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National Resources Inventory August Progress Report

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Using Remote Sensing and GIS Techniques to Conduct the National Resources Inventory

Progress Report - August 1991

INTRODUCTION:

We are pleased to report that we have accomplished the major task of completing the National Resources Inventory (NRI) survey forms for the six counties used as sample sites. We are delivering all of the completed forms to the Indiana State SCS Office and only including several examples in this report for the other readers.

From a research perspective, this project had lots of opportunities and also some nightmares. We found it difficult to ignore the opportunities but were forced to do so in order to accomplish the deadline of the project. There are many possibilities for improving the NRI and we discuss some of them in this report. Some of these items will not be addressed in detail, but we would be ready to discuss them with anyone that is interested. We used many different sources of data and information in this work and have provided a section in the report to document the sources.

A Recommendations Section is included to assist others who are responsible for collecting NRI data, planning NRI research using remote sensing or geographic information systems (GIS) or who will want to use the NRI data in their work. We hope that people will seriously pursue the recommendations as the National Resource Inventory is one, if not, the best database of soil and water conservation that is available today.

We had a difficult time meeting the required deadlines of this Project. Much of this difficulty has to do with trying to accomplish the NRI survey on a large number of counties. In a research mode, it would have been better to attempt this work on a smaller number of counties. Accomplishing the repeatability of over 1300 Primary Sample Unit points left little time for creative research. We attempted to try a number of different approaches but must say that we were discouraged from doing this because of the "importance of meeting the contract deadlines". There are many research opportunities which we have listed in the Recommendations Section. Time constraints did not allow us to develop the ideas expressed but we would be happy to discuss with individuals who are interested in pursuing them. We included in Appendix I a description of the procedures used to update the NRI.

DATA INFORMATION AND SOURCES

In approaching the task of using remote sensing and GIS techniques for conducting the National Resources Inventory, we found that there are many different sources of data and information. We are aware that their are inherent errors in all data collected because of how it is obtained. If the data are measured with an instrument, one should assess the age, repeatability and calibration of the instrument. If the data are observations, one most consider if the standards and continuity were used by the individual(s) collecting the data. If the data is in a digital format, one should know if the data has been modified through calibration or rectification. If one obtains the data from a map, one should know the resolution of the data, the scale, the projection and the date the map was made. It is important that one can quantify or measure the amount of error from each data source.

In entering data or information on the NRI Survey Forms, we attempted to use many different data sets to arrive at the values which we measured, computed, interpreted, derived or estimated. A discussion of each of the data information and sources is provided so that one can understand their contribution to answers obtained.

Landsat Data

Landsat-TM data were used as a primary data sets we used for land cover and land use identification. Several reasons guided our decision on the use of Landsat-TM data (as oposed to other remote sensing systems): 1) the availability of digital data, ideal for computer-aided analysis and applications on a GIS environment; 2) the spectral coverage to the TM sensor, covering the visible, near-IR, middle-IR and thermal-IR portion of the spectrum; 3) the regional coverage of the system; and 4) the availabilty of several images over Indiana for the years of 1986 and 1987. Table 1 lists the images employed in this work.

Table 1. Landsat-TM imagery.

County	Acquisition Date	ID Number	Center Coordinates
Clay	July 17, 1986	5086815522X0	87° 05' W 39° 23' N
Delaware	June 13, 1988	5156515534X0	85° 44' W 40° 20' N
	August 16, 1988	5162915535X0	85° 44' W 40° 20' N
Elkhart	July 26, 1986	5087715450X0	85° 50' W 41° 36' N
Perry	July 26, 1986	5087715461X0	86° 40' W 38° 05' N
Pulaski	July 17, 1986	5086815513X0	86° 45' W 41° 05' N
Scott	June 27, 1987	5121315482X0	85° 45' W 38° 41' N

Aerial Photography

Another major source of data for land cover/land use identification were color and color-IR aerial photography. Table 2 shows the characteristics of this imagery. The aerial photography provided an excellent aid in the identification of land cover types because of its high spatial resolution, thus allowing us to identify features (such as urban areas, farmsteads, roads, etc.) that were very difficult to identify in the Landsat data.

Table 2. Aerial Photography.

County	Acquisition Date	Type	Scale
Clay	August, 1986 Summer 1987 & 1988	ASCS Color slides NAPP B/W[1]	1:90,000 approx. 1:40,000
Delaware	August 1986 August 1988 Summer 1987 & 1988 Summer 1987 & 1988	ASCS Color slides ASCS Color slides NAPP Color-IR NAPP B/W[1]	1:90,000 approx. 1:90,000 approx. 1:12,000 1:40,000
Elkhart	August 1986 Summer 1987 & 1988 Summer 1987 & 1988	ASCS Color slides NAPP Color-IR NAPP B/W[1]	1:90,000 approx. 1:12,000 1:40,000
Perry	August 1986 & 1987 Summer 1987 & 1988 Summer 1987 & 1988	ASCS Color slides[2] NAPP Color-IR NAPP B/W[1]	1:90,000 approx. 1:12,000 1:40,000
Pulaski	August 1986 Summer 1987 & 1988 Summer 1987 & 1988	ASCS Color slides NAPP Color-IR NAPP B/W[1]	1:90,000 approx. 1:12,000 1:40,000
Scott	August 1987 Summer 1987 & 1988 Summer 1987 & 1988	ASCS Color slides NAPP Color-IR NAPP B/W[1]	1:90,000 approx. 1:12,000 1:40,000

[1] Full stereoscopic coverage with black and white prints of color-IR transparencies.
[2] Color-IR for the 1987 slides.

Maps

The Indiana SCS office provided us with the PSU and sample point locations compiled on USGS 7 1/2 minute topographic maps for all counties. In addition, SCS staff also provided the PSU and sample point locations compiled on the soil survey maps for all six counties.

1982 NRI Data

The Indiana SCS office provided us paper originals of the 1982 NRI data. We received a computer file of the complete 1982 data for Delaware Co. only. This data file was of primary importance in the development of our 1987 databases, since many fields in the inventory (for both PSU's and sample points) remain constant between 1982 and 1987. For the other five counties we received (in a later date) a partial data set which was of limited use for our work, since one of the primary data fields (SCS-SOIL-5) was missing from this data set.

State Soil Survey Database

The Indiana SCS office provided us a computer file of the "State Soil Survey Database" for the six Counties. This databases was of primary importance in the development of our databases and models. We encountered some database inconsistencies in the State Soil Survey Database and the 1982 NRI database. The SCS staff was very helpful in correcting these problems and assisting us with many questions related to the Soils and NRI databases.

Irrigation Database

The Water Use Section of the Division of Water, Indiana Department of Natural Resources, provided us with the computer file containing the data on irrigation for the six counties. The data included among other fields, UTM coordinates of wells and water intakes, sources of water, capacity, etc.

Reach Files

We requested of EPA region V a copy of the newly created Reach-3 files. These data sets were to be delivered to us early in the project. Unfortunatelly, after an internal quality control check, EPA decided not to release these files.

Wetland Digital Data

The Indiana Department of Natural Resources has obtained maps from the Fish and Wildlife Service. These maps were digitized in a GIS format to run on ARC/INFO software. We requested a copy of these files but never received them to use with this effort. We assume that these data and information on wetlands will vary from those completed by SCS personnel during this past year.

ASCS Farm Records

The ASCS has entered their records on their cooperators into a computer format at the county level. We did not have the opportunity to test the use of their records related to land cover and conservation practices information. These records would need to be used in conjunction with the aerial photography and ASCS assistance. Permission to use the records would need to be obtained since this information is confidential.

CAMPS Database

We requested a copy of the CAMPS program and databases for the six counties. We received a copy of the CAMPS manual two weeks before the project deadline . Due to the content of the databases managed by the CAMPS program, we believe that it could be of major help in the develpment of the NRI sample.

SURVEY ANALYSIS PROCEDURES

Digitizing of Primary Sample Units and Sample Points

We have completed the digitization of the PSU and sample point locations for all six counties. For each county, we have created two separate data files containing the PSU and sample point data (the accompanying diskettes contain all 12 files). The data were digitized according to the "digitizing specifications" provided by SCS. Table 3 shows a summary of this digitization and provides important information for the data files.

Table 3. Characteristics of Primary Sample Units and Sample Points digitized files

County	# of PSU's	# of Points	UTM Coordinates Upper Left	Lower Right	Pixel size
Clay	60	180	x = 478,000 y = 4,385,000	x = 506,000 y = 4,334,500	28.5 x 28.5 m
Delaware	68	204	x = 620,000 y = 4,472,000	x = 653,000 y = 4,430,000	30.0 x 30.0 m
Elkhart	81	243	x = 577,000 y = 4,625,000	614,990.5 y = 4585,014.5	28.5 x 28.5 m
Perry	66	198	x = 515,000 y = 4,273,500	x = 550,000 y = 4,185,000	28.5 x 28.5 m
Pulaski	72	216	x = 505,560 y = 4,558,110	x = 545,280 y = 4,528,111	28.5 x 28.5 m
Scott	49	147	x = 595,000 y = 4,300,000	x = 625,979.5 y = 4,268,023	28.5 x 28.5 m

Analysis of Landsat-TM Data and Color Aerial Photography

We were able to initiate the interpretation work for Delaware Co., early in the project because we decided to use two existing Landsat-TM frames, acquired during 1988 (June 13 and August 16). We used these images despite the fact that the NRI field work was performed in 1986. Two reasons justify our decision; 1) From previous experience, we know that it is not always possible to obtain satellite data for the desired time of the year, especially if the data are requested years after the acquisition date. 2) We wanted to test a procedure that used multitemporal Landsat data and ASCS slides obtained during 1986 and 1988.

After receiving five Landsat-TM images ordered from EOSAT, we performed a quality check on the data, and approved the images for Elkhart, Pulaski and Scott counties. For Clay County we found that the coordinates of the frame that was sent by EOSAT were incorrect. We were informed by EOSAT that all "movable scenes" have a coordinate shift of approximately 2-5 minutes, but the image that we originally ordered had a bigger shift. Upon EOSAT recommendation we ordered an alternate image that we have not yet received.

For the Perry Co. image, we were previously informed by EOSAT that the image that we selected originally fell within two orbital paths of the satellite. Thus they suggested an alternative image that had too many clouds over Perry Co. We have ordered an alternate image that we have not yet received.

We performed the geometric correction of the images for Elkhart, Pulaski and Perry Counties plus the two images from Delaware County. Each rectification was performed selecting up to 99 control points to guarant an adequate rectification. We used an RMS value of 0.25 (1/4 pixel) as another procedure that will provide accurate results.

In our initial methodology, we proposed the use of digital Landsat-TM and ASCS color slides to identify land cover conditions in each point of the PSU's. In early talks with Indiana SCS staff, they offered us the use of NAPP color-IR photographs at a scale of 1:12,000, for all counties except Clay Co.

Our first approach to identify the land cover conditions with Landsat data was to classify the imagery using a combination of supervised training fields and clustering algorithms. These classifications provided an indication of the spectral variability of the data. Because of this variability, we found that many spectral classes were not readily assigned to an informational classes and that the classification results had what is known in the remote sensing terminology as "salt & pepper" effect.

A more effective procedure, which provided highly accurate results was the photointerpretation method. In this case, the Landsat image was displayed on the computer monitor using the following channel combination: Red->TM4; Green->TM5; Blue->TM3. We overlaid the image with the PSU boundaries and the sample points. The land cover identification was then performed using a combination of Landsat-TM, ASCS slides and NAPP color-IR imagery.

This procedure was used for Delaware, Elkhart, Pulaski and Scott Counties. For Perry Co. we used ASCS slides and NAPP imagery, since the Landsat-TM image that we originally received had an excessive cloud cover and the EOSAT new image* was not available by the contract deadline. For Clay Co. we were forced to use ASCS slides only, since the Landsat image that we first received did not cover the entire county, the new image from EOSAT was not available by the contract deadline, and SCS did not have NAPP imagery for this county.

The combination of Landsat-TM, ASCS slides and NAPP imagery proved to be very effective to identify cover type conditions, due to the resulting synergism of the combined data set. The Landsat-TM provided wide spectral coverage in digital format; the ASCS slides provided medium resolution imagery and excellent time of acquisition; and the NAPP imagery provided high resolution photographs with adequate aerial photo standards.

In summary, we used four different procedures for the identification of land cover conditions:

1. Use of two 1988 Landsat-TM images and ASCS slides acquired in 1986 and 1988 (Delaware Co.).

2. Use of one 1986 image for Elkhart and Pulaski (1987 for Scott Co.) Landsat-TM images, ASCS color slides and NAPP imagery at scale 1:12,000.

3. Use of 1985, 1986 and 1987 ASCS color and color-IR slides (Perry Co.).

4. Use of 1986 ASCS slides (Clay Co.).

Cost Factors Relating to Using Satellite Data & GIS

The costs of Landsat data acquistion for Indiana are presented as Appendix B in the July Progress Report. We showed that the costs of total coverage of the State for Landsat Thematic Mapper data would be $44,100. We estimate that there are about 5520 PSUs in Indiana (60 PSUs x 92 counties). This would mean that it would cost about $8.00/PSU (or $2.66/PSU point) for satellite data. One has to add the costs of hardware ($25,000), software ($20,000) and training ($ 10,000 per individual) to acquire total cost of $17.95/PSU to use satellite data for measuring land cover changes.

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* Upon the identification of the problems with the Perry and Clay Co. imagery, we contacted EOSAT. They agreed to redo the Clay Co. image since it was a software problem from their part that created the shift of the area originally requested. The Perry Co. image is being reprocessed with an additional cost to the project, since we agree to change the initial request due to cloud cover problems.

We are assuming in the above analysis that the State Office would have a PSU team that would do the analysis for the entire state.

Database Development

The NRI databases are an extensive collection of information on the state of the natural resources of the country. From the research point of view, the NRI offers a complex and interesting opportunity to study various aspects about the status of soil and water resources. Our initial effort in this project was to develop a detailed design of the databases that we wanted to use to update the 1987 inventory. Of primary importance were the 1982 NRI data and the State Soils Survey Database (Soils-5). We identified and requested other databases that had potential for our work. Among them are: EPA's Reach-3 files which contains the information on rivers and streams; IDNR irrigation information which describe the location and characteristics of wells in the state; and IDNR wetlands digital maps.

We requested these databases for all six counties. We received the complete Soils Database from SCS and the irrigation data from IDNR. After an internal quality control verification, EPA decided not to release the Reach-3 files. We received a complete 1982 NRI data for Delaware Co. early in the project. This data allowed us to design and develop a complete database for this county. Three weeks before the deadline of the project we received <u>only part</u> of the 1982 NRI data for the other five counties.

Our design of the databases was guided toward more efficient access of the data, and a consistent data flow throughout the entire NRI. Before we could use the data provided by SCS and other agencies, we had to format the data in order to be loaded into our database. Since we decided to use databases produced and maintained by different agencies, we performed a careful verification of the quality of the input data. To have reliable linkages between the databases, we performed detailed data cross-checking for the fields used as keys in the linkages. This procedure consumed much time of one of our graduate students since she encountered many inconsistencies and quality problems within and between the databases. This was a very time consuming task and SCS should consider these problems in the future, in order to produce "reliable databases" that can be updated and used by SCS staff and others agencies.

To exemplify the capabilities of a GIS we developed an interactive visual query for the PSU's. With this procedure we can display a PSU map on the computer screen and request the data of a PSU by pointing to it on the computer screen. Because of the limited time imposed by the project deadline, we were not able to develop the same procedure for retrieving the point data, but have listed this in the recommendations.

RECOMMENDATIONS

The recommendations provided are based upon our observations, background and experience obtained during the course of our investigations and previous work with the National Resources Inventory. There are a number of ways that one can use remote sensing and GIS techniques for conducting the NRI Survey. One's own experience and awareness of the strengths and weakness of the data information and sources are very important in the use of these techniques. We thought it might be helpful to provide recommendations for conducting the survey followed by other recommendations for future research in improvement of the use of remote sensing and GIS techniques.

Conducting the NRI

- SCS should plan to use remote sensing technology in conducting future NRIs beyound 1992. Pilot States should be selected based upon experience in completing the 1987 NRI using these techniques.

- Geographic Information Systems have shown to be helpful tools to organize data and data sets. SCS should plan to use GIS in assisting to accomplish future NRIs.

- In using remote sensing, one should use data that were collected during the year (growing season) which you are trying to evaluate. However if the plans are to begin the survey one year prior to the mandatory year, then one should select remote sensing data when vegetation is near its maximum. This will provide the best time for discriminating the different land covers.

- In using satellite data, one should use digital techniques so that one can display the images at different scales, have the opportunity to perform a classification of the data, and check for variations in responses at different locations within the county. We tested several waveband combinations for display on the computer screen, the most effective was the following: Red->TM4; Green->TM5; Blue->TM3. The use of paper copies of satellite images is not recommended as one will have the same problems as with photographic products in terms of variability and limited scale.

- Order the satellite images at least 2-3 months prior to conducting the analysis. This will insure that you have good quality data that is cloud free over the PSU sites. Use microfiche of the images to evaluate the coverage of the scene.

- Obtain detailed training in the use of the software package selected for the analysis. We found that it was extremely helpful to have more than one person familiar with the software and the interpretations of images.

- For ASCS slides:
  + Request Kodak processing to insure that colors are properly duplicated.
  + Become familiar with the procedure that each county uses for marking slides on the black and white prints. The procedure varied slightly from county to county. Some counties label slides according to the slide tray in which they can be found or they label according to the slide roll number.
  + Arrange the selection of the slides by PSUs that follow in a north-south direction so they follow the flight lines. This will save time of pulling out black and white prints as well as the slides from boxes or trays.
  + Keep a log of the PSUs and slides selected as you obtain the slides.
  + Try to avoid ASCS offices when there is a major sign up by farmers and landowners. The ASCS personnel will be too busy to be of assistance and you will be taking up valuable space in their office.
  + Do not use the slides for measurements. There are numerous distortions in the slide scales due to altitude changes, turning of the airplane and other factors.
  + The Color Infrared slides were easiest to interpret over the normal color slides. This is not a critical factor but did become important when no satellite data were available.

- For National Aerial Photography Program (NAPP) photos:
  + This photography is helpful for assessing farmsteads, measuring drainage and measuring shelterbelts.
  + The photography is probably not worth the expense if the NRI is the only use for the photos. We found that the NAPP photography was helpful when there were no satellite images available.

- Prior to using any existing database, the NRI staff must perform a quality control assessment of the data. We found that inconsistencies within and between databases created many linkage problems, in effect a waste of time.

Future Research

- Conduct research on the use of GIS and remote sensing techniques on other Major Land Resource Areas (MLRAs) to verify if techniques used in the Midwest apply to other areas.

- Extend the NRI analysis from points to areas, to fully exploit the capabilities of a GIS and the widespread availability of digital remote sensing data. The GIS will provide a spatial dimension to the data which would also help in interpreting the results. Research on the proper size of areas, merger of added layers, merger of remote sensing data and other modeling techniques should be conducted.

- Determine a proper sampling technique that will make the most use of the remote sensing data. There are approximately 720 data points in a PSU collected by the Landsat Thematic Mapper instrument. Only twelve of these data points (0.16%) are used for land cover analysis and the remainder are discarded.

- Explore the use of digital elevation maps (DEM), digitized soil maps, reach file data, digitized property boundary maps and similar data added to digital satellite data in obtaining soil and water conservation data. Much of this data is already in existence and therefore studies can be conducted in many geographic areas.

- Use knowledge-based database systems to develop models to generate the data for some of the NRI fields (i.e., wetlands, primary and secondary use, prime farmland, potential for cropland, and conservation treatment).

- Develop GIS models to identify PSU's and sample points that may have changed in some of their characteristics (such as land-use) from the previous NRI to the current one. This will alert one to areas undergoing change and may require some data collection on the ground.

- Determine who the real users are of the NRI data and then develop the structure of the NRI databases. This will bring about more efficiencies in the use of the databases and provide more flexibility in using the NRI databases with other existing databases.

- Implement procedures in a database system to flag logical changes (i.e., forest to cropland, or cropland to urban), in PSU's and sample points to review the data for that PSU or point.

SUMMARY

Our April Progress Report covered our efforts in selecting satellite images for the Study Counties, preliminary analysis of the Delaware County Landsat data, learning how to digitize the PSU locations for Delaware County and a preliminary design of the database for collecting the data for specific items of the NRI survey form.

Our June Progress Report (covering May and June) summarized our work on technique development using satellite data that LARS already had one file. It has been noted several times in communications that we used 1988 data for Delaware County instead of 1986 data but we used 1986 and 1988 ASCS photography to assist in verification and prediction of land cover for 1986. We verified that our classification accuracy was well over 90%. We demonstrated a technique of being able to extract data from a PSU location simply by pointing to it on the screen. We continued our efforts on database structures and concentrated on the soils database and the storage of information for the NRI

Our July Progress Report provided a draft procedure for completing all items of entry for the 1987 NRI Worksheet. For each Item, we listed the techniques (database search, remote sensing analysis, geographic information system, or other data sources) that should be used to obtain an answer with a high degree of accuracy. The procedures assumed that one would not go to the field to obtain the answers. We performed geometric corrections of satellite data received for Elkhart, Pulaski and Perry Counties and tested the accuracy of classifications. We further demonstrated the ability to have an interactive visual query system for each PSU. We have accomplished the effort to show any Section 1 data for each PSU on request. (There was no encouragement received on this task so we did not complete the effort). We demonstrated that we could incorporate data from the NRI-82 and SOIL-5 databases directly into the computer form of the 1987 NRI Worksheet. We noted a number of inconsistencies between databases and have reported these to the State Office Soils staff.

Our August Progress Report (the 4th progress report as agreed in our contract) provides a summary of all data and information sources that we used in this study. Included are details of the Landsat data and aerial photography used in the land cover identification. We completed the digitization of all PSUs for the six study counties. A recommendations section was divided into 1) conducting the NRI where we provide suggestions related to the use of remote sensing and GIS technologies and 2) future research relating to how the improvement of the NRI in inventories beyond 1992.

We started a number of research efforts in this project including the development of an NRI Database structure only to find out that SCS had already done this under a contract to a private company. We continued our work in this area as we needed a computer database to record our information as it was obtained. It would have been helpful if we could have obtained a "beta" copy of the contracted software. We could have benefited from a discussion of this software held in Lincoln during June. We had travel funds in our budget for attending meetings relating to NRI but never received any invitations or information about such meetings until after the fact.

The graduate student who was working on the database structures was not paid through the contract and therefore was actually supplementing the project. The comments and criticisms of her efforts and work were very discouraging to her and to LARS researchers. Much of these types of misunderstandings comes from a basic philosophy of why we are here. As a University we are interested in exploring many different avenues in order to come up with results and, yes, more questions - which does lead to more research. The time allotted for this research project was only four months and it essentially went to six months because of delays in receiving some of the basic data. We hope to cooperate with SCS in the future as there is so much that can be accomplished related to the NRI. We would hope that future efforts be focused on research results and not just on products and deadlines.

APPENDIX I

NRI DATA ACQUISITION PROCEDURES

NRI DATA ACQUISITION PROCEDURES:

A summary listing of the data and information blanks and the source of information is provided in this appendix. Specific information on the procedure for obtaining the answers for each data or information item is provided by number - this is the number found in parentheses on the 1987 NRI worksheet.

Section I -- PSU Data

Item (4) Major Land Resource. This information is provided from the 1982 NRI Records and automatically recorded for 1987.

Item (5) Hydrologic Unit. This information is provided from the 1982 NRI Records and automatically recorded for 1987.

Item (6) Size of PSU in the County (Acres). This information is provided from the 1982 NRI Record. We have noted in Delaware County, Indiana that the precise acres will vary several acres from that recorded in 1982. Our range in measured computer values has been from 150 to 165 acres. These measurements have been made directly from the USGS topographic maps.

Item (7) Urban and Built-Up Areas: 10 Acres or Greater. Information is provided for 1982 as a reference. Classification results of the Landsat Thematic Mapper (TM) data will usually show a mixture of categories of forages, trees, and other for urban areas.. These results can be further verified by examining the latest aerial photography (i.e., the ASCS aerial color slides and the Color Infrared NAPP photography provided by SCS). New individual and multiple homes will be very evident by the increase in hard surface areas representing building roofs and driveways. New homes will usually have smaller trees and shrubs than older established buildup areas. The acreage of new urban areas can be measured with the use of a digitizing tablet. For purposes of this project, we measured the total area represented by all urban areas whether they were business, residential or other.

Item (8) Urban and Built-up Areas: 0.25 - 10 Acres. If one has determined greater than 10 acres of urban area, then a zero would be placed in this blank. If the area is less than 10 acres, procedures mentioned under Item 7 would be used to obtain an area measurement of urban and buildup areas. Note that it would be difficult to recognize urban areas of less than one acre in size from satellite data.

Item (9) Area in Farmsteads and Ranch Headquarters. The areas devoted to farmstead should be checked through the use of aerial photography. It is important to look for clues such as roads or lanes into the cropland or pasture areas from the building area in determining if this is a farmstead or an urban residence. Older photography is also useful in determining the locations of active farmsteads. Farmsteads might be abandoned which would have little evidence of road usage. It is important to note that some abandoned farmsteads are now being sold for use by individuals who work in locations other than the farm and in this case the area would need to be added to either Items 7 or 8 (Urban or built-up areas). An important clue would be whether there are lanes or roadways leading to the fields adjacent to the building area.

Windbreaks.

Item (10) Kind. The kind or type of windbreaks can be determined through the use of aerial photography. If the 1982 reply was "0" meaning none or no windbreaks, then one should check carefully to see if there are any lines of trees along the fence rows or near the farmsteads that qualify as windbreaks. One should look carefully if any newly planted windbreaks have been established. A review of the cooperator files in the CAMPS files would verify if the landowner was planning for windbreaks in his conservation plan.

Item (11) Windbreak Total Width (Feet). Assuming that either code "1" or "2" were placed in Item 10 a measurement of the total width can be made from the aerial photography with the use of the digitizing tablet. A computer program could be written to automatically enter the numbers measured for windbreaks so that this information could be stored and later retrieved for placement on the worksheet.

Item (12) Windbreak Width Within PSU (Feet). For this category, one is concerned with the width of the windbreak that is found entirely within the PSU. In the previous item, one would have measured the total width of the windbreak even as it would have extended beyond the boundaries of the PSU. If the windbreak is entirely within the PSU, the total width and the width within PSU would be identical.

Item (13) Windbreak Total Length (Feet). The aerial photography would be used for locating the length of the windbreak that is continuous and not changing in direction. The digitizing tablet can be used to precisely measure the length of the windbreak from end to end. Note that the answer to this question could include a measurement that extends beyond the boundary of the PSU.

Item (14) Windbreak Length Within PSU (Feet). This measurement would be made of the length that is found entirely within the PSU boundary. Again the digitizing tablet would be used to locate the beginning point and the ending point within the boundary or at the boundary line.

Water Bodies Less Than 40 Acres.

Item (15) Total Area. Water bodies can be easily located on satellite images and reasonably well on the aerial photography. If the water area is a farm pond that is silty, the water may appear as bare soil on a photo but can be distinguished on a computer classification of the Landsat data. The total acreage can be measured precisely from the aerial photograph with the use of the digitizing tablet. A measurement from the Landsat image classification would be accurate to about 0.5 acres. Note that the total water body would include the area with extends beyond the PSU boundaries.

Item (16) Area Within the PSU. The area of the water body that is found entirely within the PSU is measured and recorded with the use of the digitizer tracing over the aerial photography.

Perennial Streams Less Than One-Eighth Mile Wide.

Item (17) Width. Using the aerial photography and the digitizing tablet one can measure the distance from the top of one bank to the top of another. One would first verify that the stream is less than 660 feet. If this is the case, one should measure and record the width of the stream.

Item (18) Length. Using the Digitizer on the aerial photograph one can accurately measure the length of the stream including the curves and the bends in the stream. Note that only the length of the stream within the PSU boundary is to be measured.

Section II -- Point Data

Item (19) Ownership. First, one should check the 7 & 1/2 minute quad sheet and see if the PSU is shown as being owned by the public (either County, State or Federally owned). Please note that this information is only current up to the time that the map was produced - revisions shown in purple did not consider ownership. The second place to check is with the County Surveyor or County Clerk who register the ownership of all lands within the county. Some counties have computerized these records and a search can be accomplished by computer for those locations. If not, a manual search of their maps will show who owns each land holding(s) within the PSU. Note that if the land was in public ownership in 1982, there is a very high probability (>95%) that the land will still be in that ownership. Most County ASCS Directors will know if specific public lands have shifted ownership in the last five years because of the public notices, meetings and comments related to the transfer of any public land within a community.

Item (20) Soil Series Name. This information can be obtained by looking at the current soil map and determining in which mapping unit the PSU is located. The information from the 1982 NRI will show the soil series as printed on the form but is a good idea to check the soil map for each point. The State Soil Survey Database can also be checked for consistency of information for Items 20 through 27.

Item (21) SCS - SOIL 5 NO. This number is provided on the worksheet but one should do an inquiry of the State Soil Survey Database and determine that the number is correct.

Item (22) Surface Texture. This number is provided on the worksheet but one should do an inquiry of the State

Soil Survey Database and determine that the number is correct.

Item (23) Percent Slope Range. Verify if the Slope Range agrees with the mapping unit found on the soil map with the location of the PSU. Then check the State Survey Database to determine if the information printed on the worksheet is correct.

Item (24) Flood Phase. Verify if the information on the worksheet is correct by checking the State Soil Survey Database.

Item (25) Other Phase Criteria. Verify if the information on the worksheet is correct by checking the State Soil Survey Database.

Item (26) Land Capability Subclass. Verify if the information on the worksheet is correct by checking the State Soil Survey Database.

Item (27) Prime Farmland. One can verify if this soil mapping unit qualifies for prime farmland on the State Soil Survey Database. Additionally one can check the list of State Prime Farmland Soil Mapping Units to see if this mapping unit is included on that list.

Item (28) Land Cover/Land Use. The worksheet will display the code numbers for the Land Cover as determined in 1982. The land cover information can be obtained from the interpretation of satellite images for each primary sample unit. The land cover/land use information should be verified with ASCS aerial slides taken for the same year. The satellite data should be selected during the cropping season and is of the greatest value for this purpose if selected June through August.

Item (29) Native Pasture? By first checking the soil survey, one can determine if the native vegetation of the soil was timber or prairie. If timber, then the answer for Item 29 is usually no but there are provisions were a native pasture may have been established on timber soil. If prairie, then one needs to check the aerial photograph to determine what the current land cover is. If the land cover is other than a forage crop, then the answer for Item 29 is also no. If it is a forage crop, then one needs to check with the ownership files found in the CAMPS database to determine if the landowner has native pasture. If the answer is no, then the answer to Item 29 becomes "no". If Item 28 (Land Cover/Land Use) is coded "221" through "226", one would enter "yes" for native pasture.

Item (30) Use of Land

A. Primary Use. If the land cover information has changed between 1982 and 1987 one should look closely to determine if the primary use has changed. The primary use are broad categories for more easily summarizing the land cover/land use information.

B. Secondary Use. It would be unusual for an area to have a secondary use in the agricultural areas but would be more common in timber or water categories. Secondary uses could be such things as Code 25-transmission, 31-waste disposal, 41-wilderness, 42-wildlife, 43-recreation, 44-nature study, 51-research and experimentation, and 61-military.

Item (31) Cropping History. There are three cropping years prior to the current year that need to be collected under this category. The information can be readily obtained by use of the ASCS records if the farmer has been participating as a cooperator. Their information would generally show which fields were planted to specific crops. Additionally the ASCS photography from the previous years can be viewed and interpreted for the proper cropping categories.

Item (32) Double-Cropping? Double-Cropping is practiced primarily in the Southern part of the State and then is usually soybeans planted in wheat stubble. It might be difficult to ascertain if the field is double-cropped by viewing ASCS slides. The soybeans that have been doubled-cropped will be much shorter and will not have the same amount of vegetative cover that normal planted soybeans will have. If one suspects double-cropping, ASCS will likely have record of such activity, especially if the farmer is participating in the farm program.

Item (33) Irrigation Type. The Division of Water, Indiana Department of Natural Resources maintains a database of irrigation activities within Indiana. By providing the UTM coordinates of the PSU point locations, one can rapidly determine if they have record of irrigation activities for those locations. Copies of the database can be obtained by contacting Gregory A. Main at 317-232-1116 or writing to him at the Division of Water, Indiana Department of Natural Resources, 2475 Directors Row, Indianapolis, IN 46241.

Item (34) Source of Irrigation Water. See Item 33 on how to obtain this information.

Item (35) Wetland Type. Contact the District Conservationist within the county to determine if wetlands have been mapped for this location. One can also verify if the location qualifies for a wetland site by searching Item 21 in the State Soil Survey Database to determine if the soils are hydric. The Indiana Department of Natural Resources has a GIS of wetland areas as determined by the US Fish & Wildlife Service. We did not receive this information in time to evaluate it.

Item (36) Conservation Practices. Some conservation practices such as windbreaks, field borders, pasture and hay land management, proper grazing use, mine land, terraces and tree planting tend to be verified by examining the ASCS aerial photography. Additionally one should check the cooperator records of the CAMPS database to verify the conservation practices implemented by the landowner. The ASCS records which show what payments have been received for specific conservation practices should also be consulted.

Item (37) Conservation Tillage Type. The District Conservationist or County Extension Agent within the County would be excellent sources for determining if a cooperator has been using conservation tillage. They would usually be knowledgeable of the type of tillage used by the farmer. Aerial photography is useful for determining tillage type if the photography was obtained early in the growing season prior to more than 50 percent vegetative cover. Satellite image analysis using expert systems has been useful for discrimination of conservation types but has similar restrictions and has not been consistent in its accuracy.

Item (38) Conservation Treatment. A search of the soil information provided through Item 21 would show if a soil is "Highly Erodible Land" (HEL) and if the land cover/use (Item 28) is cropland, then conservation treatment will be needed. The kinds of treatment needs will be limited by the land use and other practices already verified. HEL land will need erosion control, while irrigated land will usually require irrigation management, etc.

Item (39) Ephemeral Gully Erosion? The land area needs to be in cropland before one can consider a "yes" for this answer. "No" should be recorded for all other land cover categories. With the use of the ASCS aerial photography, one can assess by the variation of the vegetation if there is current or past erosion or a potential for ephemeral gully erosion.

Potential for Cropland.

Item (40A) Dominant Soil and Water Reason. The information sought is soil and water reasons that would inhibit or prevent conversion of land to cropland. Note that if this point location has a land cover/use of cropland, urban and buildup land, rural transportation, or water, then a "99" code is recorded. For other land cover/use categories such as forage or timber, one needs to assess the State Soil Survey Database for determining adverse characteristics for conversion such as flooding, stoniness, wetlands, etc.

Item (40B) Secondary Soil and Water Reason. If there is an other reason in addition to that mentioned in Item 40A, it would need to be recorded here. Software could be written to suggest likely possibilities for Items 40A and 40B based on previous soils and other information provided.

Item (41) Other Reasons. The spatial aspect of the satellite data could assist one in determining if urban land is encroaching upon this location. One could also review the ASCS aerial photography for determining if the tract of land is to small for efficient agricultural production, and if it is an isolated track. The land ownership would also provide clues to potential for conversation such as federally or state owned land which would be unlikely to be converted to urban uses.

Item (42) Effort for Conversion. The County District Conservationist and County Extension Agent are good sources of information for determining the type of effort needed to convert the land from its existing use to cropland uses.

Item (43) Potential for Conversion. The resources noted in Item 42 should be consulted for the information needed.

Item (44) Range Data. (Will not be completed for Indiana.)

Item (45) "K" Factor (Soil Erodibility). This information will be provided from the State Soil Survey database and the numbers should be verified by an independent search of the database.

Item (46) "R" Factor (Rainfall). This item should also be verified but through the local District Conservationist or the State SCS Engineer. Note that the "R" Factor has been changed in recent years for some locations in Indiana.

Item (47) "C" Factor (Cropping Management). Note that this item will be based upon the land cover/use information (Item 28) provided earlier. A computer program could be written to provide this information automatically based upon the land cover/use information and cover data from Handbook tables.

Item (48) "P" Factor (Erosion Control Practices). A computer program could be written using the information provided in Items (36) Conservation Practices, (37) Conservation Tillage Type and (38) Conservation Treatment in conjunction with the tables of the Agricultural Handbook 537.

Item (49) Slope Length. Checking the topographic maps, one can assess the length of slope by the uniformity of the topographic lines in which the locational point falls. Using the digitizer, one can rapidly measure the length of the slope from the ASCS or similar photograph and also from a topographic map.

Item (50) Percent Slope. The total length of slope can be divided by the total of the topographic line intervals and a percent slope calculated. One should compare this with the slope range recorded under Item 23 (Slope Class %) to determine if it corresponds with that information.

Item (51) Calculated 1982 USLE. Provided for information purposes.

Item (52) "T" Factor. Provided for information purposes.