Research Publication 113

DEVELOPMENT OF A DATA MANAGEMENT FRONT-END FOR USE WITH A LANDSAT-BASED INFORMATION SYSTEM

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Office for Remote Sensing of Earth Resources

and

School of Forest Resources
College of Agriculture

Contract No. NAS5-26468
Phase III - Final Report
February 1982 - December 1982

Prepared for

NASA/Goddard Space Flight Center
Greenbelt, Maryland 20771

THE PENNSYLVANIA STATE UNIVERSITY · 1855 ·

INSTITUTE FOR RESEARCH ON LAND & WATER RESOURCES

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(NASA-CR-175151) DEVELOPMENT OF A DATA MANAGEMENT FRONT-END FOR USE WITH A LANDSAT-BASED INFORMATION SYSTEM Final Report, Feb. - Dec. 1982 (Pennsylvania State Univ.) 42 p HC A03/MF A01 CSCL 05B G3/82

N84-21418
Unclas
18832

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ABSTRACT

As the final phase of a three-year NASA-supported project to develop an operational system for satellite-based monitoring of statewide forest defoliation, the Office for Remote Sensing of Earth Resources (ORSER) at The Pennsylvania State University was required to develop and implement a data management front-end system for use with a Landsat based information system and to facilitate the processing of both Landsat and ancillary data using this system. The final tasks, reported on here, involved: (a) the implementation of the VICAR image processing software system at Penn State and the development of a user-friendly front-end for this system; (b) the implementation of JPL-developed software based on VICAR, for mosaicking Landsat scenes; (c) the creation and storage of a mosaic of 1981 summer Landsat data for the entire state of Pennsylvania; (d) demonstrations of the defoliation assessment procedure for Perry and Centre Counties, and presentation of the results at the 1982 National Gypsy Moth Review Meeting; and (e) the training of Pennsylvania Bureau of Forestry personnel in the use of the defoliation analysis system.

INTRODUCTION

The Division of Forest Pest Management (DFPM) of the Pennsylvania Bureau of Forestry has the responsibility for conducting annual surveys of the State's forest lands to accurately detect, map, and appraise forest insect infestations. Using current methods, which primarily consist of aerial sketch mapping and ground observations, this has proven to be an overwhelming and impractical task. Nevertheless, these surveys are vital to provide the spatial information needed to plan, organize, direct, and carry out control measures. These measures include the optimum use and allocation of pesticides and the introduction of natural predators.

A standardized, timely, and cost-effective method of accurately surveying forests and their condition should enhance the probability of suppressing infestations. The repetitive and synoptic coverage provided by Landsat (formerly ERTS) makes such satellite-derived data potentially attractive as a survey medium for monitoring forest insect damage over large areas. Division of Forest Pest Management personnel have expressed keen interest in Landsat data and have informally cooperated with NASA/Goddard Space Flight Center (GSFC) since 1976 in the development of techniques to facilitate their use. The results of this work indicated that it might be feasible to use Landsat digital data to conduct annual surveys of insect defoliation of hardwood forests.

Since the first Landsat data for Pennsylvania became available in 1972, it has been apparent that large contiguous areas of heavy gypsy moth defoliation could be identified and mapped from satellite passes made in late June or early July. In fact, Mr. Darrel Williams, working with the Office for Remote Sensing of Earth Resources (ORSER) was granted a Master of Science degree at The Pennsylvania State University (PSU) in 1974 with a thesis, "Computer Analysis and Mapping of Gypsy Moth Defoliation Levels in Pennsylvania Using ERTS-1 Data." Further research by Mr. Williams at GSFC and by Dr. Brian Turner at ORSER indicated, however, that if this technology was to reach an operational stage where the whole state could be scanned for accurate identification of defoliated areas, considerable gains in efficiency of computer processing and reductions in cost would be necessary.

A three-stage, three-year project was thus instituted by NASA to see whether these gains could be achieved. The specific objectives of this project were as follows:

1. To demonstrate the feasibility of conducting automated, annual assessments of the acreage and severity of insect defoliation of hardwood forests using Landsat digital data.
2. To evaluate the accuracy, timeliness and cost-effectiveness of using the automated, Landsat-based survey approach, and to compare these methods with current survey techniques.
3. To provide DFPM personnel with training and experience in the analysis of remote sensing data.
4. To assist ORSER in the development and implementation of computer software to facilitate:
   a) ingestion and analysis of entire Landsat scenes, and
   b) summarization of classification results for any given shape or size polygon (i.e., county or district boundaries) within a scene.

The project was conducted in three phases:

I. A preliminary testing, training, and development phase conducted within at least two county-wide study areas.

II. A quasi-operational testing phase, operating within the framework of entire Landsat scenes.

III. A functional technology transfer phase.

Phase I, the preliminary test phase, was designed to demonstrate the practicality and accuracy of estimating the acreage and severity of defoliation using Landsat digital data and computer processing techniques. The primary objectives of Phase I were as follows:

1. To evaluate the accuracy, timeliness and cost effectiveness of assessing defoliation damage using Landsat data in comparison to the survey techniques currently used by the DFPM.
2. To define the Landsat-based analysis techniques to meet DFPM requirements.
3. To provide training to DFPM personnel relative to the digital analysis of remote sensing data.
4. To initiate the development and implementation of computer software on the PSU computers in order to upgrade the ORSER digital image analysis package to allow both the processing of entire Landsat scenes and the tabulation of classification results for any irregular-shaped polygonal area within a scene.

Under a previous contract with GSFC (NAS5-26166), ORSER implemented the fourth objective of Phase I. The requirements of this contract were as follows:

1. To initiate the development and implementation of computer software on the PSU computers in order to upgrade the ORSER digital image analysis package to allow both the processing of entire Landsat scenes and the tabulation of classification results for any irregular-shaped polygon within that scene.
2. To examine the feasibility of developing a data base/information system to incorporate Landsat and ancillary data covering the entire state of Pennsylvania.

Under this contract and subsequent to it, almost all the programs in the ORSER system were modified to process full Landsat scenes in one pass. Through the development of a system for digitizing polygons, editing them and converting them to raster form, and the use of the existing MAPCOMP program, the ORSER system can now tabulate classification statistics for any irregularly-shaped polygon within a scene.

Also under this contract, the feasibility of developing a data base/information system to incorporate Landsat data and ancillary data for the entire state of Pennsylvania was examined. This resulted in the conceptualization of an interface between the ORSER system and general purpose geographic data analysis systems. It was demonstrated that such a data base/information system was feasible, and no major hindrances to its development in the next phase of this project were foreseen.

Phase II was designed to expand upon the Phase I effort by operating within the framework of entire Landsat scenes. The primary objectives of Phase II were as follows:

1. To test and evaluate the computer software which was developed by ORSER during Phase I.
2. To initiate the development of a data base/information system to handle Landsat data for the entire state of Pennsylvania.
3. To conduct a quasi-operational assessment of gypsy moth defoliation damage using Landsat data.
4. To provide additional training to DFPM personnel relative to digital analysis of remote sensing data.

Initial Phase II activities were to include the testing and evaluation of ORSER computer software to provide efficient methods of:

a) processing the large amounts of data associated with an entire Landsat scene;

b) digitizing, entering, and registering to Landsat data, the boundaries for all Pennsylvania counties and/or DFPM districts located wholly or partially within a Landsat scene; and

c) summarizing classification results, such as total forested acreage or the location, amount, and severity of defoliation, by county or district.

During Phase II, GSFC acquired imagery and computer-compatible tapes for the most recent, nondefoliated, and relatively cloud-free Landsat coverage of the entire state of Pennsylvania. These data were classified to create a forest/nonforest data base for the entire state.

Classification of Landsat data covering an area as extensive as Pennsylvania requires convenient methods for handling large data sets. Therefore, the development of a data base/information system was initiated to facilitate the forest/nonforest classification of Pennsylvania. This system included scene-to-scene registration, sampling methods to select areas for intensive study, and methods of data reduction. In addition, the data base contained DFPM boundaries and county boundaries. The total requirements of such a data base/information system were to be determined jointly by DFPM, NASA and ORSER personnel. The development and implementation of the data base/information system was carried out by ORSER, with NASA's assistance.

Specifically, under NASA contract NAS5-26468, ORSER was required to initiate the development and implementation of a data management front-end system on the PSU computers for use with a Landsat-based information system and to facilitate the processing of both Landsat and ancillary data using this system.

These tasks were completed as required during 1981-82. Software was developed to adapt existing ORSER programs to the peculiar needs of the Landsat mosaic data base supplied by NASA's Jet Propulsion Laboratory (JPL). Archival and retrieval techniques were developed to efficiently handle this data base and make it compatible with the requirements of the Pennsylvania Bureau of Forestry. A user-friendly front-end was constructed to facilitate access to the data base. These results are described in detail in the Phase II, Final Report (Res. Publ. No. 110 of the Institute for Research on Land and Water Resources).

Phase III was designed to effectively transfer the technology developed in earlier phases to DFPM. Specifically, several objectives were to be met:

1. Complete the data base information system.
2. Assist DFPM in the selection of a terminal and access to ORSER.
3. Conduct a symposium related to defoliation studies.
4. Produce final documentation.

PHASE III - OBJECTIVE AND SPECIFIC TASKS

The objective of the contract between GSFC and ORSER was to initiate the development and implementation of a data management front-end system on the PSU computers for use with a Landsat based information system and to facilitate the processing of both Landsat and ancillary data using this system. Under Modification No. 3 to the contract, four additional tasks were included. These tasks, reported on here, constitute Phase III of ORSER's participation in this project.

The first task required that ORSER consult with personnel from JPL to integrate the Landsat-based information system with the data management front-end system developed in Phase II. To fulfill this task, computer compatible tapes containing the Landsat digital mosaic of Pennsylvania, the Landsat-derived forest resources map, and digitized county and forest district boundaries would be supplied by GSFC. ORSER would be responsible for generating a data base from these tapes that would be compatible with the data management front-end system being developed under the existing contract.

In the second task, ORSER would ensure that additional Landsat and ancillary data could be input and registered to the data base on a routine basis. This would require that ORSER have registration and mosaic capabilities. Rather than developing these capabilities, ORSER was required to interact with the JPL and obtain mosaic software from them on a no-cost basis. JPL had already developed the software and had consented to work with ORSER. However, implementation of the JPL mosaic software necessitated that ORSER have on-line Video Image Communications and Retrieval (VICAR) software. Therefore, ORSER was required to purchase and implement this VICAR software.

For the third task, in order to ensure that the data base and the registration and mosaic software were operational, ORSER was required to create a Landsat digital mosaic of the eastern half of the state of Pennsylvania (UTM Zone 18) and to register this mosaic to the Landsat based information system. ORSER was to interact with JPL during this task.

In the fourth task, ORSER would demonstrate the capabilities of the data management front-end system and the data base by completing a Landsat-derived gypsy moth defoliation assessment over a selected county-wide study area. This assessment would require the following activities:

1. Registration of a 1982 Landsat image to the data base. (If a 1982 scene was not available, an appropriate 1981 image would be selected.)
2. Use of the front-end system to process the data, including extraction of Landsat and forest map data, image analysis, and summarization of results.

Finally, ORSER was to be responsible for training a maximum of three DFPM personnel in the use of the data base and the data management front-end system for image analysis and defoliation assessments.

ACCOMPLISHED TASKS

A. Implementation of VICAR

The VICAR image processing software system was obtained from COSMIC at the University of Georgia on a 10-year lease. This software package consists of approximately 300 programs that perform various operations on image and associated files. These programs are controlled by a master program, called VMAST, which performs all input-output operations and passes parameters to the individual programs. The individual programs are written mostly in FORTRAN, but the VMAST routine is written in IBM 360 ASSEMBLER language and needed slight modification to be compatible with PSU's operating system. This modification was accomplished with the help of A. L. Williams and H. D. Knoble, of the Computer Center's staff. Loading of the modules from tape was accomplished with the help of Raymon Masters, also of the Computer Center's staff.

Running a VICAR image processing job actually consists of two separate computer jobs. The first, often called the VTRAN job, consists of taking the VICAR control statements and generating the job control language (JCL) statements necessary to describe the data sets and to provide proper linkage of the programs that will be used. This caused several problems, since the JCL used at PSU has been modified from the IBM standard. An EXECUTE file was written by Fred Luce and George Baumer which makes most of the changes needed before the second job, called the "X-JOB" can be submitted. Currently, the running of this job is left up to the user. In the original version of VICAR, the second job is submitted automatically to the computer. So far, this has been impossible to do at PSU, but the inconvenience to the user has been minimal.

Another potential problem is that standard labelled tapes cannot be used. (This option was never incorporated into the VMAST routine which does all input-output operations for VICAR.) The potential thus exists for the routine to access the wrong tape, necessitating the rerun of an expensive job and causing a good deal of frustration to the user. We suspect that this has happened on more than one occasion during the mosaicking process.

B. Implementation of Mosaicking Software

Following the successful implementation of the standard VICAR package, JPL provided a tape containing the additional programs necessary for mosaicking entire Landsat scenes and registration to an existing data base. The implementation and testing of these modules was assisted by Ron McLeod of JPL. Mr. McLeod also supplied us with the procedures used to do the actual mosaic, and an attempt was made to mosaic two Landsat scenes from the eastern half of Pennsylvania, using summer 1981 data. Although this attempt failed because of subsequently discovered errors in the JPL-supplied procedures, it gave us experience and exposure to the mosaicking process.

C. Creation of Eastern Pennsylvania 1981 Mosaic

To ensure that ORSER would have the capability to create digital Landsat mosaics, we were required to create such a mosaic from the six Landsat scenes of 1981 data covering the eastern half of Pennsylvania, i.e., the portion of the state in UTM Zone 18. In the process of carrying out this task, the minor errors which had given us difficulty in the first mosaicking attempt were corrected and a mosaic of 1981 data registered to the original data base of 1976-79 data was created for eastern Pennsylvania. (The procedures are given in Appendix A.) Meanwhile, JPL was creating a similar mosaic for western Pennsylvania (UTM Zone 17). This data set was subsequently supplied to ORSER on tape.

D. Extension of Front-End for VICAR

In order to facilitate the use of the VICAR software at PSU, the EXEC file of INTERACT, previously developed under this contract as a front-end to both the ORSER system and the Pennsylvania Data Base, was extended to be a front-end to the VICAR system. This front-end can be used to interactively set up a run file for the VTRAN program, which then has to execute successfully before the "X-JOB" (set up by that program) can be run. An example of the use of the VICAR portion of the ORSER front-end system is shown in Appendix B.

E. Defoliation Assessment Demonstration - Perry County

As a demonstration of ORSER's ability to use the data management front-end and the data base, an assessment was conducted of the 1981 defoliation of Perry County, Pennsylvania. In the process, the following steps were taken:

1. Landsat data for Perry County were subset from the 1981 digital mosaic using the digitized county boundary information to mask out all data outside the county. This was done using the SUBDB program, which sets to zero all data outside the county boundary.
2. The forest/nonforest digital mask for Perry County was similarly subset from the forest/nonforest mask mosaic formed from the 1976-79 data base. This mask is not a 0-1 dataset but a quantization of the estimated probability of a pixel being "forest." Thus, the critical value has to be determined by sampling of the area, and comparing trial values with ground truth. In this case, the critical value had been supplied by NASA personnel who had done extensive ground truthing in part of this county. Then the HSTRETCH2 program was used to convert this dataset into a 0-1 mask.

3. A data set of the ratio of band 7 to band 5 was next formed, using the VICAR program F2. This dataset was then multiplied by the 0-1 mask, to produce a dataset where all nonforest pixels were zeros.
4. Finally, a classified map was produced using the VICAR HSTRETCH2 program, by setting breakpoints on the ratio values for delineating Heavy Defoliation, Moderate Defoliation, and Light-No Defoliation. These breakpoint values were also supplied by NASA personnel and were based on ground-checking done at the time of defoliation. Area statistics (acres by defoliation classes) were output by the HIST program.
5. The classified map was output on the electrostatic plotter and also as a tape for printing out on the film recorder at GSFC. An example of such an electrostatic-plotted map is shown in Fig. 1. A print from the film recorder is shown in Fig. 2.
6. In order to determine representative computer costs for a defoliation assessment, the same procedure was followed for Centre County, and the computing costs were compared with those for the Perry County assessment. Since Centre County is split between UTM 17 and 18, essentially two assessments had to be done, and costs were almost double those for Perry County (Table 1). Nevertheless, these costs are negligible compared to the costs of preparing mosaicked data bases and the costs of analyst time and ground truthing.

A computer printout of the Interact session required to perform a county analysis is shown in Appendix C.

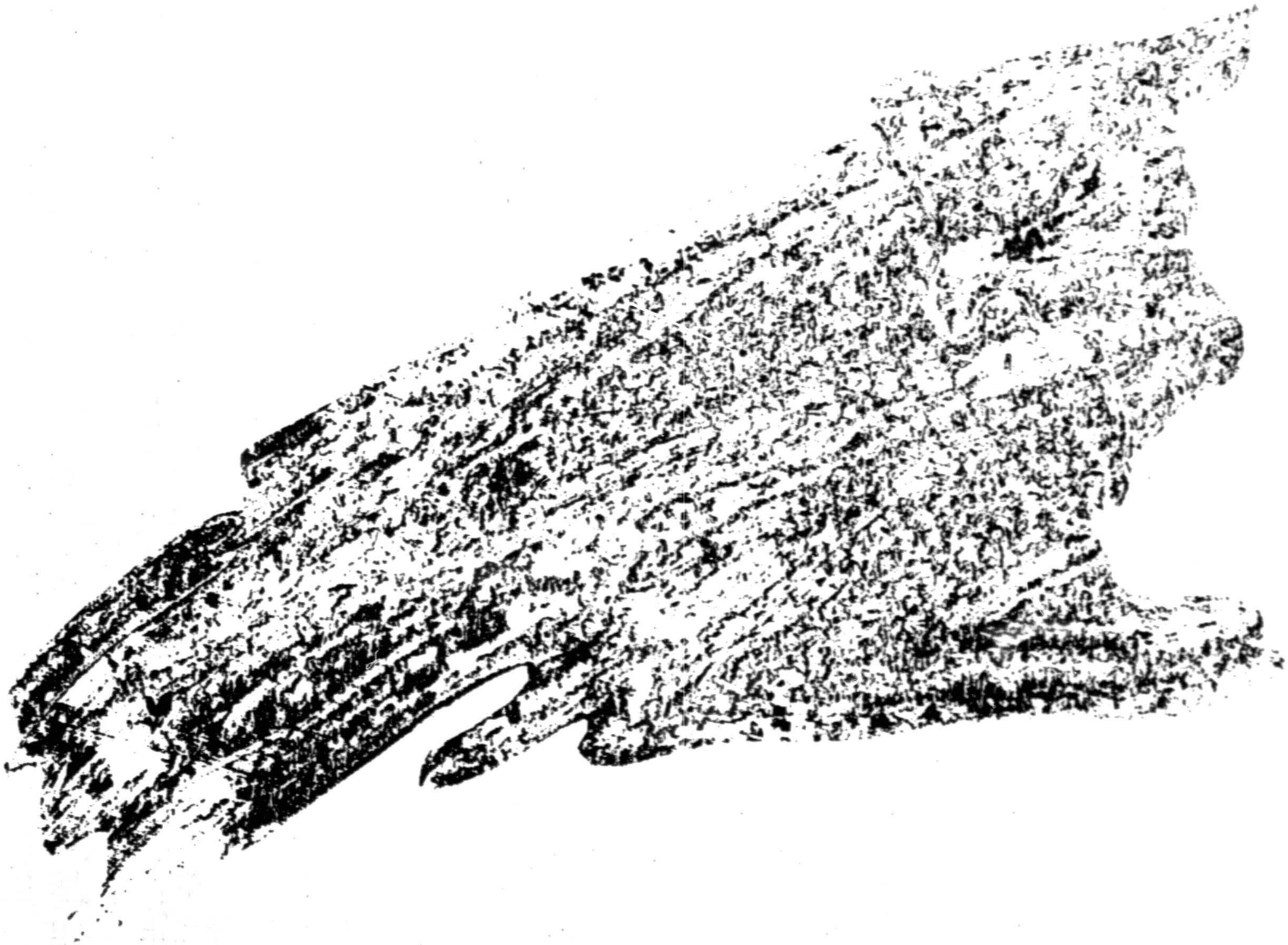

Figure 1. Electrostatically plotted map of 1981 gypsy moth defoliation in Perry County, Pennsylvania. Undefoliated forest is shown as white, defoliated forest as black, non-forest as grey.

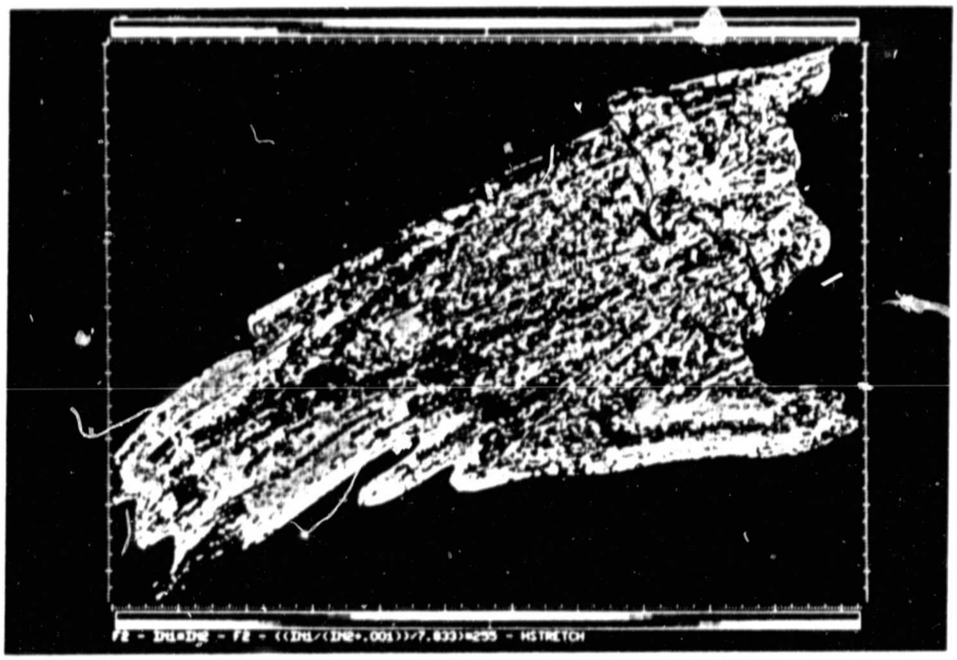

Figure 2. Film Recorder output of classification map of 1981 gypsy moth defoliation in Perry County, Pennsylvania. Undefoliated forest is shown as green, defoliated forest as yellow, non-forest as browns.

Table 1

COMPUTER COST FOR PROCESSING CENTRE COUNTY

(Totals for both halves)

	(CPU)	(Total Job Cost)
SUBDB	309 sec.	$ 9.18
VTRAN	14 sec.	.42
X-JOB	186 sec.	5.58
GENERATE TAPE	366 sec.	10.98
TERMINAL CONNECT TIME (Approx.)	60 min.	2.40
VERSATEC PRINT		19.00
		$47.56

COMPUTER COST FOR PROCESSING PERRY COUNTY

	(CPU)	(Total Job Cost)
SUBDB	159 sec.	$ 3.68
VTRAN	7 sec.	.49
X-JOB (ANALYSIS)	194 sec.	5.82
GENERATE TAPE	183 sec.	5.49
TERMINAL CONNECT TIME (Approx.)	30 sec.	1.20
VERSATEC PRINT (Approx.)		9.50
		$26.18

Note: CPU costs are calculated at the deferred rate.
VERSATEC costs are approximate due to variable size of the plot.
TAPE costs are for generating a film recorder tape.

F. Annual National Gypsy Moth Review Meeting

On 7 December 1982, ORSER personnel cooperated with GSFC and DFPM personnel in presenting an all-day workshop on "Monitoring Gypsy Moth Defoliation Using Landsat," at the Annual National Gypsy Moth Review Meeting in Harrisburg, Pennsylvania. This presentation represented the culmination of the NASA gypsy moth project, and was considered to be a final project review for all involved parties. The Perry County demonstration formed the nucleus of this technology transfer program. The two-projector presentation was well received by the several hundred participants in the meeting. (A copy of the meeting program and an outline of the presentation are shown in Appendix D.) In an informal evening session, the defoliation analysis procedure was demonstrated online, using several remote terminals connected by phone to the PSU Computation Center.

G. Training of Bureau of Forestry Personnel

Two persons from DFPM (Messrs. Quimby and Heilman) and two from the Division of Forest Advisory Services (Messrs. Hickok and Sterner) spent approximately two days being trained in the use of defoliation analysis system and discussing how the Bureau of Forestry could most efficiently use the procedure.

It was generally agreed that the best arrangement would be one whereby Bureau of Forestry personnel would monitor weather conditions and defoliation conditions on Landsat overpass days. If desirable conditions exist, ORSER would acquire the data sets, register them to the data base, and mosaic them (if more than one contiguous image/data set were acquired). The actual defoliation analysis will be carried out by DFPM personnel at ORSER (at least initially). Contractual arrangements will be made with the Bureau of Forestry for purchase of the analysis on a Landsat-scene basis, even though the actual analysis may be carried out in terms of other geographic units.

CONCLUSION

The additional tasks required under Modification No. 3 to NASA Contract NAS5-26468 have been completed as follows:

1. In consultation with personnel at JPL and GSFC, the Landsat-based information system has been integrated with the data-management front-end system developed earlier. ORSER now has in place the Landsat digital mosaic of Pennsylvania, the Landsat-derived forest resources map, digitized country and forest district boundaries, and the software to make these easily accessible.
2. With assistance from Mr. Ron McLeod of JPL, ORSER has acquired and implemented the VICAR software system and the additional modules required to perform mosaicking of Landsat scenes.
3. To ensure that the data base and the registration and mosaic software were operational, ORSER personnel created a digital mosaic of 1981 Landsat data for the eastern half of Pennsylvania and registered this mosaic to the Landsat-based information system.
4. ORSER demonstrated the capabilities of the data management front-end system and the data base by completing a Landsat-derived gypsy moth defoliation assessment for Centre and Perry Counties using 1981 data.
5. ORSER has trained two people from the Pennsylvania DFPM in the use of the data base and the data management front-end system for image analysis and defoliation assessments.

APPENDIX A: Mosaic Sequence

MOSAIC SEQUENCE

1. Reformat all bands of all frames to be used to VICAR format.
2. Log all tapes in project document.
3. Stretch and display all bands of all frames to be sure that all data are present and to inspect for problems (i.e., banding or missing data). If data problems exist, they should be corrected before proceeding.
4. Select and measure three control points for each frame. This involves six blowups for each frame, so that the control points can be measured accurately. Band 7 is usually used. Each control point, or tiepoint, is identified by a "from" line number, a "from" element number, a "to" line number, and a "to" element number; where "from" refers to the update frame and "to" refers to the data base. Also, each control point has the band 7 grey scale values of the pixel for both the update frame and the data base. At different steps in the processing, a correlation value may be associated with each control point as well as with a pair of residual values. The residual values are the differences between the "to" points and the predicted "to" values, as given by a regression model involving all points.
5. Allocate permanent disk data sets that will be used for storing control point information. This involves one data set for each frame and one data set for each pair of frames that overlap.
6. Allocate a temporary tiepoint file and a master tiepoint file that will be used for all tiepoints.
7. Run a VICAR procedure called PICREG2 for each frame, that will generate a set of control points for that frame given the three points from step 4. Auto correlation techniques are used. A grid is defined over the update frame that gives starting locations for the procedure to use in looking for the tiepoints.

8. Manually inspect the points generated in step 7 and delete those that are "unreliable." Unreliable points are those that have a too-low correlation value or have residuals that are vastly different from their neighbors. It was found that the point at which a correlation value would be declared "too-low" varied for each frame. A guess was made for each frame by looking at all of the correlation values along with their associated residuals and trying to pick a value for "too-low" that would eliminate all tiepoints with residuals that were "too-different" from their neighbors. Some points also had to be deleted that had high correlation points but also large residuals--this indicates that a good match was found but it was the wrong one.

9. Define a "cut file" for each frame. This "cut file" is a polygon along which each frame will be "trimmed" before being mosaicked in step 19. The "cut file" must lie in the area of overlap of adjacent scenes. Therefore, for scenes that are in the same path, there is not much choice; but for scenes in the same row, there is a relatively large choice of where the cut should be made. The "cut files" determine where the seams will be in the final mosaic.

10. Run a procedure called PICREG for each pair of frames that overlap. Input to this program is the "cut file" described in step 9 and the 2 frames. Output is a set of control points "between " the two frames. Again, auto correlation techniques are used.

11. Repeat step 8 for the points generated in step 10. (Here correlation values were found to be very high in frames that were in the same path and from the same day. Correlation values for frames in the same row are not as high. This is due partly to differences in overall brightness.)

12. Check the spatial "distribution" of the points obtained so far. It is important that all large areas have control points and that the distribution of points is somewhat uniform.

13. Check that all jobs run so far have run properly and that no errors were committed.

14. Compile all the tiepoints into IBIS format (using procedure PEN1) and repeat step 8 using all of the control points. As in steps 8 and 11, residuals and correlation values of all tiepoints must be inspected and decisions made as to whether the residuals are outliers and/or the correlations too low for the point to be acceptable.

15. Run procedure PENSET2 which transforms the edge-matching points from local line sample to the reference grid.

16. Run procedure PEN3 which subtracts user-supplied offsets from all of the "to" tiepoint values for each frame. This keeps the output data sets from the final step from being too large, with a large area of missing data in the upper and left areas. (Vicar files must start at 1,1.)

17. Once again, edit and review tiepoints and check for errors.

18. Use the PEN4 procedure to geometrically correct one band of each frame. The "cut-file" is used again here. All data outside of the cut file boundary are set to zero.

19. Use the FASTMOS program to mosaic the corrected frames into one dataset. The priority of overlay of scenes is determined by the order in which the corrected frames are given to the FASTMOS program.

20. Visually inspect for errors. This involves producing one small-scale Versatec print for both the new mosaic and the database. A light table is used to visually check the registration. Blow-ups of several areas can be made to provide a more accurate check. If problems exist and

they can be localized, those points can be checked and edited and the process redone from step 18. Once a satisfactory mosaic has been formed, steps 18 and 19 are run for the other bands.

21. The DBGEN program is run to reformat the data from VICAR format to the ORSER data base format. The data set is then ready for access by county, forest district, quad or user-defined area, through the ORSER SUBDB program.

APPENDIX B: Use of the ORSER/VICAR Execute File

USE OF THE ORSER/VICAR EXECUTE FILE

The following is a smaple session using the ORSER/VICAR execute file. Data are read from a Landsat tape in VICAR format, a uniform contrast stretch is performed on a subset of the data, text is added, and a border is put around the data set.

```
? ;  comment -- execute the orser exec file
? exec fro men.u41000.gmb.lib/orsergo on cat cle

    WELCOME TO THE ORSER SYSTEM

    HELLO --- THIS IS AN UPDATED VERSION OF THE ORSER
    EXECUTE FILE. PLEASE CALL 863-3532 IF YOU ENCOUNTER
    ANY PROBLEMS.    ENJOY!!

OK TO CLEAR ACTIVE FILE ? ok
ENTER PROGRAM NAME (OR HIT RETURN FOR MORE INFORMATION)
-->vicar

  WELCOME TO THE VICAR EXEC FILE


    THE VICAR MANUALS ARE AVAILABLE FOR YOUR
    USE IN THE ORSER LIBRARY.



ENTER THE DATA SET NAME FOR SAVING THE VTRAN STEM (OR HIT RETURN
FOR A DEFAULT OF MEN.P39100.FCL.VTRAN)
-->MEN.P39100.FCL.v.testl


ENTER THE OUTPUT DATA SET NAME FOR THE VTRAN JOB (OR HIT RETURN
FOR A DEFAULT OF MEN.P39100.FCL.XJOB)
-->MEN.P39100.FCL.x.testl


  ENTER THE VICAR CONTROL CARDS (TYPE 'END' WHEN FINISHED)

--> tape,*,vic004,a,6

-->note,vic004 is a landsat tape that covers central pa.

-->note,reserve temporary disk space

-->reserve,3,(500,10000),500,*,(b,c,d)

-->note,create space for the final output image data set

-->save,1,(600,18000),700,vol005,men.u41000.pub.testl.data,e

-->exec,sar,(*a/02),b,(300,500,500,500)

-->note, the above exec statement copies 500 lines and elements

-->note, from the second file of'A'which is the vic004 tape

-->note, now the data will be stretched, text added, and the

-->note, border put on.
```

```
-->exec,astrtch2,b,c,,smooth

-->exec,textad,c,d,,par

-->p,par

-->    backgrnd,255

-->    large,black

-->    text,250,250,'hawk run  pa,'

-->exec,mask76,d,e

-->end


ENTER THE JOB CATEGORY (CR=CAT 1)
-->

ENTER THE JOB SERVICE (N=NORMAL,E=EXPEDITE,D=DEFER;CR=DEFER)
-->

OK TO SUBMIT VTRAN JOB (CR=NO)? ok
JOB 0509 MN1FCL75 AW JCL CONVERSION
V.TEST1 SAVED ON VOL005

THE JOB STEM IS IN YOUR FILE CALLED 'ACTIVE'. THE FIRST JOB STEM HAS
BEEN SAVED AS 'V.TEST1'. TYPE 'EXEC' WHEN NOTIFIED THAT THE VTRAN JOB
IS FINISHED. THE SECOND JOB STEM WILL BE COLLECTED IN YOUR FILE 'ACTIVE'.

   -> EXE PAUSE
? list ; the active file
        //MN1XXXXX JOB
        /*JP V=D
        //VICAR  PROC CLASS=B,DISP=OLD,PRGM=VTRAN
        //TTM EXEC PGM=TTMSA,PARM='#<EVIL2>'
        //STEPLIB  DD DSN=MEN.P92250.PUB.IPL1.SDSRUN,DISP=SHR
        //SYSPRINT DD SYSOUT=A
        //SYSPUNCH DD DSN=&EVILTMP,UNIT=SYSDA,SPACE=(80,(500,100)),
        // DISP=(NEW,PASS),DCB=(RECFM=FBS,LRECL=80,BLKSIZE=6400)
        //SYSLIB DD DSN=MEN.P92250.PUB.IPL1.TTMLIB,DISP=SHR
        //VTR  EXEC PGM=&PRGM,PARM='CLASS=&CLASS,&DISP'
        //STEPLIB  DD DSN=MEN.P92250.PUB.IPL1.SDSRUN,DISP=SHR
        //FT01F001 DD UNIT=SYSDA,SPACE=(2880,(12,6)),
        // DCB=(RECFM=FB,LRECL=72,BLKSIZE=2880)
        //FT02F001 DD UNIT=SYSDA,SPACE=(72,500),DCB=OPTCD=C
        //FT03F001 DD UNIT=SYSDA,DSN=&VICSORCE,SPACE=(80,(500,100)),
        // DCB=(RECFM=FBS,LRECL=80,BLKSIZE=6400),DISP=(NEW,PASS)
        //FT05F001 DD DSN=&EVILTMP,DISP=(OLD,DELETE)
        //FT06F001 DD SYSOUT=A
        //FT08F001 DD DUMMY
        //FT10F001 DD DUMMY
        //FT10F002 DD DUMMY
        //FT10F003 DD DUMMY
        //SUBMIT EXEC PGM=IEBGENER,COND=(0,LT,VTR)
        //SYSPRINT DD DUMMY
        //SYSUT1 DD DSN=&VICSORCE,DISP=(OLD,DELETE)
        //    DD   DSN=MEN.P92250.PUB.IPL1.PROCLIB(SLSHASTR),DISP=SHR
        //SYSUT2 DD UNIT=DISK,VOL=REF=MEN.P39100.FCL.LIB,
        // DSN=MEN.P39100.FCL.X.TEST1,DISP=(NEW,KEEP),SPACE=(TRK,(1,1),RLSE)
        //SYSIN DD DUMMY
```

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```
 30.      //  PEND
 31.      // EXEC VICAR
 32.      TAPE,*,VIC004,A,6
 33.      NOTE,VIC004 IA A LANDSAT TAPE THAT COVERS CENTRAL PA.
 34.      NOTE,RESERVE TEMPORARY DISK SPACE
 35.      RESERVE,3,(500,10000),500,*,(B,C,D)
 36.      NOTE,CREATE SPACE FOR THE FINAL OUTPUT IMAGE DATA SET
 37.      SAVE,1,(600,18000),700,VOL005,MEN.U41000.PUB.TEST1.DATA,E
 38.      EXEC,SAR,(*A/02),B,(300,500,500,500)
 39.      NOTE, THE ABOVE EXEC STATEMENT COPIES 500 LINES AND ELEMENTS
 40.      NOTE, FROM THE SECOND FILE OF 'A' WHICH IS THE VIC004 TAPE
 41.      NOTE, NOW THE DATA WILL BE STRETCHED, TEXT ADDED, AND THE
 42.      NOTE, BORDER PUT ON.
 43.      EXEC,ASTRTCH2,B,C,,SMOOTH
 44.      EXEC,TEXTAD,C,D,,PAR
 45.      P,PAR
 46.         LARGE,BLACK,BACKGRD,255
 47.         TEXT,250,250,'--- HAWK RUN, PA.'
 48.      EXEC,MASK76,D,E
 49.      END
 50.      /*
 51.      // EXEC PGM=UMSG,PARM=(INTERACT,'TO FCL VTRAN JOB FINISHED')
FROM OPR (OPERATOR): (MN1FCL75) VTRAN JOB FINISHED

? exe

READY FOR THE X-JOB

   17.     //VSYS01 DD LABEL=(,BLP),DISP=(OLD,KEEP),UNIT=TAPE,


DO YOU NEED TO ADD A TAPE CARD (YES/NO;CR=NO)? yes
ENTER TAPE NAME -->vic004
READ OR WRITE (R/W)? r
DO YOU NEED ANOTHER TAPE CARD (YES/NO;CR=NO)?

ENTER THE JOB CATEGORY (CR=CAT 1).
-->

ENTER THE JOB SERVICE (N=NORMAL,E=EXPEDITE,D=DEFER;CR=DEFER)
-->

  OK TO SUBMIT VTRAN JOB (CR=NO)? ok
  JOB 0529 MN1FCL76 IN JCL CONVERSION

  YOUR FILE 'ACTIVE' NOW CONTAINS THE SECOND JOB STEM.
  THE 'X-JOB' STEM WILL BE SAVED AS 'X.TEST1.'

  X.TEST1 REPLACED ON VOL005

  END OF VICAR EXEC FILE

? list; the active file
    1.      //MN1XXXXX  JOB  MSGLEVEL=(1,1)
    2.      /*TAPE VIC004,R
    3.      /*JP V=DEFER
    4.      /*JP FULLSKIPS
    5.      //JOBLIB  DD  DSN=MEN.P92250.PUB.ORLIB,DISP=SHR
    6.      //        DD  DSN=MEN.P92250.PUB.IPL1.JPLMODS,DISP=SHR
    7.      //        DD  DSN=MEN.P92250.PUB.IPL1.SDSRUN,DISP=SHR
    8.      //STEP1    EXEC PGM=VMAST
    9.      //MSP  DD  DUMMY             ,DISP=SHR
   10.      //SYSOUT DD SYSOUT=A,DCB=BLKSIZE=141
```

```
//FT06F001  DD  SYSOUT=A
//FT07F001 DD SYSOUT=B
//VIDEOPDA DD DUMMY       ,DISP=SHR
//VHISTORY DD DSN=MEN.P92250.PUB.IPL1.VHISTORY,DISP=SHR
//VSYS00 DD VOL=SER=VOL005,UNIT=DISK,SPACE=(TRK,2),
//  DCB=(RECFM=U,LRECL=7200,BLKSIZE=7200,OPTCD=C),
//  DISP=(NEW,PASS),DSN=&&TEMP
//VSYS01 DD LABEL=(,BLP),DISP=(OLD,KEEP),UNIT=TAPE,
//              VOL=SER=VIC004,
//              DCB=(BLKSIZE=00000,LRECL=00000,DEN=3)
//VSYS02 DD DCB=(BLKSIZE=10000,LRECL=00500),DSN=&&B,
// SPACE=(10000,(00025,00006)),SEP=VSYS00,UNIT=SYSDA
//VSYS03 DD DCB=(BLKSIZE=10000,LRECL=00500),DSN=&&C,
// SPACE=(10000,(00025,00006)),SEP=VSYS02,UNIT=SYSDA
//VSYS04 DD DCB=(BLKSIZE=10000,LRECL=00500),DSN=&&D,
// SPACE=(10000,(00025,00006)),SEP=VSYS03,UNIT=SYSDA
//VSYS05 DD UNIT=SYSDA,DISP=(NEW,KEEP),
// DSN=MEN.U41000.PUB.TEST1.DATA,
// VOL=SER=VOL005,
// DCB=(BLKSIZE=18000,LRECL=00600),
// SPACE=(18000,(00024,00005))
//SYSIN  DD    *,DCB=(BLKSIZE=80)
                           *********************
                           *                   *
     MN1FCL8X              * VICAR VERSION 6-3 *        STEP 1
                           *                   *
                           *********************
TAPE,*,VIC004,A,6
NOTE,VIC004 IA A LANDSAT TAPE THAT COVERS CENTRAL PA.
NOTE,RESERVE TEMPORARY DISK SPACE
RESERVE,3,(500,10000),500,*,(B,C,D)
NOTE,CREATE SPACE FOR THE FINAL OUTPUT IMAGE DATA SET
SAVE,1,(600,18000),700,VOL005,MEN.U41000.PUB.TEST1.DATA,E
EXEC,SAR,(*A/02),B,(300,500,500,500)
NOTE, THE ABOVE EXEC STATEMENT COPIES 500 LINES AND ELEMENTS
NOTE, FROM THE SECOND FILE OF 'A' WHICH IS THE VIC004 TAPE
NOTE, NOW THE DATA WILL BE STRETCHED, TEXT ADDED, AND THE
NOTE, BORDER PUT ON.
EXEC,ASTRTCH2,B,C,,SMOOTH
EXEC,TEXTAD,C,D,,PAR
EXEC,MASK76,D,E
END
P,     PAR
   LARGE,BLACK,BACKGRD,255
   TEXT,250,250,'--- HAWK RUN, PA.'
 VIC004 IA A LANDSAT TAPE THAT COVERS CENTRAL PA.
 RESERVE TEMPORARY DISK SPACE
 CREATE SPACE FOR THE FINAL OUTPUT IMAGE DATA SET
                   A FILE  2                  1
  1 SAR      MN1FCL8X  300  500  500  500  1 0 0 0 0 0 0 0 0 0 2 0 0 0

  THE ABOVE EXEC STATEMENT COPIES 500 LINES AND ELEMENTS
  FROM THE SECOND FILE OF 'A' WHICH IS THE VIC004 TAPE
  NOW THE DATA WILL BE STRETCHED, TEXT ADDED, AND THE
  BORDER PUT ON.
  2 ASTRTCH2 MN1FCL8X    1    1    0    0  2 0 0 0 0 0 0 0 0 0 3 0 0 0
   SMOOTH

  3 TEXTAD   MN1FCL8X    1    1    0    0  3 0 0 0 0 0 0 0 0 0 4 0 0 0
   LARGE,BLACK,BACKGRD,255
   TEXT,250,250,'--- HAWK RUN, PA.'

  4 MASK76   MN1FCL8X    1    1    0    0  4 0 0 0 0 0 0 0 0 0 5 0 0 0
```

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```
   74.
   75.      /*
   76.      /*
   77.      // EXEC PGM=UMSG,PARM=(INTERACT,'TO FCL X-JOB FINISHED')
   78.      /*EOF

? locate
JOB 0529 MN1FCL76 EXEC
JOB 0509 MN1FCL75 AW FETCH
? locate
JOB 0529 MN1FCL76 EXEC
JOB 0509 MN1FCL75 AW FETCH
? ###

FROM OPR (OPERATOR): (MN1FCL76) X-JOB FINISHED


? ; comment -- look at the output; check to see if it ran correctly
? fet * fil o !l unn fil o
   95.     - LAST LINE.

                                    *********************                    N
                                    *                   *                    N
           MN1FCL7X                 * VICAR VERSION 6-3 *        STEP 1      N
                                    *                   *                    N
                                    *********************                    N
       TAPE,*,VIC004,A,6                                                     N
       NOTE,VIC004 IS A LANDSAT TAPE THAT COVERS CENTRAL PA.                 N
       NOTE,RESERVE TEMPORARY DISK SPACE                                     N
       RESERVE,3,(500,10000),500,*,(B,C,D)                                   N
       NOTE,CREATE SPACE FOR THE FINAL OUTPUT IMAGE DATA SET                 N
       SAVE,1,(600,18000),700,VOL005,MEN.U41000.PUB.TEST1.DATA,E             N
       EXEC,SAR,(*A/02),B,(300,500,500,500)                                  N
       NOTE, THE ABOVE EXEC STATEMENT COPIES 500 LINES AND ELEMENTS          N
       NOTE, FROM THE SECOND FILE OF A WHICH IS THE VIC004 TAPE              N
       NOTE, NOW THE DATA WILL BE STRETCHED, TEXT ADDED, AND THE             N
       NOTE, BORDER PUT ON.                                                  N
       EXEC,ASTRTCH2,B,C,,SMOOTH                                             N
       EXEC,TEXTAD,C,D,,PAR                                                  N
       EXEC,MASK76,D,E                                                       N
       END                                                                   N
       P,     PAR                                                            N
          BACKGRND,255                                                       N
          LARGE,BLACK                                                        N
          TEXT,250,250,'HAWK RUN   PA '                                      N
        VIC004 IS A LANDSAT TAPE THAT COVERS CENTRAL PA.                     N
        RESERVE TEMPORARY DISK SPACE                                         N
        CREATE SPACE FOR THE FINAL OUTPUT IMAGE DATA SET                     N
                         A FILE  2                 1                         F
004042   1 SAR      MN1FCL7X  300  500  500  500  1 0 0 0 0 0 0 0 0 0 2 0 0 0 T
INPUT    NL=    2983 NS=    3596
22381-15090  30JUL1981  S.C./ALTOONA                              EC
PATH 17 - ROW 32  BAND 7  *IR2*  LANDSAT - 2                      EL
OUTPUT  SL=     300 SS=     500 NL=     500 NS=     500
LABELS SAME AS INPUT
        THE ABOVE EXEC STATEMENT COPIES 500 LINES AND ELEMENTS               N
        FROM THE SECOND FILE OF A WHICH IS THE VIC004 TAPE                   N
        NOW THE DATA WILL BE STRETCHED, TEXT ADDED, AND THE                  N
        BORDER PUT ON.                                                       N
004231   2 ASTRTCH2 MN1FCL7X    1    1    0    0  2 0 0 0 0 0 0 0 0 0 3 0 0 0 T
INPUT    NL=     500 NS=     500
          SMOOTH                                                             P
```

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```
22381-15090  30JUL1981  S.C./ALTOONA                                        EC
PATH 17 - ROW 32  BAND 7  *IR2*  LANDSAT - 2                                EL
OUTPUT  SL=        1 SS=        1 NL=       500 NS=      500
LABELS SAME AS INPUT
BEFORE EXCLUSION . . .
MEAN  =  .6261E  2
SIGMA =  .1328E  2
AFTER EXCLUSION . . .
MEAN  =  .6261E  2
SIGMA =  .1328E  2

 T R A N S F O R M A T I O N
IN         0        1        2        3        4        5        6        7        8
OUT      0.0      0.0      0.0      0.0      1.0      1.0      1.0      1.0      1.0     1
IN        15       16       17       18       19       20       21       22       23
OUT      1.0      1.0      1.0      1.0      1.0      2.0      2.0      2.0      3.0     3
IN        30       31       32       33       34       35       36       37       38
OUT      6.0      9.0      9.0     10.0     12.0     13.0     14.0     16.0     17.0    19
IN        45       46       47       48       49       50       51       52       53
OUT     30.0     32.0     35.0     37.0     40.0     41.0     46.0     48.0     54.0    57
IN        60       61       62       63       64       65       66       67       68
OUT     93.0     96.0    111.0    115.0    124.0    135.0    141.0    155.0    156.0   173
IN        75       76       77       78       79       80       81       82       83
OUT    219.0    230.0    231.0    237.0    240.0    242.0    247.0    248.0    251.0   251
IN       255
OUT    255.0
*** RAMP CDF TABLE STRETCH GENERATED.
*** INPUT TRANSFER TABLE MODE
*** STRETCH RUN COMPLETED
004237   3 TEXTAD   MN1FCL7X    1    1    0    0 3 0 0 0 0 0 0 0 0 0 4 0 0 0 T
INPUT   NL=     500 NS=      500
          BACKGRND,255                                                          P
22381-15090  30JUL1981  S.C./ALTOONA                                        EC
PATH 17 - ROW 32  BAND 7  *IR2*  LANDSAT - 2                                EC
 RAMP CDF STRETCH                                                           HL
OUTPUT  SL=        1 SS=        1 NL=       500 NS=      500
LABELS SAME AS INPUT
          LARGE,BLACK                                                           P
          TEXT,250,250,'HAWK RUN  PA.'                                          P

*** TEXTAD END
004242   4 MASK76   MN1FCL7X    1    1    0    0 4 0 0 0 0 0 0 0 0 0 5 0 0 0 T
INPUT   NL=     500 NS=      500
22381-15090  30JUL1981  S.C./ALTOONA                                        EC
PATH 17 - ROW 32  BAND 7  *IR2*  LANDSAT - 2                                EC
 RAMP CDF STRETCH - TEXTAD                                                  HL
OUTPUT  SL=        1 SS=        1 NL=       500 NS=      500
LABELS SAME AS INPUT
** NO ACCOUNTING DATA WAS AVAILABLE
**       661 OUTPUT LINES -       524 ELEMENTS PER LINE - OUTPUT TO DISK
004246 VICAR RETURNING TO SYSTEM

ACTIVE TAPE    FILES PROCESSED
   VIC004      002
? ; comment -- note that the final output was 661 lines by 524 elements
```

APPENDIX C: National Gypsy Moth Review Meeting Program and Outline of Presentation

NATIONAL GYPSY MOTH REVIEW AND NASA WORKSHOP ON MONITORING GYPSY MOTH DEFOLIATION

December 7-9, 1982
Host Inn, Harrisburg, Pennsylvania

Tuesday, December 7

8:00 a.m. - 10:00 a.m.	Registration
8:30 a.m. - 9:30 a.m.	Boardroom - National Gypsy Moth Management Board Business Meeting - Don Kludy, Chairman
10:00 a.m.	Ballroom - Welcome - Don Kludy, Chairman, NGMMB

NASA WORKSHOP
MONITORING GYPSY MOTH DEFOLIATION USING LANDSAT

A Technology Transfer Program Presented by NASA-Goddard Space Flight Center in Cooperation with the Pennsylvania Bureau of Forestry and The Pennsylvania State University.

<u>Program Moderator</u> - Ross Nelson - NASA

10:05 a.m.	Introduction	.Mike Calabrese, Program Manager, Renewable Resources Branch, NASA Hdq. Washington
10:15 a.m.	Historical Perspective	.John Quimby, PA Bureau of Forestry
	<u>Systems Overview</u>	
10:45 a.m.	-The Landsat System: Multispectral Scanner Data.	.Darrel Williams, NASA
11:30 a.m.	LUNCH	
1:00 p.m.	-Basic Classification Procedure: The Ratio Vegetation Index.	.Ross Nelson, NASA
1:25 p.m.	-Pennsylvania Data Base.	.Brian Turner, PA State University
1:45 p.m.	Analysis and Evaluation.	.George Baumer, PA State University
2:30 p.m.	BREAK	
2:45 p.m.	Accuracy of Digital Products	.Mark Stauffer, Computer Science Corp.
3:15 p.m.	Data Products: Users & Costs.	.John Quimby, PA Bureau of Forestry & Darrel Williams, NASA
3:40 p.m.	Summary and Conclusions.	.Ross Nelson, NASA
4:10 p.m.	Interactive Terminal Display/Demo.	.All Participants
5:00 p.m.	Adjourn for the Day	

OUTLINE
Gypsy Moth Review Board Workshop
December 7, 1982

I. Introduction

A. Purposes of meeting: report on the development and use of an automated defoliation assessment system which uses satellite data to detect forest canopy disturbance.

B. System overview:
1. Speed and capacity of the computer, and the synoptic coverage afforded by the satellite data provide a means to monitor gypsy moth defoliation on a yearly basis.
2. Historical records are maintained in a magnetic tape archive, data storage and retrieval capabilities enhanced.

C. Workshop will report on how the computerized forest assessment system is used to produce results of interest to the field forester or entomologist. Workshop agenda to accomplish this objective.
1. Historical perspective: pre-satellite data collection and storage.
2. Automated Defoliation Assessment System components
   - The Landsat multispectral scanner (MSS) satellite system.
   - The classification procedure used to locate defoliated forest.
   - The data base used to maintain satellite data and thematic information.
3. Using the Automated Defoliation Assessment System. The Penn State front-end system.
4. Assessing the accuracy of the data products
5. Using the data products
6. Summary, Discussion.

II. Historical Perspective: pre-Landsat defoliation assessment

A. Purpose of damage assessment
1. Locate candidate areas for protection (spray)
2. Locate areas of extensive mortality, salvage operations.

B. Current approach to statewide damage assessment - aerial sketchmapping over forested areas.
1. Pilot, 2 observers - light, wing-over aircraft such as a Cessna 172.
2. Observers have 7-1/2' topo maps upon which they sketch damage on either side of the plane. Each observer responsible for 1 mile swath on one side of plane. Pilot flies parallel flightlines 2 miles apart.
3. Aerial coverage: 1970-1979: 100% of forested area of state; 1980-1981: approximately 50% of forested areas sketchmapped.

C. Sketchmapping results forwarded to county to help pinpoint problem areas for following years programs. Information also entered into Division of Forest Pest Managements' Forest Pest Locator Grid (FPLG). FPLG maintains historical records of defoliated areas - latitude longitude grid system.

D. Aerial sketchmapping considerations
   1. Time necessary to fly all or a portion of forests in state
   2. Cost per acre
   3. Accuracy of product. Aerial sketchmaps subject to gross positional inaccuracies inherent in approach, and defoliated assessment is observer-dependent.

E. Application of satellite technology seems appropriate to overcome aerial sketchmapping problems. To this end, the Automated Defoliation Assessment System was developed.

III. The Automated Defoliation Assessment System

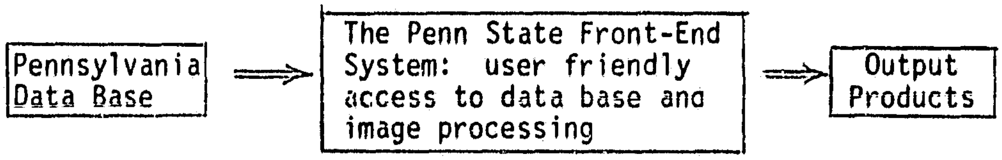
A. The Landsat multispectral scanner (MSS)
   1. Obtains digital data in four wavelength bands
      green band, 0.5 - 0.6 μm
      red band, 0.6 - 0.7 μm
      first near infrared 0.7 - 0.8 μm
      second near infrared 0.8 - 1.1 μm
   2. Reflectance in the four wavelength bands measured over contiguous 57 meter square picture elements-pixels.
   3. - 7.5 million pixels/Landsat scene
      - 4 brightness measurements/pixel; 0 - dark in the given wavelength, no detectable light, 128 - scanner saturation, very bright in the given wavelength.
      - data from one Landsat MSS scene collected in 25 seconds.
   4. Different covertypes have different spectral responses:
      - vegetation typically lower in red wavelengths due to chlorophyll absorption, and high in near infrared.
      - soil higher than vegetation in visible, lower in infrared
      - water low in visible, lower in infrared.
   5. Can use these spectral relationships for land cover identification using computer-aided analysis techniques.

B. Classification procedure to delineate gypsy moth defoliation
   1. Defoliated forest is spectrally similar to certain non-forested agricultural areas. Remove this source of confusion by using a forest/non-forest mask. All non-forest data zeroed out, not considered in subsequent classification steps.
      a. Use healthy Landsat data set to construct forest/non-forest mask.
      b. apply mask to defoliated data set.
   2. Use relationship of red wavelength to near infrared wavelength to determine which forested areas have been defoliated.

3. Reductions in forest canopy cover result in decrease in band 7 (near infrared) response, increase in the band 5 (red) response. Hence a reduction in canopy density result in smaller 7/5 ratio.
4. "Slice" the 7/5 response into defoliation cateogires:
   healthy forest   0-30% canopy removed
   moderate defoliation   30-60% canopy removed
   heavy defoliation   60-100% canopy removed
5. Principles above form basis for analysis procedures used in conjunction with the statewide data base.

C. The Pennsylvania Digital Data Base: Layers of digital information. All layers registered to UTM grid.
   1. Digital layers
      2nd date - 1981 - Landsat data
      1st date - 1976 - 1979 - Landsat data
      forest district boundaries
      county boundaries
   2. Data base maintained on Penn State University computer-magnetic tape - Computer is IBM 3033.

D. Use of the data base



Subsequent sections detail the use of the PSU Front-End System and report on the accuracy and uses of the data products.

IV. The Penn State Front-End System
Interacting with the Landsat data base to manufacture products useful to natural resource personnel.

A. The Front-End System is a complex computer command file (i.e., clist, exec, macro) which allows the user to specify the area of interest and the type of image processing needed.
   1. Front-End asks user questions concerning area of interest, processing requirements, output product format.
   2. When queries are satisfied, Front-End produces a job stem which is submitted to the main frame for execution.
   3. User friendly system, if user does not understand question or is not sure of choice of answers to a question, he may request help. Front-End will explain question more fully and direct user to additional sources of information.

B. Areas accessed through the Front-End
   1. County (by name)
   2. Forest District (by number)
   3. 7-1/2 minute topographic map (by name)
   4. User chosen data base subsection in terms of lines and columns of data.

C. Interaction of user with the computer to produce information for regions of interest. Best method of explaining analysis sequence is actual example. Perry County classification demonstration.
   1. Workshop packet: example of interactive session, produce results for Perry County.
   2. Output products supplied: versatec (grey scale) map output, tabular summaries.

D. Analysis sequence is a series of steps:
   1. Select area of interest (in this case Perry County). Submit job to copy area to another tape. Result: Masked Landsat data copied to tape. Will have Landsat data (4 bands) in county area, zeros - no data - in non-county area.
   2. Mask non-forest areas within county using forest/non-forest mask.
   3. Generate 7/5 ratio image
   4. Density slice 7/5 response to delineate healthy forest, moderate defoliation, and heavy defoliation.
   5. Generate output products
      a. Tabular summaries
      b. graphics, versatec maps

E. Capability must exist to add layers to data base. Software is in place to update data base with most current Landsat MSS data. Data base additions may be transparent to user, PSU personnel maintain data base.

V. Accuracy of the Digital Products

A. Types of error considered
   1. Classification error: how closely do Landsat product(s) and actual conditions on ground agree.
      a. forest vs. non-forest
      b. healthy vs. defoliated forest
   2. Positional error: displacement of pixels relative to the UTM map projection. Data base layers do not exactly lay atop one another.

B. Accuracy of the forest/non-forest mask - statewide

		Landsat	
		Forest	Nonforest
Airphoto-interpretation	Forest	94%	6%
	Nonforest	20%	80%

Overall Accuracy (per pixel): 90%

NOTE: Accuracies reflect use of nonborder test pixels in ground reference data.

C. Accuracy of delineating defoliated forest from relatively healthy forest. Comparison of Landsat results and aerial skethmapping to airphotointerpretation (ground reference) information, Doubling Gap, Pennsylvania.

		Landsat		Aerial Sketchmapping	
		Heavy	Healthy-Mod	Heavy	Healthy-Mod
Airphoto interpetation	Heavy Def.	77.94	22.1	91.43	8.6
	Healthy-Mod	22.48	77.5	43.46	56.6
		Average Acc.	77.7	Average Acc.	74.0
		Overall Acc.	77.7	Overall Acc.	70.1

Neither approach (Landsat analysis nor aerial sketchmapping) accurately delineates healthy forest from moderate defoliation. Both cover types spectrally very similar, reliable separation extremely difficult spectrally.

D. Positional Inaccuracies: Misregistration errors

UTM Zone	Quad	Avg. Misregistration Error Line	Avg. Misregistration Error Column	Worst Case Line	Worst Case Column
17	1	0.65	0.67	1.7	1.3
	2	0.46	0.89	1.2	2.3
	3	0.92	1.64	2.1	2.7
	4	0.86	3.16	2.5	10.6
18	5	1.08	1.13	3.2	4.7
	6	1.23	3.26	6.0	9.8
	7	0.65	0.63	2.7	1.6
	8	0.97	1.40	3.6	7.2

E. Constraints on use of data due to accuracy figures cited above.
   1. If healthy forest, moderate defoliation, and heavy defoliation cover types identified, healthy-moderate confusion will be high, reliability of these cover types low.
   2. Registration problem forces user to consider larger cell block sizes to overcome inability to exactly locate oneself on ground.

VI. Data Products: Use and Cost

A. Results of Landsat data analysis essentially replace aerial sketchmapping as remote sensing tool.

B. Division of Forest Pest Management uses results to update their Forest Pest Locator Grid - historical data, tabular format, registered to Latitude Longitude grid.

C. Results of Landsat data analysis will be supplied to the counties in lieu of aerial sketchmapping products.

D. Use results to more accurately delineate areas of mortality - salvage operations.

E. Data base not limited to forest uses. Additional layers of information may be added.
   1. Thematic Data:
      a. Watershed boundaries
      b. Additional political boundaries such as land ownership.
      c. Land cover identities, such as USGS 1:250,000 land cover maps of Pennsylvania.
   2. Additional digital data sources
      a. Thematic Mapper data - degraded to a 57 meter cell.
      b. Topographic data, DEM or DMA elevation tapes, calculate slope, aspect information.

F. Cost considerations - Any cost assessment is dependent on the situation of the prospective user. Best and worst case costs given; actual costs fall in between.
   1. Best Case: assumes all equipment, software, and personnel in place and readily available to user.
      a. Costs of assessing defoliation for Centre County - cost of running jobs via front end.
      b. Equivalent figures for Perry County.
   2. Worst Case: no equipment, software, and personnel available.
      a. Cost of computer (IBM 3081) $5 million. This computer is configured to service 55,000 users for research and education. Such a system for individual state needs is questionable. A mini computer for under $1 million is a very real possibility.
      b. Yearly maintenance and operating cost.
      c. VICAR software (leased for 10 years through cosmic): $2400.
      d. OCCULT (ORSER) software: $2180.
      e. Data base analyst, responsible for updating data base and handling software problems - $40,000.
      f. Possibility exists to set up state data base on PSU computer, charge, 3 x normal processing cost (S0.21/CPU second vs. $0.07/CPU sec normal).

G. Cost comparisons should be done with multiple-purpose outlook. Data base provides capability to assess current defoliation situation. Archival capability serves as a historical data base, uniform format. Various Department of Environmental Resource agencies may be interested in supporting such a data base since uses are not restricted to forest applications.

VII. Summary and Discussion

A. User friendly interactive system. Remote sensing background helpful but not manditory.

B. Cost effectiveness - compare costs involved with new and old methods of assessing gypsy moth damage.

C. Landsat analysis techniques more accurate when heavy defoliation delineated from other forest cover types.

D. Data base is dynamic, constant updates of current years MSS data. Thematic information may also be added. Address problems of cloud cover.

E. Landsat data availability - Landsat 4 MSS and TM provide continuity and an additional, potentially rewarding data source, respectively.

F. Registration problems may be rectified by remosaicking data using soley Landsat-4 MSS data, hence possibility exists to improve registration inaccuracies.