZD

GENERAL INSTRUCTIONS FOR V2

(1) DE 3529 RECORD TYPE - Preprinted on form.
(2) DE 3579 FORMAT CODE - Preprinted on form.
(3) DE 0003 BLM ADMINISTRATIVE UNIT - Enter Administrative State Code(alpha) and the District, Resource Area and Planning Unit numbers.
(4) DE 0968 ALLOTMENT - Enter designated RMAS 4 character number.
(5) DE 3905 PASTURE - Enter pasture number, blank if none: (must be unique within Allotment).
(6) DE 3507 SITE WRITUP AREA - Enter SWA number.
(7) DE 3508 TRANSECT - Enter Transect number.
(8) DE 6618 DATE - Enter Date of data collection (Yr,Mo,Day).
(9) DE 7350 ACTION CODE - Enter "A" to Add new data: "D" to Delete existing data.
(10)DE 3514 TREES & SHRUBS - Check plot size for trees & shrubs.
(11)DE 3510 GRASSES & FORBS - Check plot size for grasses & forbs. NOTE: Circle plots to be clipped & characterized.
12)DE 3512 PLOT NO. - Enter plot number from which weight estimate and characterization data is being collected.
(13)DE 2646 PLANT SYMBOL - Enter SCS standard plant symbol.
(14)DE 3830 AVAILABILITY - Enter average availability by plant species occuring in the plot. Code as follows:
A - Available 100 %
P - Partially Available 75 %
H - Half Available 50 %
L - Limited Availability 25 %
U - Unavailable 0 %
(15)DE 3712 PHENOLOGY - Enter average phenology by plant species occuring in the plot. Code as follows:
1 - Begin Growth
2 - Vegetative Stage
3 - Boot Stage
4 - Peak Flowering
5 - Seed Ripe
6 - Mature
7 - Dormant
8 - Regrowth
(16)DE 3832 UTILIZATION - Enter average utilization by plant species occuring in the plot. Code as follows:
0 - 0 %
1 - 01 to 20 %
2 - 21 to 40 %
3 - 41 to 60 %
4 - 61 to 80 %
5 - 81 to 100 %
(17)DE 3532 GRAMS PER PLOT - Record weight in grams per plant species for each height category as follows:
HT1 - 0 to 3'
HT2 - 3 to 4 1/2'
HT3 - 4 1/2 to 7'
HT4 - OVER 7'
A minimum of 2 plots per transect will be clipped and weighed. Enter the weight estimate for all plots and enter and circle actual clipped weight on the clipped plots.
(18)DE 3504 HEIGHT - Record average height in feet and tenths of feet for each species encountered in plot.
(19)DE 3522 CROWN DIAMETER - Record the average crown diameter in feet and tenths of feet for each species encountered in plot.
(20)DE 3502 AGE CLASS - For each plant species record each age class encountered on plot. Use separate lines for each age class. Codes are as follows:
S - Seedling
Y - Young
M - Mature
D - Decadent
O - Old (trees only)
P - Pole (trees only)
R - Resprout (shrubs only)
See SVIM Manual 1731, Illustration 9, page 2 for detailed explanation.
(21)DE 3503 FORM CLASS - For each species record each form class encountered on plot. Use separate lines for each form class. Codes are as follows:
1 - Normal & Vigorous
2 - Dying Center (grasses only)
3 - Hollow Center (grasses)
3 - Dead or dying (forbs, shrubs, trees)
4 - Clump Edge (grasses only)
5 - Dead
(22)DE 3918 NUMBER CHARACTERIZED - Enter total number of plants characterized. Characterize all grasses and forbs, and a minimum of five shrubs and trees per species. The balance of the shrubs and trees within the plot are counted and recorded under item (23. Dot count column to left may be used to tally plant species characterized.
(23)DE 3531 NUMBER NOT CHARACTERIZED - Enter the number of shrubs and trees not characterized in excess of the five characterized.

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DSC INTERIM FORM 1731-7
MAY 1979

Page ___ of ___

U.S. DEPARTMENT OF THE INTERIOR

BUREAU OF LAND MANAGEMENT

SOIL VEGETATION INVENTORY METHOD

••••••• SVIM •••••••

DRY/GREEN WEIGHT CONVERSION

FACTOR DATA

RECORD TYPE . . . . (1) V 6

FORMAT CODE . . . . (2) D

BLM ADMIN UNIT (ST/DI/RA/PU). (3) |_|_|_|_|_|_|_|_|_|

DATE (YYMMDD) . . . . (4) |_|_|_|_|_|_|

ACTION CODE (A,D) . . . . (5) |_|

(6) PLANT SYMBOL	(7) PHENOLOGY	(8) GREEN WEIGHT	(9) % AIR DRY WEIGHT	(10) DRY WEIGHT	(11) GRASSES BASAL DIMENSIONS MINIMUM X MAXIMUM	(12) FORBS, SHRUBS, TREES CROWN DIMENSIONS LENGTH X WIDTH	(13) ALL SPECIES AVE. HT.	(14) SHRUBS AV LEADER LENGTH
					_._ X _._	_._ X _._	_._	_._
					_._ X _._	_._ X _._	_._	_._
					_._ X _._	_._ X _._	_._	_._
					_._ X _._	_._ X _._	_._	_._
					_._ X _._	_._ X _._	_._	_._
					_._ X _._	_._ X _._	_._	_._
					_._ X _._	_._ X _._	_._	_._
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ABCDEFGHIJKLMNØPQRSTUVWXYZ 1234567890

GENERAL INSTRUCTIONS FOR V6

(1) DE 3529 RECORD TYPE - Preprinted on form.
(2) DE 2579 FORMAT CODE - Preprinted on form.
(3) DE 0003 BLM ADMINISTRATIVE UNIT - Enter Administrative State Code(alpha) and the District, Resource Area and Planning Unit numbers.
(4) DE 6618 DATE - Enter Date of data collection (Yr.Mo.Day).
(5) DE 7350 ACTION CODE - Enter "A" to Add new data; "D" to Delete existing data.
(6) DE 2646 PLANT SYMBOL - Enter SCS standard plant symbol.
(7) DE 3712 PHENOLOGY - Enter standard phenology by plant species. Code as follows:
1 - Begin Growth
2 - Vegetative Stage
3 - Boot Stage
4 - Peak Flowering
5 - Seed Ripe
6 - Mature
7 - Dormant
8 - Regrowth
(8) DE 3941 GREEN WEIGHT - Enter grams weighed at time plant clipped.
(9) DE 3546 % AIR DRY WEIGHT - Enter the percent air dry weight is of green weight.
(10)DE 3942 DRY WEIGHT - Enter air dry weight in grams of clipped material.
(11)DE 3533 BASAL DIMENSIONS - Enter basal dimensions in feet and hundredths of feet for all grasses.
(12)DE 3534 CROWN DIMENSIONS - Enter crown dimensions in feet and tenths of feet for all forbs, shrubs and trees.
(13)DE 3504 HEIGHT - Enter height in feet and tenths of feet for each species.
(14)DE 7313 AVERAGE LEADER LENGTH - Enter average leader length in feet and tenths of feet for shrub species.

(16) DATE ____ (17) ESTIMATOR ____ (18) ECO[illegible] ____

(19) PSU NO. ____ MORTALITY TALLY (20) PINYON ____ JUNIPER ____ CRO[illegible] ____ MEASUREMENT ____

(1) PLOT TYPE	(2) TREE NUMBER	(3) STEM NUMBER	(4) NO. OF STEMS	(5) SPECIES	DGH	(7) DSH	(8) DSH	HEIGHT	[illegible]	[illegible]	(15) CLOSED CANOPY
X	XX	XX	XX	X	XX	XX.X	XXX.X	X	X	X	X

4-19

(1) PLOT TYPE

Enter code as follows:

1 - PJ plot

2 - Forest plot

(2) TREE NUMBER

Record tree number as indicated on photo

(3) STEM NUMBER

Record stem numbers consecutively from 1 to number of stems (see 4)

(4) NO. OF STEMS

Record number of stems with DSH greater than or equal to 3 inches (PJ), or a DBH greater than or equal to 4 inches (Forest)

(5) SPECIES

Record species codes as follows:

1 - Pinyon pine

2 - Juniper

3 - Ponderosa pine

(6) DGH

Record diameter at ground height in inches (to nearest tenth). PJ plots only.

(7) DSH

Record diameter at stump height (12") in inches (to nearest tenth). PJ plots only.

(8) DBH

Record diameter at breast height (4.5') in inches (to nearest tenth). Forest plots only.

(9) TOTAL HEIGHT

Measure and record total height to the nearest whole foot for growth sample trees (the 23 foot height class, for example, includes 23.0 up to but not including 24.0 and is coded 023). Measure or estimate and record for all other trees to the nearest whole foot.

(10) MAJOR CROWN DIAMETER

Record major crown diameter to the nearest foot for the aggregate crown resulting from a multistemmed tree or for the crown of a single stemmed tree. Note: major and minor diameters are measured at right angles to each other. PJ plots only.

(11) MINOR CROWN DIAMETER

Record minor crown diameter to the nearest foot for the aggregate crown resulting from a multistemmed tree or for the crown of a single stemmed tree. Note: major and minor diameters are measured at right angles to each other. PJ plots only.

(12) AVERAGE CROWN DIAMETER

Estimated average crown diameter for each stem as determined in 4 above. PJ plots only.

(13) AGE

Total age of those trees bored (growth sample trees).

(14) 10-YEAR RADIAL GROWTH

Record the length of core for last 10 years growth in inches (to nearest tenth).

(15) OPEN/CLOSED CANOPY

Record code as follows:

0 - open canopy

1 - closed or partially closed canopy

Forest plots only.

(16) DATE

Record year, month and day for the date of data collection.

(17) ESTIMATOR

Record name of person doing height and crown diameter estimates.

(18) RECORDER

Record name of other (see 18 above) member of ground crew.

(19) PSU NO.

Record the PSU and plot number as annotated on the back of the LSP prints.

(20) MORTALITY TALLY

Record the number of mortality trees that intersect the plot transects that died within the last five years.

U.S. Government

MEMORANDUM

Lyndon B. Johnson Space Center — NASA

REFER TO:	DATE	INITIATOR	ENCL
SF5/79-213	August 14, 1979	SF5/KJHancock:cmg:8/14/79:4735	

TO: MEMO FOR RECORD

cc: SF5/O. G. Smith
BLM/DSC/Ed Work
BLM/Arizona/Dwayne Sykes
ESL/Mike Gialdini

FROM: SF5/Kenneth J. Hancock, Technical Monitor
Contract NAS 9-15339

SIGNATURE: Kenneth J. Hancock

SUBJ: Phase II Project Status Review No. 2

LOCATION: St. George, Utah

ATTENDEES:
Ed Work, BLM/DSC
Ken Moore, BLM/Arizona
Dwayne Sykes, BLM/Arizona
Cub Wolfe, BLM/Arizona
John Morgart, BLM/Arizona
Mike Gialdini, ESL
Joel Dye, ESL
Len Zuras, ESL
Randy Thomas, UCB
Ken Hancock, JSC

DISCUSSION:

Ed Work gave a brief resume of the status of the Idaho Test Site Project. There have been 350 flight lines allocated with 10 plots per flight line. The flight lines are two kilometers in length and require three wide angle photos per stereo pair. The photography and PI work is contracted out to Jim Nichols, Resource Inventory System. The photography is now being flown and the PI is scheduled to be completed by November 1979. Ground data collection begins in July with two persons from BLM/DSC and four from BLM/Idaho. The digital classification is to be done by EROS Data Center.

The project status report was reported by ESL and their subcontractor, UCB, following the enclosed agenda (enclosure 1).

1. Landsat Data Processing Results (enclosure 2).

* Classification and Class Descriptions - Spectral classes determined through clustering of Landsat coverage represented by 120 LSP's from 1978. The clusters were then tested in 4 ISA's with training added as needed. The resulting 83 clusters were then used for classifying the entire study area. As a result of assigning these clusters to 26 summary categories, confusion was noted in hi and low desert. BLM/Arizona provided ESL an elevation strata mask for the two desert categories on a 1:250,000 topo map. Using the elevation data for reassignment of spectral classes where "confusion" existed resulted in 117 clusters and 27 summary categories. Although the results are tentative, this demonstrates the possible value of using elevation as a means of elimination spectral confusion.

* Digitizing - GCP's (Ground Control Points) have been digitized as well as all administration boundaries.

National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas
77058

Reply to Attn of SF5/79-211

August 14, 1979

TO: BLM/DSC - Ed Work
BLM/Arizona - Dwayne Sykes
ESL - Mike Gialdini

FROM: SF5/Kenneth J. Hancock, Technical Monitor, Contract NAS 9-15339

SUBJECT: Update to Phase II Project Status Review No. 2 Memo, June 11, 1979

My memo Phase II Project Status Review No. 2 had three action items that needed to be completed. In addition, the memo requires amending. Please note below the disposition of the action items and the correction to the memo.

1. Enclosure 1 is a correction sheet to the memo. Please replace page one of the memo with the enclosure.

2. Action Item 1. The letter and enclosure from Joel Dye report on allocation of PSU's (enclosure 2). Further comments on this item are welcomed from BLM, otherwise, the action item is closed.

3. Action Item 2. Comments on the Final Report draft on Sections 2.1 through 2.4 were received, combined with the JSC comments and forwarded to ESL on July 10, 1979.

4. Action Item 3. The revised form for ground data collection for forest and woodland and instructions is enclosed (enclosure 3).

Ken Hancock

Kenneth J. Hancock

3 Enclosures

E S L INCORPORATED • 495 JAVA DRIVE • SUNNYVALE, CALIFORNIA 94086
PHONE (408) 734-8844 • TWX (910) 339-9386

10 July 1979

Mr. Ken Hancock
NASA/JSC
Earth Resources Program Office
Code SF-5
Houston, Texas 77058

Dear Mr. Hancock,

In response to action item number 1 in your memo (SF5/79-152) on the Phase II Project Status Review No. 2, Randy Thomas of UCB and I prepared the enclosed report. The report contains our evaluation of the problem and a recommendation for further analysis if a detailed quantitative evaluation of the impact is desired. I would appreciate any comments you have on this report.

Sincerely,

Joel Dye

JD:ms

Enc.

STATEMENT OF PROBLEM:

The UCB allocation of flight lines (PSUs) was based on assigning each PSU in the population (image) to the cover type class to which the plurality of pixels in the PSU belongs.

The ESL selection of PSUs was based on creating a population of PSUs for each cover type class to be sampled. PSUs were put into these populations if there was at least one pixel in the PSU of the cover type class of interest.

DISCUSSION:

The justification for selecting PSUs in this way was 1) the difficulty and expense of assigning a cover type class to a PSU based on plurality and 2) the large number of pixels, up to 40%, within any one cover type class that would not be available for sampling when the plurality rule is used. Lack of detailed vegetation description information at this point in the project added some uncertainty to the grouping of detailed classes and the names associated with the resultant cover type classes.

The impact on the project of this action is to reduce the efficiency of the sampling in terms of productivity estimation in two ways. First, within and between PSU variance is increased, thereby increasing the sample size required to produce a given level of sampling error. Second, the number of PSUs having a low number of pixels in the class of interest is increased relative to that expected using a plurality rule. This in turn lowers the probability of obtaining the desired number of photo plots in that class using a straight line flight path.

To quantify this impact, a detailed study would need to be made. The recommended analyses to evaluate the magnitude of this efficiency reduction are discussed below. The first would involve recomputing required sample sizes and resulting costs when the within and between PSU variances obtained from the ESL procedure are used. The relative cost difference at a fixed sampling error

requirement would thus be available. In addition, the decrease in estimate precision would be determined when cost (a function of the number of sample units actually measured) is fixed at the UCB recommended levels. The second analysis would be designed to determine the expected increase in sample size necessary to obtain the required number of photo plots per class.

U.S Government

MEMORANDUM

Lyndon B. Johnson Space Center — NASA

REFER TO:	DATE	INITIATOR	ENCL
SF5/79-241		SF5/KJHancock:tlm:10/10/79:4735	8

TO: Memo for Report

FROM: SF5/Kenneth J. Hancock,
Technical Monitor, NASA/BLM APT

CC
SF5/O.G.Smith
Arizona State Office/G.Ramey
BLM/DSC/E.Work
BLM/Az.Strip Dist./K.Moore
ESL/M.Gialdini

SIGNATURE Ken Hancock
Kenneth J. Hancock

SUBJ: NASA/BLM APT Phase II Status Review No. 3

DATE: September 17, 1979

LOCATION: St. George, Utah

ATTENDEES: George Ramey, BLM/Arizona State Office
Ed Work, BLM/DSC
Ken Moore, BLM/Arizona
Dwayne Sykes, BLM/Arizona
L. D. Walker, BLM/Arizona
Cub Wolfe, BLM/Arizona
Bob Davis, BLM/Arizona
Mike Gialdini, ESL
Ken Hancock, NASA/JSC

DISCUSSION:

Ken Hancock reviewed the Action Items from the previous review. No comments were made on the actions taken; therefore, all items were considered closed. Dwayne Sykes will be transferring to BLM/Nevada in October. Actions are being taken to have him attend the November Data Analysis Workshop and the January 1980 Phase II Final Review. Mike Gialdini handed out the July-August 1979 bimonthly report and reported that the draft sections of the Final Report are in typing and will be in the mail shortly.

The project status was reported by ESL following the enclosed agenda and its enclosures.

1. Photo interpretation Procedures and Progress.

The PI work on the large scale ground truth photography is 25% complete and should be completed by the end of October. Range plots are being done at a rate of 5 flight lines per day, woodland and forest plots at 3 1/2 per day. The forms developed for doing the PI are enclosed. The Phase II PI Form is used for all plots. The Tree Measurement Form is also completed for all woodland and forest plots. The forms are generally self explanatory; however, several of the entries are further explained.

PI Form

6-9 Scale - The scale of plots ranged from 1:500 to 1:2000 with estimated average of 1:1200. Nominal scale was to be 1:750 but there is no PI problem with the smaller scales.

10 Template - There are 9 templates for the varying scales. The templates are marked with the rectangle area to be interpreted.

12-13 Homogeneity Index - The index can be determined using the codes. The purpose of the index is to give an indication of how geometric misregistration may affect accuracies of the cover class. The code reflects the number of cover classes within the plot and the additional cover classes identified within a 75 meter radius of the plot center. Thus, the more new classes located within the 75 meter radius, the more misregistration will affect the classification. The wide-angle photos are used for the 75 meter radius tally.

Tree Measurement Form

10 Template - This is a different template with a 150' transect drawn in two 75' representative lengths parallel to the direction of flight and to be positioned on the left-hand photo. The upper edge of the lines is used to count trees and P/J that interact the transect.

18-21 Crown Diameter - Diameter readings are made at the photo scale to the nearest .01".

22-23 Height - Tree and P/J heights are estimated to the nearest 5' and are true height estimates. Parallax bar measurement will be made on selected plots to check the interpreters estimates.

2. Ground Plot Selection Procedures and Results

All plots were bin sorted into the initial 27 summary categories. Similarity of some categories, i.e., 9, 12 and 27; 10 and 13; and 17 and 18, allowed grouping of these with a resultant of 23 bins. The exact plots to ground visit were then determined by random selection For example, bin 1 category had 159 plots and the planning model said 9 of these should be visited for productivity estimation. By taking the random number selected and counting down through the plots, the exact flight line and plot on that line was identified to be visited. This was the primary plot to be used in

the Planning Model for productivity and for class descriptions. The plots were designated for class descriptions and verification purpose only. The secondary plots were selected on the same flight line as a primary plot for field data collection efficiency. There were a total of 181 plots to ground visit; 136 for woodlands; and 29 for forest. Two of the forest plots were not visited as they did not have trees. ESL had not received the final word from RRI, but they had indicated field work should have been completed by September 14. RRI is to deliver all data to ESL by October 1.

As an added feature RRI has agreed to provide instances where they encountered difficulties or problems in implementing the BLM SVIM field methods while doing the project work. RRI has previous experience using the SVIM procedures.

3. Data Analysis Workshop

The workshop is now scheduled for four days, November 13-16, 1979 at ESL. Joel Dye, ESL will be responsible for the workshop preparation, agenda, and hands-on portion of the training. Jim Nichols will be heavily involved in the lectures.

Action No. 1 - An Agenda will be prepared by ESL by October 12. Attendance will be; 4-5 from BLM/DSC; 3-4 from BLM/Arizona Strip District; 1 from BLM/Arizona State Office; 1 from BLM/Nevada; and 1 from NASA/JSC. The attendance, by name, will be provided to ESL by October 31.

4. Output Products

ESL presented some slides showing results of the new DMA algorithm for aggregating cover categories into 10 acre minimums. The results show a bias in the horizontal direction; however, results are superior to the original RECLAS algorithm. ESL is studing this horizontal bias.

The aggregations were done by ESL to prove the algorithm could be used to aggregate an area as large as the Arizona Test Site. This algorithm will be used in the output products for Phase II. Advantages of the algorithm are; (1) different minimums can be established for each class; (2) classes can be interactively changed/added/deleted if desired; and (3) classes can be outlined in polygons to produce a CCT for plotting polygons plot maps. Things needed to improve the algorithm are; (1) eliminate horizontal bias; (2) link the polygon plot capability to a potter; and (3) develop a smoothing algorithm for the polygon plot.

The present 27 summary classes will be further grouped into about nine classes for the final maps. These classes will be determined during the November workshop. Statistical data, i.e., tabulations will be based on the final 10 acre aggregated classes.

Action No. 2 - BLM will determine what ancillary data to have imbedded in the final maps. (Examples are roads and feature names.) BLM will send a letter to NASA/JSC, info ESL, listing the type data desired by September 21, 1979. ESL will check with Seiscom on how these data are to be provided by BLM. As things are presently scheduled proofs of the map side of the output products from Seiscom Delta should be ready for review by December 1, 1979.

Action No. 3 - A date will be established by ESL to have BLM, JSC and ESL review and approve the proofs in Houston. The tabulated data for the backside of the maps should be ready for review by January 10, 1980.

6. Concluding Remarks

A. Schedules

Complete PI work-range and woodlands October 15; forest November 1, 1979.
Production estimations-December 31, 1979.
Final Draft, Final Report-January 27, 1980.

B. Final Phase II Project Review

The review was tentatively set for January 30 - February 1, 1980, at the BLM State Office in Phoenix.

Action No. 4 - George Ramey BLM/Arizona State Office, will make arrangements for the review in Phoenix.

Action No. 5 - BLM/DSC will determine the possibility of including the BLM/Alaska evaluation of Phase I products and the results of the BLM/EDC work in the Arizona Test Site classification as a part of the Phase II Review.

Action No. 6 - BLM/DSC will prepare a preliminary agenda for the review.

Action No. 7 - NASA/JSC will assure all matters pertaining to the review are cleared up by December 31, 1979, to provide time to invite outside participation.

U.S. Government

MEMORANDUM

Lyndon B. Johnson Space Center NASA

REFER TO:	DATE	INITIATOR	ENCL
SF5/79-286	December 6, 1979	SF5/KJHancock:tlm:12-3-79:4735	4

TO: Memo for Record

CC: SF5/O.G. Smith
BLM/Az. State Office/G. Ramey
BLM/DSC/W. Bonner, E. Work
BLM/Az. Strip District/L.D. Walker
ESL/M. Gialdini

FROM: SF5/Kenneth J. Hancock,
Technical Monitor, NASA/BLM APT

SIGNATURE: Ken Hancock
Kenneth J. Hancock

SUBJ: Phase II Project Status Review No. 4 and Data Analysis Workshop

DATE: November 13-16, 1979

LOCATION: ESL Inc., Sunnyvale CA

ATTENDEES: George Ramey, BLM/Arizona State Office
Ed Work, BLM/DSC
Laura Hall, BLM/DSC
Bill DiPaolo, BLM/DSC
Paul Cuplin, BLM/DSC
Jack Chugg, BLM/DSC
L.D. Walker, BLM/Arizona Strip District
Cub Wolfe, BLM/Arizona Strip District
Bob Davis, BLM/Arizona Strip District
Ken Hancock, NASA/JSC

PROJECT STATUS REVIEW

The status review was presented by Mike Gialdini following the enclosed agenda (Enclosure 1). Pertinent facts that may provide a reference to Landsat data processing, sample selection and output products are listed below for your information.

(1) Landsat Data Processing

- The 1978 LSP wide angle photos were used for PI and class descriptions and clustering of Landsat pixels represented by the LSP's resulted in 87 clusters that were subsequently grouped into 26 summary classes.

- Four ISU's (512 x 512 pixels) were selected within the project area for testing these clusters and/or adding additional training as needed.

- Elevation data provided by BLM/Arizona was introduced to eliminate high and low desert confusion

- Introduction of elevation data was limited on the west by the 114° meridian because of a mismatch of the DMA DTD tapes. This is a very small portion of the project area.

- Introduction of the elevation data resulted in 117 clusters grouped into 27 summary classes.

(2) Sample Selection for 1979 LSP

- Method of sample selection: Probability Proportional to Area for Woodland. Equal Probability for Forest and Range.

- PSU's - 200 LSP flight lines with 15 plots per flight line: Woodland-45; Range-108; Forest-47.

- Ground Data Collection-181 plots (2 selected on each flight line): Woodland-16; Range-136; Forest-29 (2 did not have forest and were not visited but used as volume = 0).

- The LSP flight lines were bin sorted into the 27 summary classes.

(3) Output Products - 4 total

- 1:250,000 - Classification of entire project area.

- 1:63,360 - Area B, Forest.

- 1:126,720 - Range allotments within outline of project area.

- 1:126,720 - Woodland allotments with neat line showing only portion of project area.

- Products will be oriented to UTM Grid North. The maps will have a double arrow showing UTM Grid North (GN) and True North (TN).

- At this time the schedule for delivery of the map products was January 25, 1980. (See later developments in the Workshop part of this report).

After completion of the Status Review, Ken Hancock covered the action items from the September 17, 1979 Status Review No. 3. Refer to my trip report for details of each action item. Status of Actions follows:

Action No. 1- complete and closed out.

Action No. 2- BLM is preparing the overlays to provide Seiscom Delta the ancillary data.

Action No. 3- Review of the map proofs was estiblished for December 17, 1979. Again see workshop part of report for changes.

Action No. 4 - George Ramey is working on arrangements for the Phoenix review in January 1980.

Action No. 5 - The meeting Bill Bonner was to attend in Alaska to determine if BLM/Alaska would participate in the review was delayed until December. The action is still open.

Action No. 6 and 7 - still open

DATA ANALYSIS WORKSHOP

The workshop was planned and presented by Joel Dye with assistance from Mike Gialdini, Dennis Noren and Jim Nichols. The agenda for the Workshop is enclosed (Enclosure 2). The Workshop was primarily concerned with data manipulation and analysis for determination of production estimations for range, forest and woodlands. A good portion of the time was involved in working with project data to determine class descriptions and summary classes based on percent cover estimates (ANOVA tables) for the 1979 LSP. This also involved hands-on computer time for visual reference of class to class association assisted by the field knowledge of the Arizona people.

It became fairly obvious that the initial class descriptions assigning the 117 clusters into 27 summary classes were not satisfactory. An "all-nighter" was put in Thursday night reverting to the 117 computer clusters and using the 1979 LSP PI ANOVA data for class identification. Twenty percent of the 1979 LSP plots (in clusters containing more than 30 plots) were withheld as verification plots. See enclosure 3 for a single sheet summary of the major ground cover species by percent coverage. Using this, a species composition list was compiled for each of the 117 clusters. This list was then matched with the classification framework to tie names to clusters and to group them into summary classes. Enclosure 4 is the preliminary grouping of the clusters into level 3 of the framework. Clusters forming each class are listed. Including agriculture, water and barren, there were seven level 1 categories representing fifteen level 3 classes. These could be represented on the maps by ten basic colors with shades of the basic colors representing the other classes.

At this point (Friday afternoon) a call was received from Bill Bonner. His concern was the output of a level 3 map through the APT based on Landsat data analysis. The EDC product displayed level 2 classification. The difference here may be that the APT work in sample selection and PI for the specified allotments and areas were based on level 3 classification. By using the ANOVA tables of percent cover in concert with the classification framework, it was easy to place clusters with sufficient (usually 3 or more) photo plots in a level 3 category. In fact using the ANOVA tables, the framework and the field knowledge of the Arizona personnel it was difficuly to include a cluster in more than one level 3 category. Before this exercise there was concern, by others as well as myself, as to feasibility of grouping the clusters and maintaining

valid statistics. However, and I present two "ifs" here, IF the framework is to be the only basis for class descriptions and IF the ANOVA data for the clusters is to be used as a basis for describing the clusters, then it seems there is little doubt that a level 3 map with accompying statistics is a creditable output product. Please note this is my opinion and not necessarily the opinion of all the Workshop attendees.

BLM/DSC requested that further consideration on the summary classes for the output product be delayed until a concensus of opinion within BLM could be determined. The delay was agreed to with the realization that output of the products would be delayed and that a proof product would not be available for review and approval until after the first of the year. The BLM action on the framework classification level was to be completed within a week with word relayed to ESL for preparation of the classified CCT's for output product generation. This action was to be taken by BLM/DSC since I was to be on leave past the date of the action. Action has now been set by BLM for the week of December 10, 1979.

As a result of the telecon from Bill Bonner the requirements to determine the final summary classes, assign colors to the classes and prepare menus for each class were not completed. It will be necessary for both BLM/DSC and BLM/Arizona to return to ESL after resolution of the classification level issue to accomplish these tasks.

Action Items

Action No. 1 The BLM people had not reviewed drafts of the Final Report Vol. I, Section 1.0, and Vol. II, Section 2.1.4.1 - 2.1.4.3. BLM will review and forward comments to NASA/JSC by November 27, 1979. This will be combined with JSC comments and sent to ESL.

Action No. 2 BLM provided a final copy of the Framework classification. Ken Hancock will amend contract to include this framework. It is the framework being used by ESL.

Action No. 3 Several items not on the EDC maps were to be considered by BLM/DSC for inclusion on the APT maps: 1) Total acreage of maps; 2) Hierarchical number on the menus as well as on the Legend; 3) UTM Grid North (GN) arrow and True North (TN) arrow. BLM will notify NASA/JSC of their decision on these items.

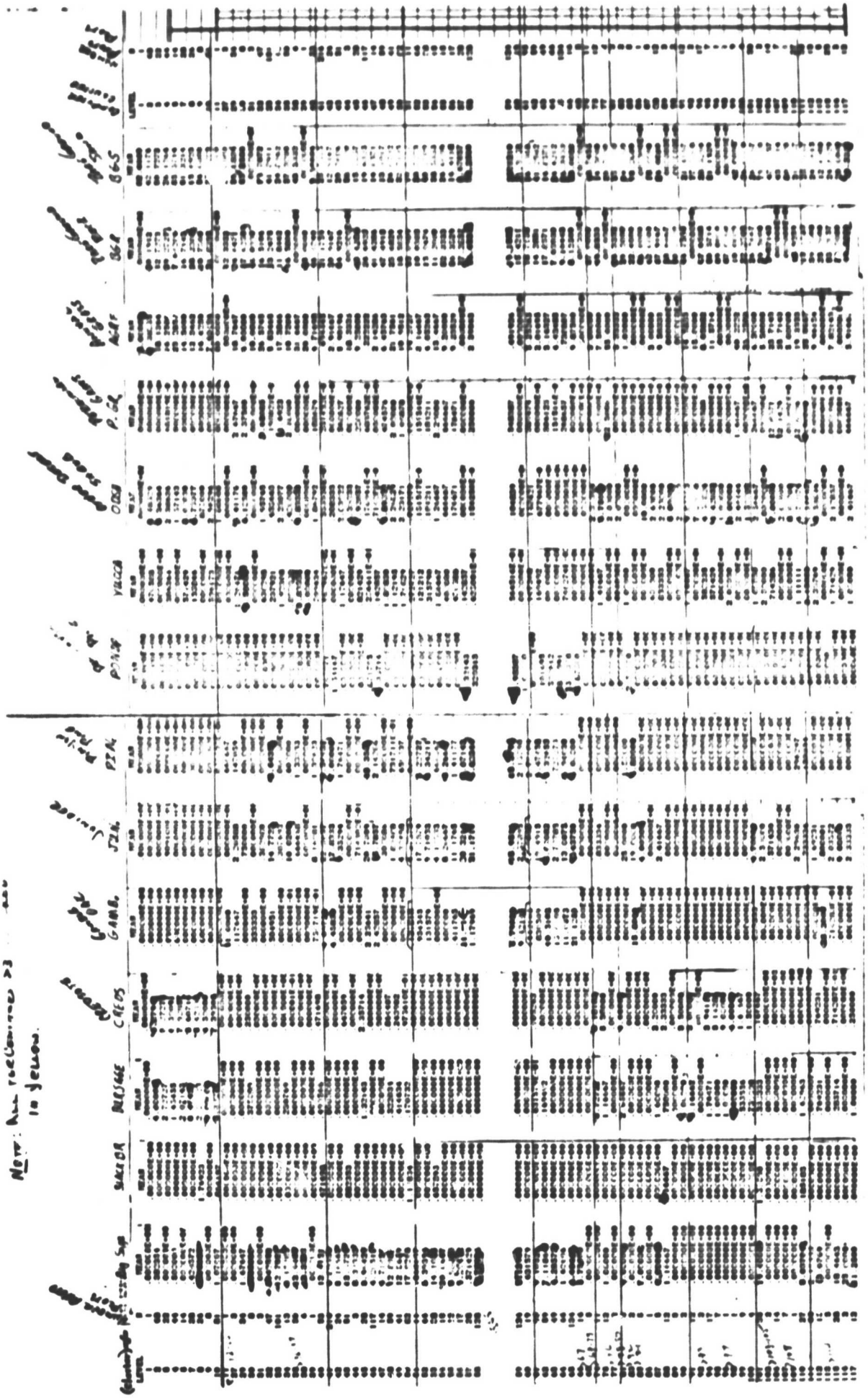
Action No. 4 BLM/DSC will determine the framework classification level at which they desire the maps to be prepared by November 27, 1979, rescheduled for week of December 10, 1979.

Action No. 5 In initial discussions on Allotment 4811, BLM required only the northern parcel of the three separate parts for range production. A question arose on the possibility of including both the northern and southern parcels. If this were done at this time, only average production and statistics for the two parcels could be provided by ESL within budget guidelines. The BLM decision was to include only the northern parcel. Action complete.

AGENDA

NASA/BLM APT PHASE II
STATUS REVIEW
NOVEMBER 13, 1979
SUNNYVALE, CALIFORNIA

	TIME
SIGN-IN AND PHOTOS	8:30 AM
SECURITY BRIEFING	9:00 AM
OVERVIEW PROJECT-TO-DATE	9:30 AM
COFFEE BREAK	10:00 AM
OUTPUT PRODUCTS DISCUSSION	10:15 AM
PROJECT COMPLETION TIMELINE	11:00 AM
CONCLUDING REMARKS	11:30 - 12:00 AM



PRELEMINARY SUMMARY CLASS GROUPING

LEVEL I	LEVEL III	MAP COLOR/SHADE	COMMUNITY	CLUSTERS
2	211	A	Ponderosa Pine Forest	64
3	311	B	Pinyon-Juniper Woodland	33, 35, 41, 42, 43, 46, 47, 52, 53, 55, 56, 57, 58, 59, 61, 62, 63, 65, 66, 83, 85
3	322	C	Riparian Woodlands	25, 26
4	412	D	Upland Desert Shrub	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 74, 75, 81, 86, 87, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98
4	421	E/1	Great Basin Sagebrush	28, 29, 30, 32, 34, 38, 40, 44, 48, 49, 50, 54, 101, 102, 103, 105, 106, 108, 110, 112, 115, 116, 117
4	423	E/2	Blackbrush	88
4	424	E/3	Other Tall Shrub	111
4	425	E/4	Half Shrub	45
4	432	F/1	Oakbrush	27, 60, 113
4	433	F/2	Other Mountain Shrub	31, 39, 51
5	511	G/1	Perennial Grasslands	36, 37, 77, 104, 107, 109
5	512	G/2	Annual Glasslands & Forbs	99, 100
6	6XX	H	Barren	76, 78, 79, 80
7	7XX	I	Water	67, 68, 69, 70, 71, 72, 73, 82

Enclosure 4

PRELEMINARY SUMMARY CLASS GROUPING (cont.)

LEVEL I	LEVEL II	MAP COLOR/SHADE	COMMUNITY	CLUSTERS
8	8XX	J	Agriculture	15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 114
			Unknown	84

A G E N D A

DATA ANALYSIS WORKSHOP

13-16 November 1979

Tuesday, 13 November

1. Photo Interpretation Review

   Procedures used in photo interpretation

   Attributes being measured/estimated

   - Relate these attributes to those measured on the ground.

2. Stat Review

   Review basic statistical terminology and concepts:

   - Mean
   - Standard deviation
   - Coefficient of variation
   - Standard error of the estimate
   - Confidence bounds
   - Analysis of variance
   - Regression analysis
   - Contingency analysis
   - Correlation coefficient
   - Simple random sampling
   - Systematic sampling
   - Multistage sampling
   - Multiphase sampling
   - Sampling proportional to size

   Present the basic framework for connecting these concepts into an estimator.

End 2

Wednesday, 14 November

3. Present the use of ANOVA and contingency analysis for generating class descriptions.

   Sources of data:

   - Photo interpretation
   - DTD
   - Landsat classification

   Verification procedure

4. Hands on experience working with the data

   Percent cover estimates → class description → menu

   DTD - Landsat classification contingency table
   DTD menu

   Review of actual class description results (% cover)

5. Evaluation of preliminary aggregations of computer classes and generation of new aggregations (as necessary) based on class description results with the use of the IDIMS color display (Part 1 - Range).

Thursday, 15 November

6. Present the use of photo/ground regression in the estimation procedure.

7. Review the impact of the correlation coefficient on sample size (using actual data if available) required to reach desired accuracy.

8. Evaluation of preliminary aggregations (Part 2 - woodland and forest)

Friday, 16 November

9. Estimation procedures for range resources

   Review range production estimators

   Intuitive explanation of the production estimation

   Review the quantities to be estimated and accuracy "specifications"

10. Estimation procedures for forest and woodland resources

    Review forest and woodland production estimators

11. Wrap-up and review

    Need to have color selection and names for each class to be displayed on the final output products

U.S. Government

MEMORANDUM

Lyndon B. Johnson Space Center NASA

REFER TO: SF5/80-132	DATE June 5, 1980	INITIATOR SF5/KJHancock:cmg:6/4/80:2204	ENCL 6

TO: SA/Director of Space and Life Sciences
THRU: SF/Chief, Earth Observations Division

FROM: SF5/NASA/BLM APT Project Manager

CC

SIGNATURE Kenneth J. Hancock

SUBJ: NASA/BLM APT Phase II Arizona, Final Review

DATE: May 28-30, 1980

LOCATION: Denver Service Center, Denver, Colorado

PURPOSE: To conduct Phase II Final Review of Accomplishments and Results

ATTENDEES: See Enclosure 1

DISCUSSION:

Meetings were held on the afternoon of May 28 and morning of May 29 with BLM/SSD and the contractor, ESL, Inc., to discuss the proposed agenda and presentations (Enclosure 2).

Copies of the presentations by Mike Gialdini and Jim Nichols are enclosed (Enclosure 3 and 4). The presentations were followed by open discussions. These discussions were very fruitful in that BLM personnel from other disciplines were made more aware of the capabilities that were developed and made available to the BLM Branch of Remote Sensing as a direct result of the APT. Output products and associated statistics were presented by Mike Gialdini and Brian Fine. This was the first opportunity to review the products made by Seiscom Delta. Several minor errors were found in the ancillary printed data. Brian Fine retained the products to have the discrepancies corrected prior to delivery.

The Friday morning presentations were conducted as round table discussions with good participation by all attendees. Bill Bonner reported that, as a preliminary estimate from the field evaluation work conducted in the project area earlier in May, accuracies of the digital classification work were better than 75%. In comparison, an evaluation of conventional ground cover data being used by BLM/Arizona for a URA (Unit Resource Analysis) task in the project area indicated a 65% accuracy. This evaluation, conducted by BLM/SSD, used large scale photography accomplished as a part of the APT as a basis for ground truth data. Previously, accuracy estimates had not been conducted on the ground cover data. Thus, the quality of the data was improved with associated accuracy estimates through use of Landsat analysis.

George Ramey, Arizona State Office, discussed the value that BLM Arizona could realize in the application of Landsat digital processing to their existing procedures. His views are well presented by the correspondence he has written in support of the technology (Enclosure 5). He then presented a list of priority tasks using Landsat data as an added capability that are being included in the BLM Arizona FY81 budget (Enclosure 6). The BLM/Branch of Remote Sensing acknowledged the severe strain that approval of the total package would place on their computer facility; however, it was granted that this type of situation far exceeds the possibility of the BLM State and District Offices not accepting the technology as a viable and useful source of data.

George Ramey made several predictive estimates of overall savings that may be realized by taking advantage of the techniques available through Landsat digital processing. He considered that costs of soils surveys, especially in arid, sparce vegetation areas, could show a 30-50% savings. The net savings on vegetation inventories was estimated at 20-40%. Please note that these are separate tasks and the estimated savings are not directly additive for overall savings. The primary problem he envisioned was the training and "educating" BLM people to use the technology, e.g., training in sampling techniques, data utilization and data analysis.

Ken Moore then discussed several applications of remote sensing analysis in his immediate area of concern.

1. Sagebrush Treatment Areas - The output map product provided a general idea of the extent and location of sagebrush. Knowing this, he can introduce additional parameters, e.g., topographic information, accessibility, density, etc., and pinpoint specific areas of interest using information already stored in the computer or additional parameters that could be digitized from existing file data.

2. Controlled Burns - The blackbrush and sagebrush areas most suitable for clearing through burning can be more precisely identified in both extent and location. Further, through use of the digitized ground truth and large scale photo interpretation data, areas with a high percentage of understory grasses for carrying burns can be extracted, thus aiding in clearing large areas. These cleared areas are then seeded for better pasture leases.

3. Woodland Cutting of Pinyon Pine and Juniper- As with item 2 above, the pinyon-juniper areas can be identified and through further specification of parameters the density can be determined. Areas with 80-90% cover could be blocked out for thinning and the wood sold for fence posts and cord wood. Within these thinned areas, grasses will grow more readily. After a season or so these areas would be burned as covered under item 2 and seeded for better pasture.

I would like to note here that it was self-admitted by both George Ramey and Ken Moore that they were rather dubious of the results that would come out of the project and the use of Landsat digital analysis. Both are now firmly convinced that Landsat will provide BLM additional capability and recognize that Landsat is not a panacea but another very versatile tool to assist in accomplishing their job.

Friday afternoon, Lorin Schwartz, Chief, Branch of Remote Sensing, arranged a demonstration on their minicomputer system. The Arizona project data were used and the demonstration was very informative showing the versatility of manipulation of information files stored in the computer.

Following the demonstration, meetings were held with BLM/SSD to discuss arranging a general workshop for invited agencies to cover the overall APT accomplishments and the resulting value to the BLM. The workshop will be an excellent means for demonstrating the value of the NASA APT/ASVT programs to user agencies. The following actions were established.

1. Preliminary date of the workshop: October 8-9, 1980

2. Location: Denver, Colorado, so the BLM computer system can be used for real time demonstration.

3. Invitations to: BLM Washington Office, NASA Headquarters, USFS, USP&W, SCS, selected BLM State and District Offices, etc.

4. Bill Bonner will complete a proposed agenda from our preliminary discussions.

6. Ken Hancock will submit an Action Document for ESL to assist in conducting the Workshop as a task under the Phase III contract.

Overall, I considered the Phase II Final Review as a successful culmination of a very rewarding and productive project. The success can be directly attributed to the cooperation and determination of the people involved from both BLM and ESL.

My special appreciation for their part goes to Bill Bonner and Mike Gialdini.

NASA ESL ARIZONA CONTRACT REVIEW ON ASVT PROJECT

NAME	ORGANIZATION
Lorin Schwartz	BLM Branch of Remote Sensing
Ken Hancock	NASA/JSC
Mike Gialdini	ESL, Inc.
Jim Nichols	Resource Inventory Services
Ken Moore	BLM Arizona Strip
Paul Cuplin	BLM, DSC
Wallace Crisco	BLM, DSC (D-410)
Cub Wolfe	BLM Arizona Strip
George Ramey	BLM ASO
Carolyn A. Clark	Lockheed/EMSCO - Houston
Jimmy R. Bell	USDA/JSC Houston, Texas
Ed Work	BLM/DSC - Branch of Remote Sensing
Mike Garratt	BLM - SSD
Gary C. Lucich	BLM - SVIM Team - DSC
Ronnie D. Clark	RLM - Res. Inv. Systems - DSC
Ken Andresen	BLM - SSD
Bill Bonner	BLM - SSD
Ralph Marker	BLM - SSD
Bob Dennen	BLM - SSD
Bill Williams	BLM - RIS- DSC
Scott McPherson	BLM - Data Base
Herb Inskeep	BLM - Data Operations
Bryan Fine	Seiscom Delta, Houston, TX

Encl 1

NASA/BLM APT PHASE II ARIZONA REVIEW

May 29-30, 1980

Denver Service Center

THURSDAY AFTERNOON, May 29

1:00 - 1:10	Welcome & Introductions	Ralph Marker, BLM/DSC Ken Hancock, NASA/JSC
1:10 - 1:20	Arizona Project Overview	Mike Gialdini, ESL
1:20 - 1:50	Landsat Data Processing	Mike Gialdini, ESL
1:50 - 2:20	Multistage Sampling	Jim Nichols Resource Inventory Svcs.
2:20 - 2:35	BREAK	
2:35 - 2:55	Data Collection	Mike Gialdini, ESL
2:55 - 3:15	Productivity Estimation	Mike Gialdini, ESL
3:15 - 3:35	Output Products	Mike Gialdini, ESL
3:35 - 3:50	BREAK	
3:50 - 4:10	Map Products - Seiscom Delta	Brian Fine Seiscom Delta
4:10 - 5:00	General Discussion	

FRIDAY MORNING, May 30

8:00 - 8:30	Review of APT	Bill Bonner, BLM/DSC
8:30 - 9:30	Operational Remote Sensing in Arizona	George Ramey, BLM/ASD
9:30 - 9:45	BREAK	
9:45 - 10:45	Arizona Strip District Use of Products	Ken Moore, BLM, ASD
10:45 - 11:30	Recommendations & Discussion	George Ramey, BLM/ASD

FRIDAY AFTERNOON, May 30

1:00	Branch of Remote Sensing BRIEFING AND TOUR	Lorin Schwartz, BLM/DSC

NASA BLM APT PHASE II

PROJECT OVERVIEW

- OBJECTIVES
  - DEMONSTRATE INTEGRATION OF REMOTE SENSING TECHNOLOGY WITH EXISTING TECHNIQUES TO PRODUCE: A VEGETATION TYPE MAP AND ESTIMATES OF VEGETATION PRODUCTIVITY.
  - TRANSFER OF THE TECHNOLOGY TO BLM PERSONNEL TO PROMOTE THE IMPLEMENTATION AND UTILIZATION OF THE PROCEDURES AND TECHNIQUES WITHIN THE BLM OPERATIONS FRAMEWORK.

- APPROACH
  - TECHNOLOGY DEMONSTRATION

    INTEGRATE LANDSAT, LARGE-SCALE AERIAL PHOTOGRAPHY AND GROUND DATA WITHIN APPROPRIATE SAMPLING SCHEME TO MEET OBJECTIVES.
  - TECHNOLOGY TRANSFER

    "HANDS-ON" WORKSHOPS TO PROVIDE EXPOSURE TO TECHNIQUES USING PROJECT DATA.

Encl 3

PROJECT ELEMENTS

- LANDSAT PROCESSING
- MULTISTAGE PROCESSING
- DATA COLLECTION
- PRODUCTIVITY ESTIMATION
- OUTPUT PRODUCTS

LANDSAT PROCESSING RESULTS

- o CLASSIFICATION
- o CLASS DESCRIPTIONS
- o DIGITIZING
- o DIGITAL TERRAIN DATA

C-2

CLASSIFICATION

- SOURCE DATA

  SCENE ID 2947-17074, 26 AUGUST 1977

- TECHNIQUE

  SUPERVISED - UNSUPERVISED

- RESULTS

  83 INITIAL RAW CLASSES

CLASS DESCRIPTIONS

- PRELIMINARY

  SPECTRAL CONFUSIONS NOTED BETWEEN ENVIRONMENTAL TYPES

- FINAL

  - 117 DETAILED CLASSES
  - AGGREGATED INTO 27 SUMMARY CLASSES FOR SAMPLING
  - 27 SUMMARY CLASSES DESCRIBED BASED ON ANOVA PERFORMED ON 1978 BLM LARGE-SCALE AERIAL PHOTOGRAPHY

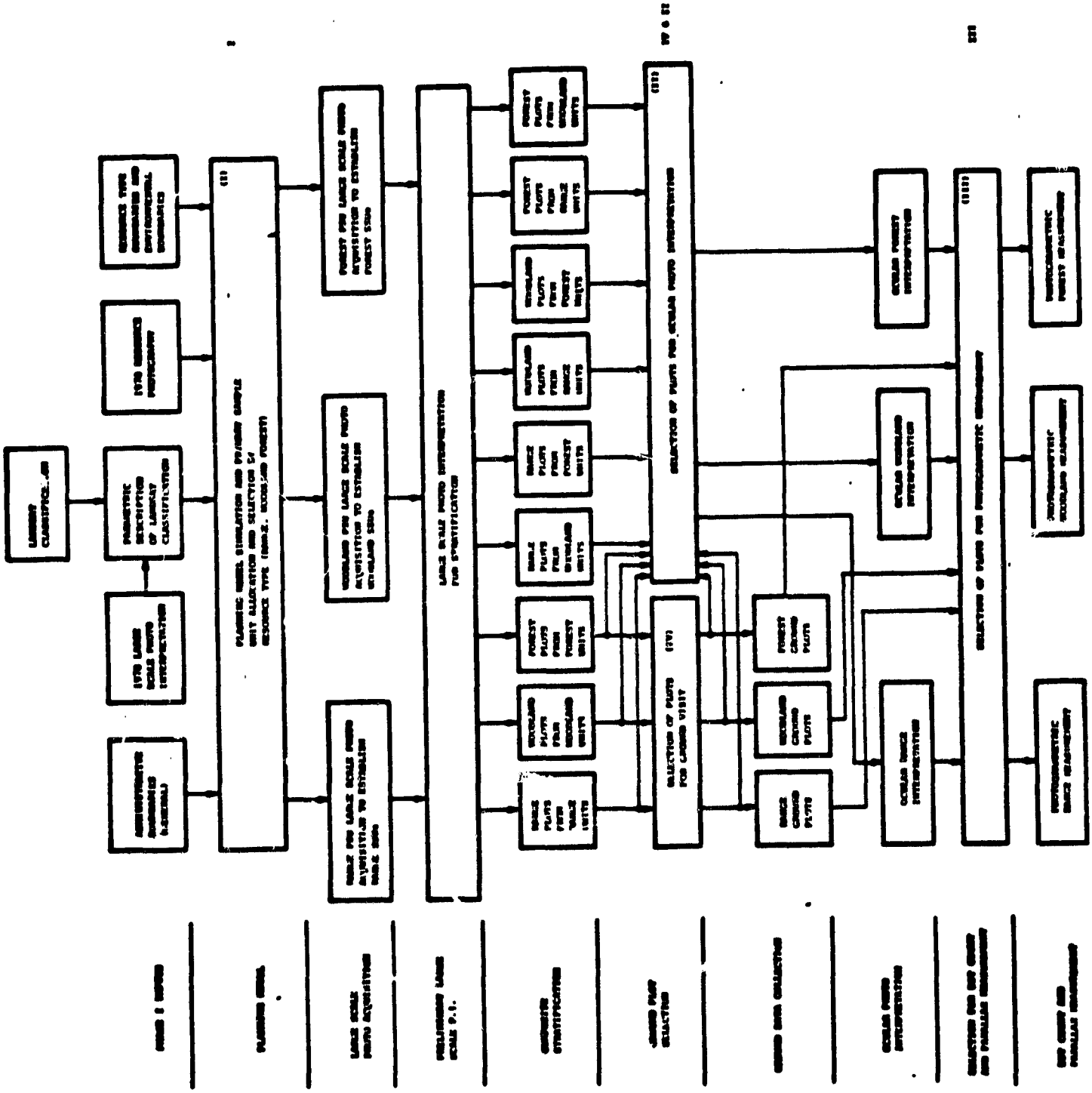
DIGITIZING

- CONTROL POINT NETWORK
  - SCENE REGISTRATION
  - MAP OVERLAY REGISTRATION
- ADMINISTRATIVE INFORMATION
  - PROJECT AREA
  - ALLOTMENTS AND PASTURES
- ENVIRONMENTAL INFORMATION
  - ELEVATIONAL ZONES
- SAMPLE POINT DATA
  - 1978 LSP STRIP COVERAGE
  - 1978 LSP PHOTO PLOT LOCATIONS
  - 1979 LSP PHOTO PLOT LOCATIONS

DIGITAL TERRAIN DATA

- MOSAIC OF ADJOINING BLOCKS
- TOPOGRAPHIC DESCRIPTION OF VEGETATION CATEGORIES

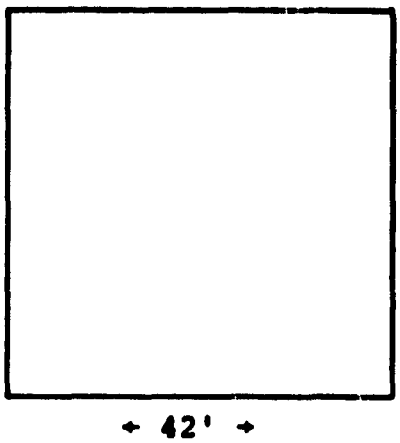
ORIGINAL PAGE IS
OF POOR QUALITY



PLOT CONFIGURATIONS

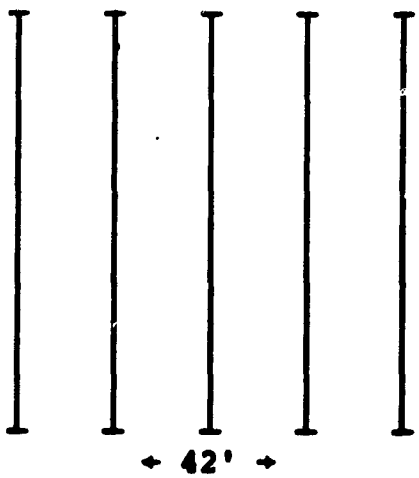
RANGE

PHOTO PLOT



- % COMPOSITION WITHIN FRAME

GROUND PLOT

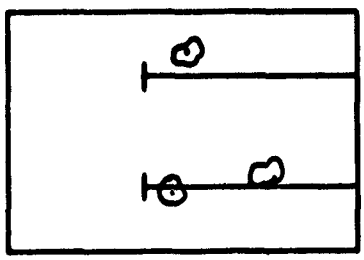


- 5 TRANSECTS
- 40 POINTS/ TRANSECT (COMPOSITION)
- POINTS/TRANSECT WEIGHT AND CHARACTERIZATION)

PLOT CONFIGURATIONS

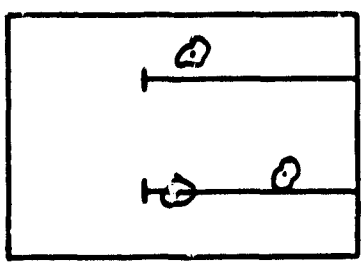
FOREST & WOODLAND

PHOTO PLOT



- 2 - 75' TRANSECTS IN STEREO OVERLAP OF PHOTO PLOT

GROUND PLOT



- 2 TRANSECTS MATCHING THOSE ON PHOTOS USED IN LOCATING PLOT ON GROUND

SAMPLE SELECTION RESULTS

TYPE	CLASS	TOTAL # PSU'S	S.P.M. RESULTS	# PSU'S TO SELECT	# OF PSU'S FOR GRND	# OF GRND PER PSU	TOTAL GROUND
WOODLAND	14	96	5		2	2	4
	15	168	11	45	3	2	6
	16	122	10		3	2	6
	17	1	-				
FOREST	20	11	2	4	2	2	4
	21	447	15	26	15	1	15
	2	32	10	17	10	1	10
RANGE	1	761	9	15	9	2	18
	2	104	2	4	3	2	6
	3	70	2	4	3	2	6
	6	72	2	4	3	2	6
	8	6	2	4	3	2	6
	17,18	19	2	4	3	2	6
	9,12,27	722	3	15	9	2	18
	10,13	280	5	8	5	2	10
	11	104	4	8	4	2	8
	14	208	5	8	5	2	10
	15	513	6	10	6	2	12
	16	380	5	8	5	2	10
	21	5	2	4	3	2	6
	23	8	2	4	3	2	6
	26	164	4	8	4	2	8
							181

SAMPLE SUMMARY

PSUs - 200 FLIGHTLINES OF 15 PLOTS EACH

WOODLAND	= 45
FOREST	= 47
RANGE	= 108
	200

GROUND - 181 GROUNDPLOTS TO BE VISITED

WOODLAND	= 16
FOREST	= 27*
RANGE	= 136
	179

*NOTE: TWO SELECTED FOREST GROUND PLOTS DID NOT HAVE ANY TREES; THEREFORE THEY WERE NOT VISITED.

DATA COLLECTION

- LARGE-SCALE PHOTOGRAPHY

  ACQUISITION

  INTERPRETATION

  - PRELIMINARY "BIN-SORT" FOR GROUND PLOT SELECTION
  - RANGE, WOODLAND AND FOREST DETAILED PI

- GROUND PLOTS

  RANGE

  WOODLAND AND FOREST

- RANGE

  POUNDS PER ACRE (Kgs/Ha) OF FORAGE AVAILABLE FOR LIVESTOCK

  - BY LANDSAT STRATA
  - BY PASTURE AND ALLOTMENT

- WOODLAND

  CUBIC FEET PER ACRE (CUBIC METERS PER HECTARE) OF JUNIPER AND PINYON

  - BY ALLOTMENT

- FOREST

  BOARD FEET PER ACRE OF PONDEROSA PINE

  - BY STAND

OUTPUT PRODUCTS

- FINAL REPORT

  VOLUME I - EXECUTIVE SUMMARY

  VOLUME II - TECHNOLOGY DEMONSTRATION

  VOLUME III - TECHNOLOGY TRANSFER

- MAP PRODUCTS

  RANGELAND SUITABILITY

  POTENTIAL RANGELAND SUITABILITY

  SAGEBRUSH TREATMENT AREAS

  FIRE - FLASH FUELS

- TABULAR SUMMARIES

RANGE FORAGE ESTIMATES BY ALLOTMENT

PALATABLE SPECIES ONLY - CURRENT AMOUNTS AVAILABLE OR UNAVAILABLE

ALLOTMENT	AREA			FORAGE PER UNIT AREA			
	ACRES	HECTARES	% OF TOTAL	LB/ACRE	CONFIDENCE INTERVAL	KG/ HECTARE	CONFIDENCE INTERVAL
JUMP CANYON (4801)	27,796	11,248	5.2	19.3		21.7	
WHITEROCK/SOAPSTONE (4804)	18,686	7,562	3.5	20.2		22.6	
MAINSTREET (4805)	108,881	44,063	20.5	19.1		21.4	
WOLFHOLE CANYON (4811)	25,541	10,336	4.8	13.8		15.5	
LITTLEFIELD COMM. (4827)	78,352	31,708	14.7	11.8		13.2	
PARASHAUNT (4829)	75,607	30,597	14.2	18.8		21.1	
LOWER HURRICANE (4837)	45,876	18,566	8.6	15.0		16.8	
BLACKROCK (4841)	37,323	15,104	7.0	13.9		15.6	
BLACKWILLOW/TASSI (4851)	101,198	40,954	19.0	5.0		5.6	
TOQUER TANK (4861)	12,698	5,138	2.4	19.5		22.2	
TOTAL	531,957	215,276	100	14.4		16.1	

RANGE FORAGE ESTIMATES BY ALLOTMENT

PALATABLE SPECIES ONLY - AMOUNTS AVAILABLE AND PROJECTED FOR FULL UTILIZATION

ALLOTMENT	AREA			FORAGE PER UNIT AREA			
	ACRES	HECTARES	% OF TOTAL	LB/ACRE	CONFIDENCE INTERVAL	KG/ HECTARE	CONFIDENCE INTERVAL
JUMP CANYON (4801)	27,796	11,218	5.2	17.7		19.8	
WHITEROCK/SOAPSTONE (4804)	18,686	7,562	3.5	18.2		20.3	
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TOQUER TANK (4861)	12,698	5,138	2.4	20.8		23.3	
TOTAL	531,957	215,276	100	13.7		15.3	

JUNIPER

ALLOTMENT	TOTAL AREA IN ACRES	SAMPLING FRAME AREA (BLM LAND) IN ACRES	TOTAL CUBIC FOOT VOLUME	CUBIC FOOT VOLUME/ ACRE	STANDARD ERROR	RELATIVE STANDARD ERROR	AVERAGE SIZE IN FEET	AVERAGE AGE IN YEARS
WOLFHOLE	13,308	12,418	2,215,250 (1,479,121;2,951,391)	178.4 (119.1;237.7)	45.9	.26	14.0 (8.9;19.1)	126 (41;211)
WOLFHOLE MTN.	14,727	14,721	2,770,360 (1,756,200;3,784,535)	188.2 (119.3;257.1)	53.5	.28	15.6 (9.8;21.5)	101 (60;143)
BLACKROCK	37,323	32,814	4,831,310 (3,119,171;6,543,425)	147.2 (95.1;199.4)	40.6	.28	12.4 (6.6;18.2)	183 (137;228)
TOTALS	65,358	59,953	9,816,920 (8,533,232;11,100,611)	163.7 (142.3;185.2)	16.7	.10	13.6 (7.8;19.4)	137 (67;206)

VOLUME ESTIMATES APPLY TO BLM LAND ONLY

NUMBERS IN PARENTHESES ARE 80% CONFIDENCE INTERVALS

PINYON

ALLOTMENT	TOTAL AREA IN ACRES	SAMPLING FRAME AREA (BLM LAND) IN ACRES	TOTAL CUBIC FOOT VOLUME	CUBIC FOOT VOLUME/ ACRE	STANDARD ERROR	RELATIVE STANDARD ERROR	AVERAGE SIZE IN FEET	AVERAGE AGE IN YEARS
WOLFHOLE	13,308	12,418	341,194 (77,163;605,259)	27.5 (6.2;48.8)	16.5	.60	18.5 (11.8;25.2)	140 (68;211)
WOLFHOLE MTN.	14,727	14,721	478,220 (58,728;897,735)	32.5 (4.0;61.0)	22.1	.68	14.5 (3.6;25.4)	66 (46;85)
BLACKROCK	37,323	32,814	857,445 (209,593;1,505,289)	26.1 (6.4;45.9)	15.4	.59	21.2 (10.2;32.2)	160 (35;285)
TOTALS	65,358	59,953	1,676,859 (1,137,275;2,216,421)	28.0 (19.0;37.0)	7.0	.25	18.8 (11.7;26.0)	135 (57;213)

VOLUME ESTIMATES APPLY TO BLM LAND ONLY

NUMBERS IN PARENTHESES ARE 80% CONFIDENCE INTERVALS

PONDEROSA PINE (STRATA 20, 21 & 22)

STAND	TOTAL AREA IN ACRES	SAMPLING FRAME AREA IN ACRES	TOTAL BOARD FT VOLUME	BOARD FT VOLUME PER-ACRE	NO. OF PHOTO SAMPLES
AREA A	209,723	2199	353,163	161	26
AREA B	168,628	14,416	5,398,451	374	220
TOTAL	378,351	16,615	5,751,614	346	246

PONDEROSA PINE (ALL STRATA)

STAND	TOTAL AREA IN ACRES	SAMPLING FRAME AREA IN ACRES	TOTAL BOARD FT VOLUME	BOARD FT VOLUME PER ACRE	NO. OF PHOTO SAMPLES	RELATIVE STANDARD ERROR	NO. OF PHOTO SAMPLES
AREA A	209,723	30,425	868,060	29 (13,45)	12	.42	180
AREA B	168,628	56,590	9,764,597	173 (149,197)	19	.11	510
TOTAL	378,351	87,015	11,271,272	130 (113,147)	13	.10	690

NUMBERS IN PARENTHESES ARE 80% CONFIDENCE INTERVALS

COLOR CODES - NASA/BLM APT
VEGETATION CLASSIFICATIONS

LEVEL 2 - Vegetation Classification - Arizona Test Site

Vegetation Type	Framework Classification	Color	Computer Class
AG	1-	BLACK	1
CONIFEROUS FOREST	21	DKGREEN	2
EVERGREEN WOODLAND	31	BROWN	3
DECIDUOUS WOODLAND	32	AQUA	4
MOHAVE DESERT SHRUB	41	RED	5
GREAT BASIN DESERT SHRUB	42	ORANGE	6
MOUNTAIN SHRUB	43	PURPLE	7
PLAINS GRASSLAND	51	YELLOW	8
BARREN LAND	6-	GREY	9
WATER	7-	MEDBLUE	10

LEVEL 3 - Vegetation Classification - Arizona Test Site

AG	1--	BLACK	1
PONDEROSA PINE FOREST	211	DKGREEN	2 *
PINYON-JUNIPER WOODLAND	311	BROWN	3 *
RIPARIAN WOODLAND	322	AQUA	4
UPLAND DESERT SHRUB	412	RED	5 *
GREAT BASIN SAGEBRUSH	421	ORANGE	6 *
BLACKBRUSH	423	LTRED	7 *
OTHER TALL SHRUB	424	TAN	8 *
HALF SHRUB	425	SAND	9
OAKBRUSH	432	VIOLET	10 *
OTHER MOUNTAIN SHRUB	433	PURPLE	11
PERENNIAL GRASSLAND	511	YELLOW	12
BARREN LAND	6--	GREY	13
WATER	7--	MEDBLUE	14

* VERIFIED BY SEPARATE ANOVA

VEGETATION DESCRIPTION

COMPARISON: SUMMARY CLASS 2

	% COVER BY TYPE			
	INITIAL DESCRIPTION		VERIFICATION DESCRIPTION	
VEGETATION COVER TYPE	MEAN	STD. ERROR	MEAN	STD. ERROR
PONDEROSA PINE	26.1	1.8	20.6	2.7
PINYON PINE	4.3	.7	5.3	1.6
JUNIPER	9.0	.9	10.3	1.8
OTHER TREE	2.0	.3	1.8	.3
BIG SAGEBRUSH	3.1	.6	2.9	1.1
OTHER SHRUB	1.8	.3	2.3	.6
GAMBELS OAK	12.4	1.2	13.1	2.2
TURB. OAK	.8	.2	1.2	.7
OTHER MTN SHRUB	3.3	.7	5.2	1.9
PERENNIALS	0	0	0	0
ANNUALS	2.4	.8	1.6	.7
BARREN (ROCKY)	6.4	1.1	3.6	1.4
BARREN (SANDY)	27.2	1.3	31.4	2.4
WATER	.1	.1	0	0
SHADOW/UNINTERP.	1.1	.8	0	0
TOTALS:	100%		99.3%	

-14 SUMMARY CLASSES DESCRIBED BY ANOVA ON 80% OF PHOTO SAMPLES

- 7 SUMMARY CLASSES VERIFIED BY ANOVA ON REMAINING 20%

PRELIMINARY COSTS SUMMARY

TASK	TOTAL ESL MAN-HOURS	MAPPING COMPONENT	ESTIMATION COMPONENT	ADDITIONAL COSTS
LANDSAT PROCESSING	570	450	120	
MULTISTAGE SAMPLING	270	120	150	$4,800*
DATA COLLECTION				
PHOTO ACQUISITION	50	50	-	$11,300**
PHOTO INTERPRETATION	700	500	200	
GROUND DATA COLLECTION	100	-	100	$31,970*
PRODUCTIVITY ESTIMATION	1250	240	1010	$700*
OUTPUT PRODUCTS				
MAP OUTPUT	180	180	-	
TABULAR SUMMARIES	120	40	80	
	3240	1580	1660	$48,770

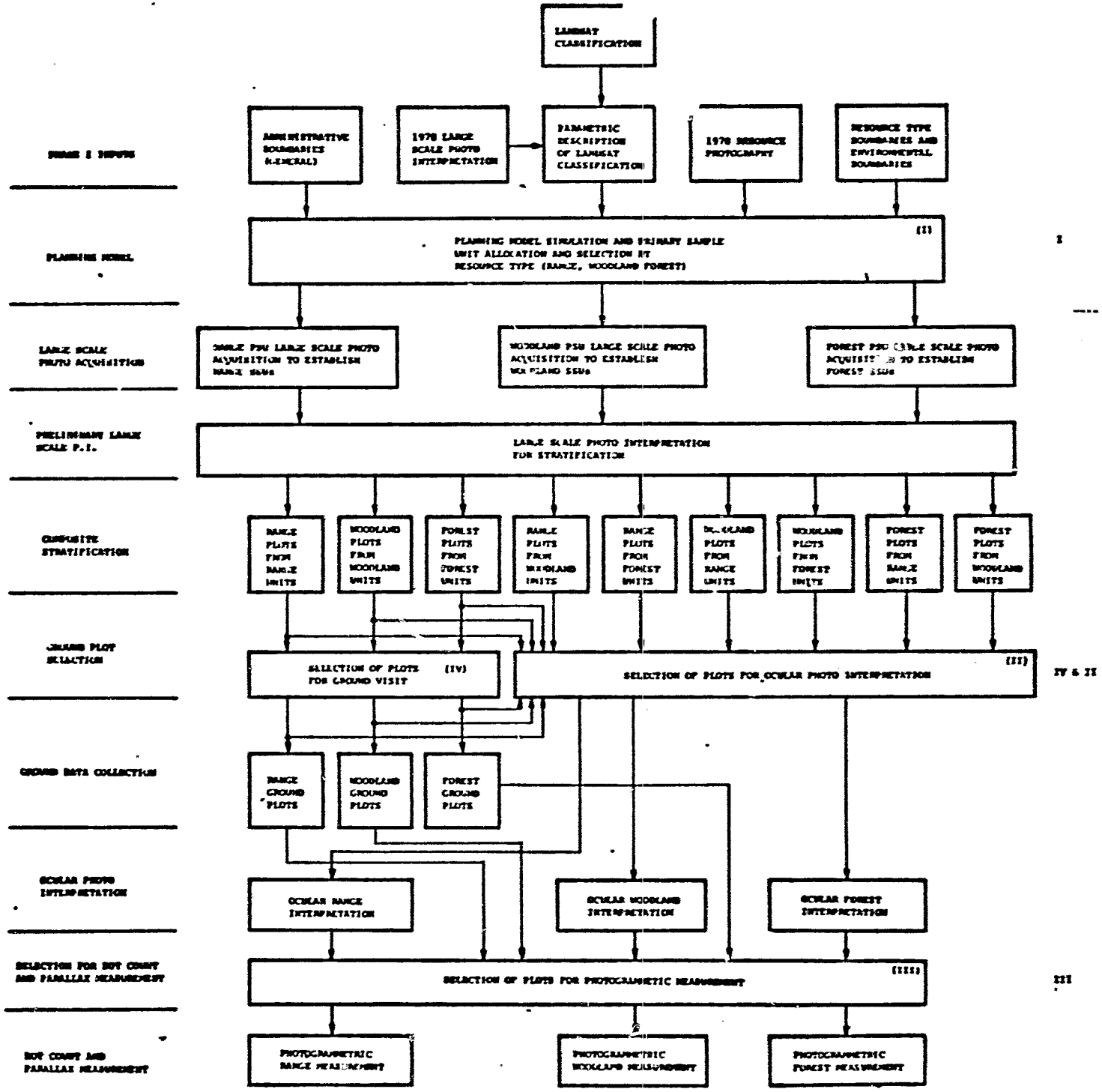
1. AVERAGE COST PER ESL HOUR = $31.70 (THROUGH FEE; BASED ON PROJECT DATA)

2. THEREFORE, THE VEGETATION MAPPING FOR THE PROJECT AREA = [(1580 HRS x $31.70/HR) + $11,300] ÷ 2.2 MILLION ACRES = 3¢/ACRE

3. PRODUCTIVITY ESTIMATION ON 550,000 ACRES GIVEN THE MAPPING =[(1660 HRS x $31.70) + $37,470] ÷ 550,000 = 16.3¢/ACRE

* ASSOCIATED WITH PRODUCTIVITY ESTIMATION

** ASSOCIATED WITH MAPPING PRIMARILY BUT REQUIRED FOR ESTIMATION ALSO


LANDSAT CLASSIFICATION
ADMINISTRATIVE BOUNDARIES (GENERAL)
1978 LARGE SCALE PHOTO INTERPRETATION
PARAMETRIC DESCRIPTION OF LANDSAT CLASSIFICATION
1978 RESOURCE PHOTOGRAPHY
RESOURCE TYPE BOUNDARIES AND ENVIRONMENTAL BOUNDARIES
PLANNING MODEL SIMULATION AND PRIMARY SAMPLE UNIT ALLOCATION AND SELECTION BY RESOURCE TYPE (RANGE, WOODLAND FOREST)
(I)
RANGE PSU LARGE SCALE PHOTO ACQUISITION TO ESTABLISH RANGE SSUs
WOODLAND PSU LARGE SCALE PHOTO ACQUISITION TO ESTABLISH WOODLAND SSUs
FOREST PSU LARGE SCALE PHOTO ACQUISITION TO ESTABLISH FOREST SSUs
LARGE SCALE PHOTO INTERPRETATION FOR STRATIFICATION
RANGE PLOTS FROM RANGE UNITS
WOODLAND PLOTS FROM WOODLAND UNITS
FOREST PLOTS FROM FOREST UNITS
RANGE PLOTS FROM WOODLAND UNITS
RANGE PLOTS FROM FOREST UNITS
WOODLAND PLOTS FROM RANGE UNITS
WOODLAND PLOTS FROM FOREST UNITS
FOREST PLOTS FROM RANGE UNITS
FOREST PLOTS FROM WOODLAND UNITS
SELECTION OF PLOTS FOR GROUND VISIT (IV)
SELECTION OF PLOTS FOR OCULAR PHOTO INTERPRETATION (II)
RANGE GROUND PLOTS
WOODLAND GROUND PLOTS
FOREST GROUND PLOTS
OCULAR RANGE INTERPRETATION
OCULAR WOODLAND INTERPRETATION
OCULAR FOREST INTERPRETATION
SELECTION OF PLOTS FOR PHOTOGRAMMETRIC MEASUREMENT (III)
PHOTOGRAMMETRIC RANGE MEASUREMENT
PHOTOGRAMMETRIC WOODLAND MEASUREMENT
PHOTOGRAMMETRIC FOREST MEASUREMENT
IV & II
III

SAMPLE SUMMARY

PSUs - 200 FLIGHTLINES OF 15 PLOTS EACH

WOODLAND	=	45
FOREST	=	47
RANGE	=	108
		200

GROUND - 181 GROUNDPLOTS TO BE VISITED

WOODLAND	=	16
FOREST	=	27*
RANGE	=	136
		179

*NOTE: TWO SELECTED FOREST GROUND PLOTS DID NOT HAVE ANY TREES; THEREFORE THEY WERE NOT VISITED.

SAMPLE SELECTION RESULTS

TYPE	CLASS	TOTAL # PSU'S	S.P.M. RESULTS	# PSU'S TO SELECT	# OF PSU'S FOR GRND	# OF GRND PER PSU	TOTAL GROUND
WOODLAND	14	96	5		2	2	4
	15	168	11	45	3	2	6
	16	122	10		3	2	6
	17	1	-				
FOREST	20	11	2	4	2	2	4
	21	447	15	26	15	1	15
	22	32	10	17	10	1	10
RANGE	1	761	9	15	9	2	18
	2	104	2	4	3	2	6
	3	70	2	4	3	2	6
	6	72	2	4	3	2	6
	8	6	2	4	3	2	6
	17,18	19	2	4	3	2	6
	9,12,27	722	9	15	9	2	18
	10,13	280	5	8	5	2	10
	11	104	4	8	4	2	8
	14	208	5	8	5	2	10
	15	513	6	10	6	2	12
	16	380	5	8	5	2	10
	21	5	2	4	3	2	6
	23	8	2	4	3	2	6
	26	164	4	8	4	2	8
							181

IDAHO 1C

	TR	SH	GR	AG	WL	NV	
$\bar{y}$	1.78022	29.3681	52.445	0	0	16.4006	Plots 1 & 2
s^2	40.4929	453.472	859.552	0	0	373.467	
s_b^2	60.0134	743.465	1559.91	0	0	532.188	
ρ	.482074	.639496	.814789			.430035	
$\bar{y}$	1.60989	31.1319	53.3242	0	0	13.9341	Plots 1 & 3
s^2	40.1619	406.778	732.939	0	0	286.36	
s_b^2	63.2867	635.509	1254.21	0	0	377.302	
ρ	.57579	.5623	.7112			.365256	
$\bar{y}$	1.93956	29.2418	53.4286	.549451	0	14.8407	Plots 1 & 4
s^2	56.1234	393.72	755.363	54.945	0	280.637	
s_b^2	87.2982	573.771	1218.23	54.945	0	396.432	
ρ	.555468	.457306	.612774	0		.308703	
$\bar{y}$	1.69231	29.0439	52.456	.549451	0	16.2582	Plots 1 & 5
s^2	50.8993	383.092	777.1	54.945	0	345.253	
s_b^2	70.453	513.629	1210.66	54.945	0	467.438	
ρ	.384165	.340747	.558181	0		.253837	
$\bar{y}$	1.23626	29.8791	51.5989	.549451	0	16.7363	Plots 1 & 6
s^2	30.8334	414.671	825.224	54.945	0	437.92	
s_b^2	35.9038	583.026	1336.19	54.945	0	532.948	
ρ	.164446	.405999	.619184	0		.217655	
$\bar{y}$	1.44505	28.2912	53.2143	0	0	17.0494	Plots 1 & 7
s^2	41.0439	367.544	818.832	0	0	424.357	
s_b^2	53.1272	512.034	1211.11	0	0	537.445	
ρ	.294399	.393121	.479073			.288494	
$\bar{y}$	1.08242	29.4945	52.3681	0	0	17.055	Plots 1 & 8
s^2	28.1534	378.749	769.329	0	0	427.555	
s_b^2	29.1807	509.428	1145.07	0	0	534.016	
ρ	3.64901E-02	.345028	.488397			.249	
$\bar{y}$	1.11538	30.8791	52.0989	.247253	0	15.6593	Plots 1 & 9
s^2	28.18	385.245	696.741	11.1264	0	323.696	
s_b^2	29.4675	536.659	1055.58	11.1264	0	407.443	
ρ	4.56898E-02	.393034	.515024	0		.259724	
$\bar{y}$	1.07692	29.5989	53.3516	0	0	15.9725	Plots 1 & 10
s^2	28.1708	390.717	747.257	0	0	357.74	
s_b^2	30.3214	488.002	1078.18	0	0	444.382	
ρ	7.63388E-02	.248093	.442855			.242124	

TABLE 1 Auto Correlation Vs Plot Spacing

CV = 60 AE = 10

Corr.	N= 1	N= 2	N= 3	N= 4	N= 5	N= 6	N= 7	N= 8	N= 9	N= 10	N= 11	N= 12	N= 13	N= 14
.05	36	19	14	11	9	8	7	6	6	6	5	5	5	5
.1	36	20	15	12	10	9	9	8	8	7	7	7	6	6
.15	36	21	16	13	12	11	10	10	9	9	8	8	8	8
.2	36	22	17	15	13	12	12	11	11	10	10	10	10	10
.25	36	23	18	16	15	14	13	13	12	12	12	12	11	11
.3	36	24	20	18	16	15	15	14	14	14	13	13	13	13
.35	36	25	21	19	18	17	16	16	16	15	15	15	15	15
.4	36	26	22	20	19	18	18	18	17	17	17	17	16	16
.45	36	27	23	22	21	20	19	19	19	19	19	19	19	19
.5	36	27	24	23	22	21	21	21	20	20	20	20	20	20
.55	36	28	26	24	23	23	23	22	22	22	22	22	21	21
.6	36	29	27	26	25	24	24	24	24	23	23	23	23	23
.65	36	30	28	27	26	26	26	25	25	25	25	25	25	25
.7	36	31	29	28	28	27	27	27	27	27	27	27	26	26
.75	36	32	30	30	29	29	29	29	28	28	28	28	28	28
.8	36	33	32	31	31	30	30	30	30	30	30	30	30	30
.85	36	34	33	32	32	32	32	32	32	32	31	31	31	31
.9	36	35	34	34	34	33	33	33	33	33	33	33	33	33
.95	36	36	35	35	35	35	35	35	35	35	35	35	35	35
1	36	36	36	36	36	36	36	36	36	36	36	36	36	36

TABLE 2 Number of flight lines required (N).
Isoproduction function for cluster sampling for
CV= 60%, specified allowable error (AE =±10%)
7 times out of 10.

AUTO COR.	N= 1	N= 2	N= 3	N= 4	N= 5	N= 6	N= 7	N= 8	N= 9	N= 10	N= 11	N= 12	N= 13	N= 14
.05	30	38	42	44	45	48	49	49	54	60	55	60	65	70
.1	30	40	45	48	50	54	63	64	72	78	77	84	78	84
.15	30	42	48	52	60	66	79	80	81	99	99	96	104	112
.2	30	44	51	60	65	72	84	88	90	100	110	120	130	140
.25	30	46	54	64	75	84	91	104	108	120	132	144	143	154
.3	30	48	60	72	80	90	105	112	126	140	143	156	169	182
.35	30	50	63	76	90	102	112	128	144	150	165	180	195	210
.4	30	52	66	80	95	108	126	144	153	170	187	204	208	224
.45	30	54	69	88	105	120	133	152	171	190	209	216	234	252
.5	30	54	72	92	110	126	147	168	180	200	220	240	260	280
.55	30	56	78	96	115	138	161	176	198	220	242	264	273	294
.6	30	58	81	104	125	144	168	192	216	230	252	276	299	322
.65	30	60	84	108	130	156	182	200	225	250	275	300	325	350
.7	30	62	87	112	140	168	189	216	243	270	297	324	338	364
.75	30	64	90	120	145	174	203	232	252	280	329	336	364	392
.8	30	66	96	124	155	168	210	240	270	300	330	360	390	420
.85	30	68	99	128	160	192	224	256	288	320	341	372	407	434
.9	30	70	102	136	170	198	231	264	297	330	363	396	429	462
.95	30	72	105	140	175	210	245	280	315	350	385	420	455	490
1	30	72	108	144	180	216	252	288	324	360	396	432	468	504

TABLE 3 Number of plots required U.S.M.
Isoproduction table for cluster sampling for
CV = 60% and specified allowable error (AE = ±10%)
7 times out of 10.

ORIGINAL PAGE IS
OF POOR QUALITY

-----GROUND CREW COSTS-----

CREW COST /HOUR	40.125
$/MILE BETWEEN PSU'S	13.25
$/MILE BETWEEN SSU'S	38.5
$ TO SET UP PSU	12.0313
$ TO SET UP SSU	2.40625
$ TO MEASURE 1 LINE	2.41667

-----PHOTO INTERPRETATION COSTS-----

INTERPRETER COST $/HOUR	25.0529
$ TO SET UP PSU	2.50529
$ TO SET UP SSU	.626322
$ TO MEASURE 1 LINE	.208774

-----PHOTO ACQUISITION COSTS-----

AIRCRAFT AND CREW $/HOUR	71.0004
$/MILE BETWEEN PSU'S	.655559
$/MILE BETWEEN SSU'S	.99201
$ TO SET UP FOR PSU	4.79369
$ TO PHOTOGRAPH 1 SSU	1.5

TABLE 4 $CV =$ f (line length)

$\rho_{ac} =$ f(plot spacing)

These functional relationships were estimated from sample data.

-----PARAMETERS SET BY OPERATOR-----

FIRST PHASE CORRELATION	0
PHOTO GROUND CORRELATION	.743
SIZE OF AREA	300000
PERCENT COVER	20
ALLOWABLE ERROR	20
PROBABILITY LEVEL	.8
STARTING LINE LENGTH	100
LINE LENGTH INCREMENT	10
MAXIMUM LINE LENGTH	200
STARTING PLOT SPACING	200
INCREMENT PLOT SPACING	2002
MAXIMUM PLOT SPACING	10200

AUTO CORRELATION		.609EPG
PLOT SPACING		200
AIRCRAFT BETWEEN PLOT	$	3.41670E-02
GROUND BETWEEN PLOT	$	4.45837

# G PSUS	# P PSUS	# SSUS	LGTH.	D/G	$ CMP	$ PHOTOS	$ P.I.	$ TOTAL
20	81	1	100	4.03295	4414.05	1120.27	295.892	5819.37
15	59	2	110	3.99786	4167.79	1091.34	289.248	5528.29
17	70	1	120	4.10537	4075.46	1091.77	232.815	5248.14
16	67	1	130	4.15657	3995.15	974.732	255.133	5225.02
15	65	1	140	4.29895	3812.94	384.604	250.028	4948.52
14	60	1	150	4.29332	3791.3	350.342	274.72	4825.16
13	57	1	160	4.34975	3523.00	380.509	225.55	4528.55
10	42	2	170	4.15637	3401.51	947.004	222.177	4555.74
12	53	1	180	4.35552	3442.41	201.9	215.503	4459.82
11	47	1	190	4.4193	3329.35	753.093	201.925	4234.32
11	48	1	200	4.35561	3347.74	777.343	200.253	4325.34

MINIMUM OCCURS WHEN

# G PSUS	# P PSUS	# SSUS	LGTH.	D/G	$ CMP	$ PHOTOS	$ P.I.	$ TOTAL
11	49	1	190	4.4193	3329.35	753.093	201.925	4284.37

AUTO CORRELATION		.596547
PLOT SPACING		2200
AIRCRAFT BETWEEN PLOT	$	.375837
GROUND BETWEEN PLOT	$	16.0417

# G PSUS	# P PSUS	# SSUS	LGTH.	D/G	$ CMP	$ PHOTOS	$ P.I.	$ TOTAL
20	81	1	100	4.03295	4414.05	1100.77	295.807	5819.17
14	57	2	110	4.02112	4232.47	1076.41	273.443	5585.33
17	75	1	120	4.10537	4075.46	1301.77	232.815	5248.14
16	67	1	130	4.15557	3995.15	374.732	255.133	5225.02
11	47	2	140	4.28937	3724.05	[illegible]	245.99	[illegible]
14	60	1	150	4.29332	3721.3	[illegible]	[illegible]	[illegible]

Table 1

Pre and Post Inventory Estimation of Parameters Used in the Inventory Planning Model

	Pre-Inventory Estimate or Assumption	Actual	Change
Landsat vs Photoground Correlation	.50 (2)	.58	+.08
P-J Photo Plot Volume vs Ground Estimated Volume	.85 (2)	.748	-.168
P-J Volume per Acre (ft^3) Coefficient of Variation	.75 (3)	.93	+.18
Average Number of P-J Trees/ Transect	3.74 ± 2.3 (3)	5.6	+1.9
Inter-Cluster Correlation for P-J Volume	0 (1)	.597	+.597
P-J Volume per Acre (ft^3)	293.6 ± 48 (3)	241	-52
Relative Standard Error of the Estimates	8.2 (3)		

Values based on 150 foot transect with an average spacing of 1368 meters.

(1) No data available

(2) Based on other related studies

(3) Estimated using Resource Inventory Services planning model

Table 4

Sample Requirements and Expected Cost to Achieve a ±20 @ .8 Probability Using the Post Inventory Estimates of the Planning Model Shown in Table 1, Column 2.

COST EFFECTIVENESS OF THE DATA SOURCE	GROUND ONLY	LANDSAT GROUND ONLY	PHOTO GROUND ONLY	LANDSAT PHOTO GROUND
Number of Photo PSU	0	0	92	63
Number of SSU/PSU	1	1	1	1
Number of Ground PSUs	38	25	22	14
Photo Acquisition ($)	0	0	1171.95	898.09
Photo Interpretation ($)	0	0	395.67	270.95
Ground Data Collection ($)	7618.66	5677.41	5244.34	3984.60
TOTAL COST ($)	7618.66	5677.41	6811.91	5153.64

3.0 --Continued.

The other errors were within the expected errors in the model and simulated runs.

The P-J inventory could have been conducted in several ways. Four possible methods are

1) a ground based inventory

2) Landsat classification followed by ground data collection

3) Large scale photographs followed by ground data collection

4) Landsat classification, large scale photography and and ground data collection.

Using the parameters from the results of the inventory, the planning model was used to estimate the sampling cost for the four methods.

To compute the cost effectiveness ratio for each method the cost of establishing the sampling frame (Landsat classification cost or manual interpretation) must be added to the cost shown in Table 4. If these costs are assumed to be equal, the cost effectiveness ratios relative to the least expensive (Landsat, photo, ground) are

1)	Landsat, Photo, Ground	1
2)	Landsat Ground Only	1.1
3)	Photo Ground Only	1.32
4)	Ground Only	1.48

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
ARIZONA STATE OFFICE
2400 VALLEY BANK CENTER
PHOENIX ARIZONA 85073

IN REPLY REFER TO
9673 (932)

May 7, 1980

Memorandum

To: Director (200) (600)

From: State Director, Arizona

Subject: Opportunity for Using Remote Sensing Technology in BLM

Through experience with remote sensing technology gained from participating in the Application Systems Verification Test (ASVT) we in Arizona have realized the importance of this tool for facilitating the accomplishment of BLM's mission.

We have structured this discussion to address immediate utility and state-of-the-art advancements for the future which will expand landsat utility.

1. Immediate Utility to BLM.

   a. Facilitate SVIM - We believe remote sensing technology may be applied to facilitate accomplishing SVIM inventory at a savings of approximately 15 to 20 percent. Remote sensing will not replace ground inventory but will facilitate inventory through an overview picture of the entire area, pre-stratification, and aid in assuring statistical reliability of sampling. A detailed scenario of application in soils and vegetation inventory was previously prepared and is attached (Memo entitled: Utilizing Remote Sensing Technology to Facilitate SVIM and Land Use Planning).

   b. Facilitate Monitoring Range Trend - This application of remote sensing has been tested during FY 80 by BLM. The process utilizes low-level large scale photography for recording trend on key areas. The process, described in WO Information Memo No. 80-90, has promise of utility in shrub land communities but may not be of value in grass-land communities.

   c. Facilitate Planning System Document Preparation - Once inventory data has been developed utilizing remote sensing data processing programs, the inventory and ancillary data record of the planning unit will be available for other uses. Through careful analysis of parameters, BLM managers may utilize this data base to produce overlays for use in land use planning. Some examples of such planning overlays are:

      Potential land treatment sites (utilizes soils data, vegetation data, topographic data and precipitation data;

Range suitability and potential suitability (utilizes soils data, topographic data, water source data, and input data for the vegetation production data from field inventory);

Potential wildlife habitat for given species (utilizes vegetation data, topographic data, input data relating to conflicting land use such as roads or disturbance zones).

The use of machine analysis is limited primarily by the data record and ancillary information that is available for input and manipulation. The utility of output products depends upon input data quality and the selection of complete, appropriate analysis parameters.

d. Land Use Monitoring - Remote sensing technology is readily usable in monitoring certain types of land uses. Examples are:

Disturbances in excess of one acre in size would be discernible;

Vegetation green-up on many sites would show and could be correlated with field truthing to determine the average date for range readiness;

Plant disease or insect attack are discernible and may be detected long before visual evidence occurs on the affected trees or vegetation.

2. Probable Utility to BLM in Three to Five Years.

Projected state-of-the-art advancements and presently available technology which was previously classified for military intelligence will become available. Our next land satellite, scheduled for orbit in 1981, will have some significant new features, including:

- Additional spectral bands to enhance data interpretation;
- Greater resolution (picture element will be larger than present technology);
- A thermal band will be incorporated to measure heat reflectance.

A later satellite will be orbitted (approximately 1985) which will provide stereo capability thereby allowing three dimensional analysis capability.

3. Probable Long Term Development and Enhanced Utility.

More state-of-the-art developments in satellite imagery, data analysis or application techniques, and probable reclassification of military intelligence hardware or techniques will further advance the utility of remote sensing during the future.

These developments will greatly enhance the utility of land satellite data for use in BLM inventory, land use planning, land use monitoring and land management decision making processes. The advancements in state-of-the-art technology will likely decrease the amount of associated effort presently required in using land satellite imagery; i.e., ground truthing and double sampling using high or low level photography.

I am convinced that remote sensing will be a principal tool for inventorying, monitoring and evaluating resources and resource activity within five to ten years. This is based on our experiences with the Arizona Strip ASVT Project and my observations of Alaska Denali ASVT Project.

The foregoing conveys our observations and thoughts as to how remote sensing may be useful to BLM immediately. Like any system or process, it has its limitation. Remote sensing should not be treated as a panacea but as another useful tool.

Attachment

9673 (932)

Chief, Division of Resources

MAY 5 1980

George Ramey, ASVT Coordinator, Arizona

Utilizing Remote Sensing Technology to Facilitate SVIM and Land Use Planning

While working with the Application Systems Verification Test (ASVT) project in the Arizona Strip District, I realized that remote sensing technology would have other significant applications. One such application of this tool would be to facilitate SVIM inventories.

Before proceeding further, I want to emphasize a critical point: REMOTE SENSING IS NOT A PANACEA -- IT WILL NOT REPLACE FIELD INVENTORY IN MOST CASES. IT IS AN ANCILLARY TOOL TO FACILITATE JOB COMPLETION.

It is my thesis, though I cannot conclusively prove, that the remote sensing technology may be used to accelerate soils and vegetation inventories and reduce costs of such work by approximately 15 to 20 percent. Proof of cost effectiveness may only come through application to inventory work.

There may be similiar benefits for wildlife and wild horses and burro habitat inventories. There may possibly be similar benefits for other land use inventories required for preparing land use plans. Briefly, the utility for land use planning follows:

1. Some products from the Arizona ASVT effort would be usable in preparing land use plans and useful in making management decisions. The utility of products for land use planning is dependant upon good input data and appropriate parameters.

   Product examples are the potential bighorn sheep habitat, pinyon-juniper treatment, potential sagebrush treatment, and range suitability products.

2. The Office of Arid [illegible]udies, University of Arizona, has utilized remote sensing tech[illegible]n completing land use inventories and to identify land use po[illegible]als or limitations. This work was done to provide data for sev[illegible] Arizona counties and the information was used in cour[illegible] land [illegible] planning. Our Districts may acquire copies of these da[illegible] and p[illegible]ng sets from the Arizona State Land Department's Info[illegible]tion [illegible]rces system.

The remote sensing toc[illegible] applied to FACILITATE SVIM in a manner detailed as follows:

1. Soil Survey

In the Arizona Strip ASVT project work, we discovered that spectral reflectances recorded by the land satellite were significantly influenced by soils. This factor is important since much of the public lands are characterized by sparce vegetative cover which allows exposure of the soil surface. As an example of the soils influence on the spectral classification of the vegetation/soils association, we found different spectral classes for homogenous pinyon-juniper vegetation types. We observed the difference in reflectance while reviewing the landsat on the interactive graphic terminal and large scale infrared air photos. During ground truthing, we found the soils to be the only significant difference between sites in many cases. This example and others convinced me that remote sensing would be an important tool to facilitate soil surveys.

The application scenario for soil survey follows: In advance of the field season, a landsat scene which accents soils reflectance would be selected. This would be a scene taken either during the vegetation's dormant season or during a drought period. The landsat computer tapes for the scene and work area would be acquired from EROS Data Center. Also, other important data for area analysis, such as digitized topography information (elevation, slope, aspect, geology), precipitation information, and soils association data would be acquired.

The computer process would be done to produce a spectral reflectance classification of the inventory area. The process could be done either as an unassisted computer analysis or as a "trained" analysis", i.e., field technicians would identify known soils and instruct the computer to associate particular reflectance with given soils.

The initial stratification of spectral reflectance would be further refined using digitized topographic, precipitation and soils association data. The refined stratification, or preliminary soils map, would be machine transferred to overlays registered to 7½ minute photo quads of the inventory area. Also, a grey line-printer map of the stratification could be produced to assist large area interpretation.

These tools would be given to the Soils Survey Crew for their use in completing the soils survey of the area. Fieldwork for some preliminary stratifications would be essentially verification or minor refinement of the soils classification. In some

cases, the stratification would identify soils series or phases of series. Other soils stratas may involve more intensive work. Overall, I believe the savings in workmonths and funds will be significant, i.e., greater than 10 percent.

Upon completion of field sheets, the soils survey data would be digitized and entered in the computer file for the area. This would complete the soils inventory phase and set the stage for initiating the vegetation inventory.

2. Vegetation Inventory

The application scenario follows:

District range conservationists and soils scientists familiar with the inventory area would identify spectral reflectance associated with the various vegetation communities and the vegetation/soils association. Once the computer is "trained", the soils survey record would be used to produce a preliminary rangesite stratification. This could further be refined using elevation, precipitation and aspect information. The refined range site stratification would then be machine transferred to overlays registered to 7½ minute quads for use by the vegetation mapping crew.

The vegetation mapping crew would then verify the stratification (vegetation community and condition classes) and refine the stratification to delineate site write-up areas (SWAs).

The refined vegetation stratification map would then be digitized and input to the computer for vegetation stratum aggregation; i.e., stratum summary such as acres and number of SWAs. The sampling guidance from preplanning analysis would be factored in and the computer would allocate the samples for each stratum.

The computer would be used to make a random selection of the allocated samples for each stratum. These SWAs would be identified on the vegetation stratification maps for subsequent field transecting using SVIM procedures.

Once the transecting is completed and the data summarized, the computer could be used to do a statistical analysis of the stratum samples. Where a stratum sample falls outside of statistical confidence limits, the computer would determine the appropriate additional samples needed. The computer would then be used to make a random selection of SWAs for sampling to bring the given stratum sample within statistical confidence limits.

The remote sensing tool and available data could also be used to perform the suitability classification for the planning unit. The suitability classification would require digitized

topographic data, soils erodability or SSFs data, and livestock water location information. Once processed and machine transferred to overlays registered to 7½ minute quads, the preliminary suitability classification would be given to the field mapping crew for refinement. The fieldwork would be accomplished in conjunction with the vegetation classification refinement and verification work, thereby avoiding redundancy.

There are several other uses of the remote sensing technology which could be listed. I believe BLM will discover many additional uses for this tool once our personnel become familiar with the capabilities and application of the technology. Scheduled state of the art improvements (new land satellites featuring larger pixcel sizes, additional spectral bands, heat sensors, and stereo capability) will extend the resolution greatly and enhance utility of this modern tool.

I hope this discussion will enhance understanding of the remote sensing's potential and capabilities. Furtherwore, I hope this enhanced understanding of the remote sensing tool will motivate BLM's use and application of this modern tool.

George Ramey

BLM ARIZONA FY81 PRIORITY TASKS USING LANDSAT

1. Phoenix RMP (Resource Management Plan, formerly URA)
   - 6.313 million acres in small scattered allotments from Mexico to Navajo. 220 allotments
   - Use to facilitate modified SVIM

2. Vermillion Resource Area
   - 1.7 million acres in the Strip District, N.W. Arizona
   - Assist in soils surveys an modified SVIM
   - Personnel have remote sensing experience

3. Havasu Resource Area
   - 0.858 million acres in Yuma District, West Arizona
   - Assist in classification of ephemerial range and wildlife habitat in 16 allotments

4. Gila Resource Area
   - 2.147 million acres in Safford District
   - Use for modified SVIM
   - Personnel have remote sensing experience

ENCLOSURE 6