A Special Report by the Soil and Water Conservation Society

A History of Natural Resource Inventories Conducted by the USDA's Soil Conservation Service and Natural Resources Conservation Service

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TABLE OF CONTENTS

Introduction

Natural resource inventory work has a long history within the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) and its predecessor agency, the Soil Conservation Service (SCS). In fact, the first inventory conducted by federal officials on the nation's soil resources had its genesis several years prior to the establishment of SCS in the mid-1930s.

Hugh Hammond Bennett and his colleagues wrote extensively about the threat posed by soil erosion to the nation's agricultural industry in the late 1920s. In particular, "Soil Erosion—A National Menace," written by Bennett and W.R. Chapline and published by USDA in 1928, established a rationale for conducting soil erosion studies on a nationwide basis and led to creation of eight soil erosion experiment stations.

Work at those eight stations, coupled with the onset of the Dust Bowl, led to establishment in 1933 of the Soil Erosion Service within the U.S. Department of the Interior. Shortly thereafter, Bennett, as head of the new agency and spurred on by the severity of drought throughout much of the Great Plains, laid the groundwork for the 1934 National Erosion Reconnaissance Survey—the first well-documented, nationwide natural resources inventory ever conducted.

That survey, encompassing 1.9 billion acres of public and private land in every state (48 at the time), on a county-by-county basis, was completed in two months' time by 115 soil erosion specialists (Table 1). There was no statistical framework for the work, and soil erosion was its sole focus. The scientists mapped all land into one of 30 descriptive features; located eroding areas, primarily on plowed fields; and qualitatively described the degree of damage observed from wind erosion and/or water erosion (Table 2). In some cases, the specialists crudely measured the areas of eroding land using a crop meter attached to an automobile's speedometer cable—a methodology employed by USDA's Bureau of Agricultural Economics to estimate crop acreages from year to year.

Six months after completion of the survey, President Franklin Roosevelt used the findings as a basis for signing Public Law 74-46, the Soil Conservation Act of 1935. That law created SCS within the U.S. Department of Agriculture (USDA) and eliminated the Soil Erosion Service at Interior. Roosevelt named Bennett chief of the new USDA agency.

Shortly thereafter, SCS officials, in collaboration with scientists from USDA's Bureau of Agricultural Engineering, summarized findings from the erosion reconnaissance survey in a document titled "Soil Erosion, A Critical Problem in American Agriculture." That publication described wind, water, and gully erosion conditions on a state-by-state basis. A subsequently published "United States Erosion Reconnaissance Survey Map," with text, qualitatively described the various soil erosion classes by degree: little or none, slight, moderate, severe, and very severe.

Data and information from this first inventory activity were later repackaged and published in *Soils and Men, the 1939 Yearbook of Agriculture.* The accumulated data also were incorporated into county soil maps, where available, and on county road maps, postal delivery maps, topographic quadrangle maps, and even some land ownership maps.

Since the National Erosion Reconnaissance Survey, there has evolved within SCS and then NRCS a series of natural resource inventory activities that have become increasingly more frequent and far more sophisticated, both statistically and technologically. The initial activities in the series consisted of three soil and water conservation needs inventories (CNIs), conducted in 1945, 1958, and 1967, and a Potential Cropland Study, completed in 1975.

In the early 1970s the legislative and administrative foundations were established for a much more elaborate National Resources Inventory (NRI). The NRI began in 1977 as an every-five-year look at the status and condition of natural resources on nonfederal land in the United States. NRIs conducted from 1982 through 1997 for the first time provided trend information on land use and the status and condition of natural resources. Those periodic inventories were complemented in the 1990s by a series of special inventories that looked at specific issues of interest to policymakers and agency administrators. Then in 2000 the NRI began a transformation into an annual or continuous natural resource inventory activity.

Table 1: A Summary of the Natural Resource Assessment Activities Conducted by the Soil Conservation Service Prior to the 1997 National Resource Inventory.

Year	Assessment	Objective	Sample Design	Sample Size	Estimation	Comments
1934	National Erosion Reconnaissance Survey	Determine extent and effect of soil erosion on agriculture productivity	Reconnaissance	1.9 billion acres of public and private land nationwide	Not applicable	Influence passage of Soil Conservation Act of 1935
1945	National Inventory of Soil and Water Conservation Needs	Support program development and set conservation priorities	Collection and integration of available data	Not applicable	Not applicable	No field studies: all data collected from existing sources in other agencies
1958	National Inventory of Soil and Water Conservation Needs	Estimate magnitude and urgency of conservation measures needed to maintain agricultural productivity	Stratified area sample; sample segments included 40- 100- 160- or 640-acre squares of land	From 1 to 8 percent sampling rates, depending on county size	Inverse selection probabilities; adjusted by county to known inventory acres (acres of nonfederal rural land)	First use of probability based sample design; a multiagency effort
1967	National Inventory of Soil and Water Conservation Needs	Update of 1958 assessment	Stratified two-stage area sample (minor modification of 1958 sample); points systematically selected within each 1958 segment	38 points in a typical 160-acre segment	Procedure similar to 1958, but weights developed for each sample point	Two-stage sample design used to reduce data collection costs; first tabulation data set produced; only net change could be estimated
1975	Potential Cropland Study	Determine the amount, location, and characteristics of land that could be easily converted to cropland for agricultural production	Stratified multistage subsample of 1967 sample points, selected counties, segments within counties, points within segments	506 counties, 5,300 segments, 41,000 points	1967 weights multiplied by Inverse subsample selection probabilities, adjusted to reflect state inventory acres	Use of national sample as frame for special study; paired observations (same sites for 1967 and 1975) allowed investigation of land use dynamics

Table 2: Data Elements Included in the Pre-1977 Natural Resource Inventory Activities Conducted by the Soil Conservation Service.

Data Element	1934 Erosion Survey	1945 CNI	1958 CNI	1967 CNI	1975 Cropland Study
Land use		X	X	X	X
Land capability		X	X	X	
Soil type			X	X	X
Conservation treatment needs		X	X	X	
Soil erosion (severity and extent)	X				
Prime farmland status					X
Factors affecting conversion to cropland					X

Pre-NRI inventory activities

The 1945 CNI

Having completed the National Erosion Reconnaissance Survey and realizing the value of natural resource inventory information for policymaking and program management purposes, SCS officials in 1942 began work on the first CNI (Table 1). Using an eight-class Land Capability Classification System that had been developed a couple years earlier, agency scientists began assembling available data and information from existing sources, both within and outside USDA. Those sources included, among others, U.S. Census of Agriculture data, demonstration project records, agricultural statistics reports, and knowledge and experience accumulated by SCS field staff. This first CNI involved no data collection in the field.

SCS officials integrated the assembled data in a way that allowed them to make informed judgments about which land was most suitable for cultivation, grazing, forest production, and wildlife (Table 2). This work resulted in the publication in 1945 of a 109-page report "Soil and Water Conservation Needs Estimates for the United States by States." Included in the report was a basic land resource area map, along with data on land use and crops; estimates of the acreage in each land capability class, by land use; estimates of the needed conservation practices; estimates of the labor, equipment, and materials required to complete the needed conservation work; estimates of the technical assistance needed to apply and maintain the conservation practices; and cost estimates for applying and maintaining the conservation practices.

In the end, the 1945 CNI helped SCS scientists and administrators establish a rationale for conducting natural resource inventories within the agency rather than relying on data and information accumulated from other agencies and institutions.

The 1958 CNI

About a decade after completion of the 1945 CNI, the secretary of agriculture directed SCS to complete and keep current a CNI that encompassed each county in the United States and appropriate units of government in U.S. territories. The activity became a multiagency activity within USDA under the leadership of SCS. A national Soil and Water Conservation Needs Committee was established, with representation from each of the participating agencies. Similar committees were formed in the states and territories and at the county level.

Data for the 1958 CNI were developed by SCS for all nonfederal land, although the Forest Service was given responsibility for the adequacy of forest-related data on that nonfederal land (Table 1). Participating public land agencies were responsible for collecting data on land under their respective jurisdictions.

Realizing that conducting a natural resource inventory across all land was prohibitively expensive, the administrator of SCS, at the outset of field work in 1957, directed that only sample areas of land in each state and territory be included. The same directive provided for the collection of data on soils and land use acreages from soil surveys on each sample plot. This sampling procedure established the basis for the primary sample units (PSUs) included in later natural resource inventories.

Data collection for the 1958 CNI occurred in six steps: (1) preparation of land resource maps, (2) selection of sample units, (3) mapping of sample units or field inspection and revision of existing mapping, (4) map measuring and recording of data, (5) expansion of acreage data, and (6) tabulation and analysis of data.

Statistical procedures used in the 1958 CNI were developed for SCS by staff in the statistical laboratories at Iowa State University and Cornell University. A two percent sample of nonfederal land in the states and territories was included. Federal land was largely excluded unless that land was in cropland under a lease or permit. Sampling units included (1) 100-acre squares of land in 13 northeastern states, (2) 40-acre squares in most irrigated areas of the West, (3) 640-acres squares for homogenous regions in the West, and (4) 160-acre squares elsewhere across the country. All sample units of land were examined in the field by SCS employees. Data were recorded on land resource maps—essentially soil association maps—that could portray differences in climate, water resources, land use, or farming systems. This mapping convention led several years later to formal policy and specifications within SCS on general soil maps and the major land resource area concept and maps for states and counties.

The 1958 CNI used two sets of samples, one red and one blue. Each set represented a two percent sample of the land area to be inventoried. In counties exceeding 250,000 acres, where one set of sample areas provided adequate data, only the red sample set was

used. In smaller counties, both red and blue sets of sample areas were used to maintain a degree of statistical reliability.

The 1958 CNI also went beyond the traditional examination of land use, soil erosion, and conservation treatment needs when it sought to collect qualitative information about the need for small watershed projects.

Once field work was completed, the soils and land use data from the sample units were expanded so they represented the total acreages of particular conditions in each county, less the federal land involved. Those data included (1) land capability, by class and subclass; (2) land use in 1958 and expected land use in 1975 for cropland, pasture and range, forest and woodland, and other land; (3) conservation treatment needs, by land use; and (4) small watershed projects needed (Table 2). The latter data element encompassed all land, public and private, for which project action might be needed to solve various watershed-related problems. No field surveys were involved in this portion of the inventory. Data and information available from within and outside USDA were used for this purpose, along with the judgments of state and county conservation needs committee members.

The 1967 CNI

In 1965 USDA officials authorized an update of the 1958 CNI. As in the earlier work, SCS was given the lead role for conducting the inventory, and multiple agencies within USDA and the Department of the Interior were again involved (Table 1). The data elements collected for the 1967 CNI were the same as in 1958 (Table 2). Specific sample points within the PSUs were selected for the first time, establishing the system of primary sample units and secondary sample units used in subsequent inventories.

Rather than measure acreages and record other data and information for each sample unit of land in its entirely, SCS employees focused their data collection efforts on the sample points within each sample land unit. Generally, 34 to 38 sample points were identified within each 160-acre PSU. Soil type, land use, and conservation treatment needs were determined at each sample point. This approach reduced the time and cost involved in field work and made the data collected easier to process, but the methodology also reduced the statistical precision of the activity by an estimated 10 to 15 percent. This CNI resulted in two sets of usable data—the original expanded data and the final adjusted data.

With advances in soil survey techniques and procedures, SCS officials in 1970 began to attach the names of soil series to the 1967 CNI sample data.

The 1975 Potential Cropland Study

The 1975 Potential Cropland Study was not a full-scale natural resource inventory like the earlier CNIs, but rather a quick look at what had become an important national environmental issue in the early 1970s (Table 1). Moreover, the study was conducted during the important transition period between the earlier series of CNIs and the new series of NRIs that was mandated by the Congress in the Rural Development Act of 1972. In some respects, the 1975 study could also be viewed as a precursor to the series of special NRIs conducted in the 1990s

Dramatic increases in demand for food and feed crops in the early 1970s generated concern among the nation's policymakers about (1) how intensely existing cropland was being used, (2) how much good cropland was being converted to urban and related development, and (3) what potential existed to convert other land to crop production. Exacerbating the situation was the nation's increasing energy needs and growing concern among conservationists about the environmental impacts of using more marginal land for crop production purposes.

In late 1973, the administrator of SCS initiated an "Estimated Conversion to Cropland" project that was designed to gather data, by selected land capability subclass groups, on the acres of grassland, woodland, and other land converted to cropland in the fall of 1973 and the acres expected to be converted the following spring. Other information was also requested, including expected cropping systems and estimates of wind and water erosion on cropland, whether that land had adequate conservation treatment or not.

The inventory forms accompanying a single page of instructions were to be completed within three weeks' time on a county-by-county basis, without the benefit of any field investigations. SCS district conservationists were to seek help from other county, state, and federal agency office personnel. This quick-look survey was essentially repeated the following summer when, within one month's time, SCS district conservationists were asked again to report the acres of land converted in the fall of 1973 and provide the actual acreages converted in the spring of 1974.

Results of the two surveys were never published, and files with results apparently were discarded. Results of the project, however, were viewed by some SCS personnel as an incentive to conduct the 1975 Potential Cropland Study.

SCS conducted the 1975 study with design assistance from staff members at the Iowa State University Statistical Laboratory and USDA's Economic Research Service. Instructions and forms for conducting the study were sent to SCS state office personnel in May 1975. The study employed a subset of the PSUs from the 1967 CNI. Only 506 of the approximately 3,000 counties nationwide were randomly selected and stratified for study. Some nonfederal land in Puerto Rico and the Virgin Islands was also included. A random distribution of about 10 PSUs per county—a total of about 5,300—were chosen from the much larger number of PSUs involved in the 1967 inventory, and an average of nine points within each PSU were visited, as opposed to the 34 to 38 points involved in the earlier work. The number of sample points thus totaled about 47,000.

The study was to provide data statistically significant at the regional and national levels for (1) the potential for converting land in other uses to cropland, (2) the extent to which that land could be readily converted, (3) identifying problems related to developing the land for crop production purposes, and (4) land use changes and trends between 1967 and 1975 (Table 2). By using portions of the sampling frame from the 1967 CNI, SCS officials for the first time were able to portray net changes as well as dynamic changes in land use between 1967 and 1975. Some controversy developed over the use of trend numbers, however, because the 1975 data set was not precisely comparable to the expanded 1967 sample area data set, which was used instead of the final adjusted 1967 data set.

Data and information from the Potential Cropland Study highlighted concern over the nation's ability to maintain its agricultural productive capacity and created momentum for the National Agricultural Lands Study that was initiated by USDA in 1979.

Lessons from the pre-NRI era

Over the course of the agency's first four decades and its first five natural resource inventories, SCS officials learned several valuable lessons:

- Natural resource inventories can produce data and information useful for influencing the policymaking and budgetary processes. SCS, in fact, came about as an agency largely because of the National Erosion Reconnaissance Survey. Moreover, each new inventory produced data and information emphasizing the need for ever more technical and financial assistance to address conservation problems on the nation's agricultural land. Agency officials used those data and information effectively in their attempts to drive the policymaking and budgetary processes.
- The value of data sets available from other agencies and institutions became apparent when SCS officials undertook the 1945 CNI, but that value seemingly diminished once those leaders opted to conduct natural resource inventories largely or entirely on an internal basis.
- Natural resource inventory data can be tied to numerous other tools in ways that can prove useful for policymaking and program management purposes. A first example of this occurred when agency officials merged the land capability classification system with inventory data in the early 1940s. A second and perhaps more important example occurred when agency scientists began attaching soil survey information to CNI data points. This opened up a whole new realm of analysis using CNI data.
- Experience with the 1958 and 1967 CNIs and the 1975 cropland study showed clearly the value of using an established statistical sampling frame for natural resource inventory work. Sampling portions of the landscape proved far more efficient time-wise and less costly than wall-to-wall inventory activities. In addition, agency officials at least were introduced to the potential value of obtaining trend information from one inventory to the next.
- Natural resource inventory work can encompass an ever expanding portfolio of conservation issues. The sole focus of initial inventory activity in SCS was soil erosion; over four decades, that focus broadened to include soil and water conservation needs, watershed project potential, and land conversion, both to and from agricultural uses.

The NRI: A National Mandate

Congressional policymakers established a whole new context for natural resource inventory work within SCS with passage of the Rural Development Act of 1972. Section 302 of that act directed the secretary of agriculture to put in place a land inventory and monitoring program that would, among other things, study and survey damage from soil erosion and sedimentation, floodplain identification and use, land use change, and potential environmental damages resulting from the misuse of soil, water, and related natural resources. This program was to result in the publication of a land inventory report at not less than five-year intervals on the condition of the nation's soil, water, and related natural resources.

Almost immediately, SCS leaders put in place a plan to comply with the directive. Internal reorganization gave greater focus to land inventory and monitoring work; an agreement for continuing statistical services was negotiated with staff at the Iowa State University Statistical Laboratory, which had assisted with both the 1958 and 1967 CNIs; and a timetable was established for collecting and analyzing natural resource data by 1978 and publishing the first in what was assumed to be an ongoing series of five-year reports by 1980.

An Important Farmlands Mapping Project, which was undertaken in the early 1970s, distracted SCS employees' attention temporarily from the new congressional directive, but completion of the 1975 Potential Cropland Study and much of the mapping project, allowed those employees to refocus their attention on the NRI by the mid-1970s.

Work on the NRI also was hurried along by two pieces of legislation that extended the impact of the Rural Development Act: the Soil and Water Resources Conservation Act of 1977 and the Surface Mining Control and Reclamation Act of 1977. RCA, as the Soil and Water Resources Conservation Act was referred to, directed the secretary of agriculture to (1) appraise continuously the soil, water, and related natural resources on nonfederal land in the United States; (2) devise a program to further the conservation, protection, and enhancement of those resources; (3) report to Congress and the American public by 1980; and (4) provide annual evaluation reports. The surface mining act required that prime farmland be identified and plans made for its reclamation before any new mining activity could be undertaken.

The 1977 NRI

With time running short, SCS leaders redirected funds and personnel and sought the support of SCS state conservationists and conservation districts to meet pending deadlines for 1977 NRI data collection. A sampling scheme was devised that involved visits to 70,000 CNI sample plots in more than 3,000 counties and the examination of three points within each of those PSUs (Table 3). This approach, all completed in calendar year 1977, resulted in a data base considered statistically reliable at the state level.

The 1977 NRI was the first natural resource inventory to provide comprehensive data on soil erosion across the country (Table 4). Quantitative data was collected that could be used in the Universal Soil Loss Equation to estimate soil erosion by water and in the Wind Erosion Equation to estimate soil erosion by wind. Other data elements included soil capability, land use, conservation treatment needs, potential cropland, prime farmland, wetland types, and floodplain information. Those data were collected both on an area and a point basis. Base acreage data were collected in each county for total surface area, Census water, federal land, urban and built-up land, and rural transportation. A phase-II portion of the 1977 NRI collected additional data on sources of soil erosion not collected earlier; those sources included streambank erosion, gully erosion, erosion caused by construction activity, and erosion on roads and roadsides.

Results and some analysis of data from the 1977 NRI first appeared in a draft report submitted to USDA administrators to comply with the Rural Development Act mandate. More results and analysis were ultimately published in a statistical bulletin in 1982, but this was after much of the data and information from the 1977 inventory had been incorporated into the 1980 RCA appraisal report issued by USDA.

The 1977 NRI data also became the primary data source for the National Agricultural Lands Study undertaken by USDA in 1979. That study opted to use data on urban and built-up uses of land from the 1977 inventory, which not only focused more national attention on the inventory work by SCS, but also generated considerable controversy in academic circles over how much agricultural land really was being converted to nonagricultural uses. Because of this controversy, new procedures for identifying and

recording urban and built-up areas were incorporated into the 1982 and subsequent NRIs.

The 1982 NRI

If there is a crème de la crème of NRI work to date, it is perhaps the 1982 activity. The controversy over farmland protection in the 1970s, along with the RCA mandate and the visibility and importance given the 1977 NRI within SCS, elevated the priority given natural resource inventory work in the agency and substantially increased annual budgets for such work. From the outset of this activity, an expanded sample of PSUs was envisioned that would yield a data base reliable at the county level across the nation. Identified data gaps in the 1980 RCA appraisal report would also be filled with the collection of considerably more data elements (Table 4). When all was said and done, however, not all the supplemental funds given USDA for this work were allocated specifically for it; hence, an inventory sample sufficient to acquire a data base reliable at the multicounty or major land resource area level was planned for. County level data were collected only in a few states, for example, Kansas, Missouri, and Louisiana, when those states came up with sufficient funding to cover the costs of the additional data collection.

The 1982 NRI employed much the same sampling scheme used in the 1977 NRI and earlier CNIs, but in expanded form (Table 3). Worksheets and instructions for the 1982 inventory were printed in early 1980 to facilitate the collection of data by SCS staff at the field-office level. To overcome the budget shortfall and the pressures of collecting all data within a year's time, as was done in 1977, SCS officials planned for a three-year data collection effort that would represent 1982 conditions to the extent possible. This move was planned in part to overcome a growing tension between the agency's staff at the national level and staff members at the state- and field-office levels.

Field-office staff, along with conservation district officials and other local interests, increasingly expressed concern in the months leading up to the 1982 study about what impact an expanded data collection effort might have on day-to-day field-office operations—working with farmers and ranchers to put conservation on the ground. Local interests also increasingly questioned the value of an NRI that had little, in their view, to offer county level conservation efforts. As a result, SCS leaders in the agency's national office undertook an educational initiative designed to convey the importance of the NRI to the agency's overall program planning and reorder the workload associated with the NRI in ways that would smooth out the peaks and valleys of inventories conducted at five-year intervals.

Results of the 1982 NRI were not published until 1987, but the comprehensive nature of the inventory prompted an immediate flood of requests for the data from USDA officials, academic interests, and others. Extensive use of the data was made by individuals conducting analyses in support of conservation program planning purposes and policy proposals for the 1995 farm bill debate. Among the innovative policy proposals emanating from this work were the Conservation Reserve Program and the conservation compliance, sodbuster, and swampbuster provisions of the 1995 farm bill.

The comprehensive nature of the 1982 NRI also prompted SCS officials to undertake substantial outreach activities to extend the value of the data and its analysis. State offices were encouraged to disseminate results of the inventory to partnering agencies and institutions. Conservation districts became the recipients of grants from SCS to assist with this outreach effort.

In the end, the 1982 NRI became the so-called base inventory in what was to become a series of every-five-year inventories that for the first time provided policymakers and program managers with trend information on the status and condition of soil, water, and related natural resources on the nation's nonfederal land.

Important NRI Literature

While the literature surrounding natural resource inventory activities in SCS/NRCS is reasonably extensive, relatively few papers, published or unpublished, recount the history of those activities. In the course of completing this history, four such papers were identified, and much of the material herein, particularly prior to the mid-1990s, was drawn largely from those four papers. Two of those papers were published in peer-reviewed journals:

Goebel, J. Jeffrey. 1998. The National Resources Inventory and its Role in U.S. Agriculture. *Agricultural Statistics 2000*, International Statistical Institute, Voorburg, The Netherlands, 181-192.

Nusser, S.M., and J.J. Goebel. 1997. The National Resources Inventory: a long-term multi-resource monitoring programme. Environmental and Ecological Statistics 4: 181-204.

The two additional papers were written by SCS/NRCS personnel largely for internal purposes and remain unpublished:

Schmude, Keith O. 1988. Development of nationwide resources inventories in the United States. Resources Inventory Division, Soil Conservation Service, Washington, D.C.

Harlow, Jerry T. 1994. History of Natural Resources Conservation Service National Resources Inventories. South National Technical Center, Natural Resources Conservation Service, Fort Worth, Texas.

Personal communication with staff members at NRCS, particularly Jeff Goebel, who has led the NRI work for three decades, and Sarah Nusser at the Iowa State University Statistical Laboratory, complemented the four foregoing sources in a significant way.

Two additional publications examined in detail the conduct of the NRI early on and what potential existed for the use of this inventory tool to further soil and water conservation efforts in the United States. Both volumes were the outcome of a special study undertaken by the National Research Council's Board on Agriculture in the mid-1980s and a subsequent forum of experts who were asked to expand upon the results of that study:

The National Academies Press. 1986. Soil conservation: an assessment of the National Resources Inventory (volume 1). Washington, D.C. 112 pp.

The National Academies Press. 1986. Soil conservation: an assessment of the National Resources Inventory (volume 2). Washington, D.C. 314 pp.

Table 3: Summary of Periodic National Resource Inventories Conducted by the Soil Conservation Service and the Natural Resources Conservation Service, 1977 – 1997

Year	Assessment	Objective	Sample Design	National Sample Size	Estimation	Comments
1977	National Resources Inventory	To collect current information on the status, conditions, and trends of soil, water, and related natural resources, as mandated by the Rural Development Act of 1972	Stratified multistage design consisting of a subsample of the 1958 CNI segments; new selection procedure for points within selected segments	70,000 PSUs 195,000 Points	Similar to 1967 procedure, modified to account for acres of farmsteads, built-up areas, small streams, and waterbodies, collected for sample segments; new procedures to establish inventory (control) areas	A redesign of the basic CNI framework; first nationally consistent survey of erosion; was originally called the 1997 Erosion Inventory; provided basis for extensive 1980 appraisal, mandated by the Soil and Water Resources Act (RCA) of 1977; established linkage with the soil interpretations database
1982	National Resources Inventory	A five-year update of the 1977 NRI to obtain current information on the status, condition and trends of soil, water, and related natural resources, including expanded ecological concerns; substate-level inference	Expanded the 1977 multistage area sample; new sample selected for 13 northeastern states using latitute/longitude for frame construction; additional samples included to support special local-area studies	320,000 PSUs 890,000 Points	Procedure from 1977 was modified, inventory acres (controls) developed for Major Land Resource Area portion of countries; small area estimation used to improve built-up area estimates (see Goebel et al., 1985)	Modification of erosion equations and land use classes invalidated comparisonwith 1977 datais initial time point in NRI series.large increase in sample size and diversity of data elements because of analytical needs identified during 1980 RCA appraisal
1987	National Resources Inventory	A five year update of 1982 NRI; for state-level inference	A subsample of 1982 NRI samples using post-stratification based on 1982 data; augmented 97 counties where analyses indicated a need for additional samples	108,000 PSUs 304,000 Points	Weights controlled so 1982 estimates derived from 1987 data closely matched published figures for 1982; small area estimation for urban change estimates based on data collected in special urban study	Reduced monetary and human resources led to substantial reductions in sample size and number of data elements and use of remote sensing for 30 percent of sample; prior information on PSUs/points and modeling used to increase efficiency and accuracy of estimates from smaller sample
1992	National Resources Inventory	A five-year update in the NRI series: for substate-level inference	Based on a large subsample of the 1982 NRI, with a small set of additional PSUs to augment sample size in various areas; included all 1987 samples	300,000 PSUs 840 thousand Points	Imputation used to complete1987 data not observed in 1987 and not retrospectively gathered in 1992, imputation of conditions observed in the PSU, but not accounted for at the point level; taking account for inventory (control) acres	Data analysis software developed; many procedures implemented to ensure comparability between and among 1982, 1987, and 1992 observations
1997	National Resoures Inventory	A five-year update in the NRI series	Same sample as the 1992 NRI	300,000 PSUs 840,000 Points	Similar to 1992 procedure; switched from MLRA/county to Hydologic Unit/ county for control acres; geospatial data provided Federal, large water and total county acreages	New data collection technologies used to increase efficiency and ensure data consistency and quality; some data elements deleted from 1992 NRI

Table 4. Summary of data elements collected or derived in the periodic (every five years) National Resources Inventories conducted by the Soil Conservation Service/Natural Resources Conservation Service from 1977 through 1997.

Data Element	1977 NRI	1982 NRI	1987 NRI	1992 NRI	1997 NRI
Primary sampling unit (PSU/segment) data					
1. Recording Information					
a. Data gatherer(s)	X	X	X	X	X
b. Date	X	X	X	X	X
2. SCS location code	X	X			
3. MLRA		X	X	X	X
4. Kuchler cover type		X			
5. Hydrologic Unit		X	X	X	X
6. Size of PSU in county (acres)	X	X	X	X	X
7. Verification of PSU boundary/point locations					X
8. Entire PSU federal land? (Y/N)	X	X		X	X
9. Urban and built-up areas	X	X	X	X	X
10. Farmstead areas	X	X	X	X	X
11. Critical eroding areas		X			
12. Rural transportation facilities					
a. Road(s) in the PSU? (Y/N)	X				
b. Public roads					X
c. Railroads					X
d. Private roads					X
13. Windbreaks					
a. Kind		X	X	X	
b. Total width		X	X	X	
c. Width within PSU		X	X	X	
d. Total length		X	X	X	
e. Length without PSU		X	X	X	

Data Element	1977 NRI	1982 NRI	1987 NRI	1992 NRI	1997 NRI
14. Small water bodies < 40 acres)					
a. Kind		X		X	X
b. Total size	X	X	X	X	X
c. Size within PSU	X	X	X	X	X
d. Use(s)	X	X			
15. Large water bodies (<40 acres)					
a. Kind				X	X
b. Total size class				X	X
c. Size within PSU		X		X	X
16. Small perennial streams (< 1/8 mile wide)					
a. Width	X	X	X	X	X
b. Length	X	X	X	X	X
c. Area within PSU	X				
d. Use(s)	X	X			
e. Shoreline characteristics					
1) Cover classifications/widths					X
2) Human alterations					X
17. Large perennial streams (>1/8 mile wide)					
a. Large perennial stream in PSU? (Y/N)	X				
b. Large perennial stream acres		X		X	X
18. Is there construction activity of more than one acre(Y/N)?	X				
19. Number of active gullies	X				
20. Imagery					
a. Source/type of imagery				X	
b. Date of imagery				X	
c. Scale of photography				X	
d. Type of photography film				X	
e. Index numbers				X	

Data Element	1977 NRI	1982 NRI	1987 NRI	1992 NRI	1997 NRI
Point data					
1. Ownership	X	X	X	X	X
2. Soils data					
a. Ownership	X	X	X	X	X
b. Map unit symbol	X	X		X	X
c. Soil name a correlated name? (Y/N)	X				
d. Soil record number (SOILS-5)		X	X	X	X
e. Texture and surface layer modifier		X	X	X	X
f. Slope class		X	X	X	X
g. Flooding class		X	X	X	X
h. Other phases		X	X	X	X
3. Land capability/class/subclass	X	X	X	X	X
4. Soil loss tolerance factor (T)	X	X	X	X	X
5. Prime farmland (Y/N)	X	X	X	X	
6. Hydric? (Y/N)				X	
7. Highly erodible land (HEL)? (Y/N)				X	
8. Land cover/use	X	X	X	X	X
9. Use(s) of land		X	X	X	X
10. Cropping history		X	X	X	X
11. Double cropped? (Y/N)		X	X	X	X
12. Second crop				X	X
13. Native pasture? (Y/N)			X	X	X
14. Conservation tillage type			X	X	
15. Forest cover type		X		X	X
16. Habitat composition and configuration					
a. Cover categories					X
b. Segment length(s) along transects					X
17. Overland flow/delivery to water					

Data Element	1977 NRI	1982 NRI	1987 NRI	1992 NRI	1997 NRI
a. Cover categories					X
b. Segment length(s)					X
c. Type of receiving water					X
18. Conservation Reserve Program (CRP)					
a. Under contract (Y/N)				X	X
b. Sign-up number				X	X
c. Contracted practices				X	X
19. Flood-prone area? (Y/N)	X	X			
20. Wetlands					
a. Type		X	X		
b. Kind of vegetation		X			
c. Kind of wetland system		X			
d. Coward in classification		X		X	X
e. FSA wetland classification				X	X
f. Wetland/deep water habitat					X
g. Reason for gain/loss					X
h. USDA program (WRP)? (Y/N)					X
i. Wetland size					X
j. Wetland types 3-20?	X				
21. Density of urban development (%)	X				
22. Degree of erosion		X			
23. Nonarable because of past erosion		X			
24. Formerly prime farmland? (Y/N)		X			
25. Saline and/or alkali? (Y/N)		X			
26. Nonarable due to salinity				X	
27. Saline deposits on agricultural land					X
28. Irrigation					
a. Type	X	X	X	X	X

Data Element	1977 NRI	1982 NRI	1987 NRI	1992 NRI	1997 NRI
b. Source of water		X	X	X	X
c. Provides > ½ water		X			
d. Delivery system				X	X
29. Conservation practice(s)*	X	X	X	X	X
30. Treatment needs	X	X	X	X	X
31. Ephemeral gully erosion? (Y/N)			X		
32. Potential for conversion to cropland					
a. Soil and water problems	X	X	X		
b. Other problem(s)	X	X	X		
c. Type of effort necessary	X	X	X		
d. Potential for conversion	X	X	X	X	
33. Data for Universal Soil Loss Equation					
a. Soil erodibility factor (K)	X	X	X	X	X
b. Rainfall factor (R)	X	X	X	X	X
c. Cover and management factor (C)	X	X	X	X	X
d. Support practice factor (P)	X	X	X	X	X
e. Slope length	X	X	X	X	X
f. Slope length before terraces	X				
g. Slope percent	X	X	X	X	X
34. Data for Wind Erosion Equation					
a. Soil erodibility index (I)	X	X	X	X	X
b. Climatic factor (C)	X	X	X	X	X
c. Knoll erodibility	X	X	X	X	X
d. Soil ridge roughness factor (K)	X	X	X	X	X
e. Unsheltered distance (L)	X	X	X	X	X
f. Equivalent vegetative cover (V)	X	X	X	X	X
g. Length of rotation	X	X	X	X	X
35. Riaparian data					
a. Kind of area		X			
b. Kind of vegetation		X			

Data Element	1977 NRI	1982 NRI	1987 NRI	1992 NRI	1997 NRI
c. Width of strip		X			
36. Wildlife habitat					
a. Distance to:					
1) Cropland		X		X	
2) Forest land		X		X	
3) Rangeland or pastureland		X		X	
4) Water		X		X	
5) Wetlands		X			
6) Farmstead, built-up, roads, etc.		X			
b. Winter cover, cropland					
1) Kind		X			
2) Height		X			
3) Upright? (Y/N)		X			
37. Supplemental vegetation data					
a. Pastureland:					
1) Condition		X			
2) Canopy cover, woody		X			
b. Forest land					
1) Canopy cover, trees		X			
2) Basal area/stem count		X			
3) Diameter at breast height		X			
4) Forest understory composition		X			
5) Forage value		X			
38. Range data					
a. Range site		X	X	X	
b. Range condition		X	X	X	
c. Apparent trend		X	X	X	
d. Total woody canopy		X	X	X	

Data Element	1977 NRI	1982 NRI	1987 NRI	1992 NRI	1997 NRI
e. Woody canopy cover, by species		X	X	X	
f. Noxious weeds		X		X	
g. Concentrated flow erosion		X		X	
h. Gully erosion		X		X	
i. Streambank erosion		X		X	
j. Grazing level		X		X	
39. Earth cover determination					
a. Level 1 percentages				X	
b. Level 2 percentages				X	

The 1987 NRI

The workload-related tension that developed during the conduct of the 1982 NRI, coupled with a federal government-wide Productivity Improvement Program study in the mid-1980s, forced SCS officials to look hard at ways to streamline data collection for NRI purposes. Questions were even raised about conducting a 1987 NRI when the prospect arose of extending the RCA appraisals to 10-year intervals rather than five-year intervals (a fait accompli in the Food Security Act of 1985). But the 1972 mandate calling for a report every five years and the pending 1990 farm bill debate enticed SCS leaders to proceed with the 1987 study.

An examination of several options ensued that looked at an NRI of varying levels of intensity. One of the lowest cost options that would provide data reliable at the state level was eventually chosen. It was determined also that the 1987 NRI would focus more on data showing dynamic shifts between land cover/use, much like was done in the 1975 Potential Cropland Study.

Fewer PSUs (104,000) were selected for the 1987 NRI; all but 4,000 of these were from the PSU set used for the 1982 NRI (Tables 3 and 4). The emphasis on trend detection involved updating 1982 data in 1987. The resulting data set was not only large, but the different procedures used created complications for any attempt to compare data from one NRI to the next.

The controversy over what impact conduct of the NRI might have on day-to-day operations at the field-office level encouraged many states to use teams of trained personnel to collect 1987 NRI data. Another 30 percent of the data for the first time was collected using remote sensing techniques, which had been studied and endorsed a few years earlier by SCS scientists. For the first time also, data from worksheets were entered into computers at the state-office level, and improved software was used to complete various editing and compatibility checks. Additional software was developed that enabled SCS employees at the state-office level to access and sort NRI data without the use of a mainframe computer. This same software allowed agency personnel to share NRI data with the public more quickly and less expensively than had been the case previously.

The 1992 NRI

In response to a recommendation from the government-wide Productivity Improvement Program study, SCS leaders in 1988 established a work group that was asked (1) to look at alternative ways to collect NRI data and reduce the workload falling on field-office staff members, (2) recommend a data collection process that could be supported with an level annual budget, and (3) identify technologies that would reduce the time required of SCS staff to conduct the NRI and/or improve the quality of data collection. The report issued by that group a year later contained various recommendations designed to streamline the inventory process: (1) collect only those data needed to meet NRI

objectives, (2) use a continuous inventory process to resolve budget issues, (3) use highly trained teams of individuals at regional and state levels to collect NRI data and thereby reduce the workload for field-office staff, (4) use remote sensing and computer based technologies, including geographic information systems (GIS), to collect and manage NRI data collection, and (5) cooperate with other federal and state agencies in the data collection process. SCS leaders accepted all of the recommendations and directed their immediate implementation. State offices were given funds to select and train team members, acquire the necessary equipment, and develop plans for conducting the 1992 NRI.

When available, aerial photography was used to collect data for the 1992 NRI, verify 1982 and 1987 data, and fill in missing data from those two prior inventories. Use of 1992 photography enabled data collection to continue into 1993. The entire NRI sampling frame—300,000 PSUs and 800,000 points—was used once again, and the list of data elements was expanded from that in 1987 (Tables 3 and 4). An attempt also was made to make the data from the NRI more compatible with data in bases maintained by the Census of Agriculture, USDA's Forest Service and National Agricultural Statistics Service, the U.S. Geological Survey, and the U.S. Fish and Wildlife Service.

Errors were corrected for any data from the 1982 and 1987 NRIs, and data from the two earlier NRIs were updated to 1992 technology standards. Data elements for the nearly 200,000 PSUs not inventoried in 1987 were filled in, which enabled staff at the Iowa State University Statistical Laboratory to create a data base for that year reliable at the substate level. The result was a consistency among the first three NRIs that gave SCS officials the first-ever trending data base for the agency.

Improved software enabled the 1992 NRI data to be processed and checked for accuracy much more efficiently; as a result, the 1992 data became available within 12 months for use in the 1995 RCA appraisal process and the 1995 farm bill debate. All the 1992 PSU and point data were also digitized, making possible their use in GIS analyses. Further software improvements made the 1992 data base available for analysis on computer workstations by individuals outside the agency.

A unique outreach activity followed completion of the 1992 inventory. A series of attractive, newspaper-type graphics portraying certain results were developed and widely circulated. Those graphics subsequently were published in many magazines, newspapers, and other periodicals across the country.

The 1997 NRI

The 1997 NRI featured a continuation of the technology transition that began several years earlier. Pencil-on-paper worksheets gave way to hand-held personal digital assistants (PDAs) that not only increased the efficiency of data collection, but also ensured greater data quality and consistency. As in 1992, the full NRI sample frame was again used—300,000 PSUs and 800,000 points (Table 3). A number of data elements from the 1992 NRI were dropped in the 1997 inventory, and a number of others added (Table 4). Nearly all of those elements added had to do with fish and wildlife habitat.

NRCS personnel at 21 inventory collection and coordination sites oversaw day-to-day data-gathering activities. A single "help" desk also was established to answer questions and coordinate technical responses from subject-matter experts and the Iowa State University Statistical Laboratory. Data gatherers used photo interpretation and other remote sensing technologies to collect data on PSUs and points. GIS technologies also were used in some instances. Long-term rates of soil erosion by wind or water were calculated using cropping and management histories and other information from field-office records. Those same records also were used to determine if land was enrolled in the Conservation Reserve Program. Actual field visits to PSUs and points were made only if the aerial photography was not available or of too poor a quality.

All sample data were entered on PDAs that were capable of uploading or downloading sample records via internet protocols from a centralized server at Iowa State University. Quality assurance was monitored throughout the NRI network of professionals.

Various graphics and tables based on analyses of the 1997 NRI data were posted on the NRCS website, and portions of the findings were covered in news releases and other documents for public release. No fanfare surrounded the release of information from this inventory activity, however, as occurred in earlier inventories in the series. Because much of the data from this inventory was statistically reliable at the state level, most NRCS state conservationists encouraged the posting of state-level results from the inventory on state websites.

The 1997 NRI was also viewed internally at NRCS as a transition to a "new, continuous, interagency, natural resource oriented procedure for monitoring, modeling, analysis, and assessment." The traditional NRI, or foundation NRI, would be ongoing, but continuous inventories, much like the special NRI study completed in 1996, would likewise be done. There would also be periodic snapshot inventories,

making use of secondary data, such as satellite imagery, and inventories at local levels to support conservation planning. The hope was that data from such local-level inventories could be aggregated in a meaningful way at state, regional, and national levels.

Special NRI studies

As the list of issues on the national agricultural conservation agenda expanded in the late 1980s and early 1990s and as experience among the SCS scientists using the statistical sampling frame matured, the NRI was seen as a means to obtain intermediate snapshots of the status and condition of natural resources—intermediate in the sense that the snapshots were taken apart from the periodic NRIs. Six such special studies were ultimately conducted between 1991 and 1999 (Table 5). Each had a specific focus, and each employed only a small sample of the PSUs and points involved in the full NRI sampling frame.

The 1991 wetlands survey

The first of the six special NRIs was conducted in 1991. The sole focus of the inventory was to look at the status of wetlands relative to what had been observed in the 1982 and 1987 NRIs. Controversy over the continuing loss of wetlands, particularly those converted for agricultural production purposes, peaked in the 1980s. Moreover, the 1985 farm bill had put in place the swampbuster provision that tied wetland protection by the nation's farmers to eligibility for USDA farm program benefits. As a result, USDA administrators asked SCS officials to conduct the special NRI to affirm or deny the perception that the conversion of wetland acres was slowing across the country. The president earlier had proclaimed a national policy of "no net loss" of wetlands from year to year.

About 20,000 PSUs from the 1987 NRI sampling frame were selected for study (Table 5). Those PSUs were located in 900 counties across all states. At three points within each PSU, data gatherers recorded the wetland types that existed. The U.S. Fish and Wildlife Service's Circular 39 was used in determining the wetland types, which are identified as 1 to 20 in that circular. If a wetland code changed from 1987 to 1991, data gatherers were required to offer an explanation for why. Data collection occurred over a three-week period that summer.

Following analysis of the data collected in the special study, USDA issued a news release confirming that wetland conversions had indeed slowed from earlier in the 1980s and that agricultural activities seemingly had less impact on wetland conversions than expected.

A draft bulletin, "1991 Update of National Resources Inventory, Wetlands Data for Non-federal Rural Lands," was prepared later that year and distributed to top staff within SCS and USDA. The bulletin never received widespread public distribution, however.

The 1995 erosion update study

By 1995, more than a million farmers nationwide were to have their conservation compliance plans fully implemented. That same year marked a decade of experience with the Conservation Reserve Program. The two programs combined were thought to have brought about the single greatest period of soil conservation in the nation's history.

It was about this same time also that SCS became NRCS.

Agency leaders wanted to document what progress had been made on the soil erosion control front and determine where significant wind or water erosion problems might remain, thus the instruction to agency staff to undertake the erosion update study.

About 3,000 PSUs were selected for study—one percent of the PSUs involved in the 1992 NRI (Table 5). The sample, selected by the Iowa State University Statistical Laboratory staff, included all the PSUs examined in the 1982 and 1987 NRIs as well.

Teams of trained staff conducted the study, much like was done in the 1992 NRI. All data were collected in the field. No remote sensing imagery or technologies were used. Some points within PSUs were excluded from the sample based on ownership and land cover/use records from the 1992 NRI.

In addition to extensive land cover/use information, data were gathered on specific crops and cropping history; irrigation, including type of system; highly erodible land determination information from Farm Service Agency records; soils information; tillage type and resulting residue levels; conservation practices in place; and factors needed to work through the Universal Soil Erosion Equation and the Wind Erosion Equation.

Graphics based on analyses of the study data were posted on the agency's website, but no document summarizing those results was ever published and distributed. Program managers within the agency used the information gained from the study to ascertain where significant soil erosion problems remained around the country.

Table 5: Summary of special National Resources Inventories conducted during the 1990s by the Soil Conservation Service/Natural Resources Conservation Service

Year	Inventory	Objective	Sample Design	Sample Size	Estimation	Data Topics	Comments
1991	Wetlands survey	To update NRI data on wetlands from 1982 and 1987	A subsample of the 1987 NRI. Sample of counties selected from counties with wetland points	7,000 PSUs 22,000 Points	Inverse probability weights with 1987 NRI wetland estimates as controls	Wetland type; land cover/use; ownership	The administration requested this special study to document what was perceived to be a decline in the acres of wetlands being converted to other uses
1995	Erosion update study	To determine with national level inference, the severity of soil erosion on cropland	A multistage subsample of 1992 PSUs that were observed in 1982, 1987, and 1992 NRIs; several states selected with certainty, other states selected pps from remaining list of states; counties selected, then PSUs	3,000 PSUs 8,800 Points	Inverse probability weights with land cover/use acres and erosion rates from previous years as controls	Ownership; land cover/use; irrigation; highly erodible land; soils, tillage; conservation practices; USLE; WEQ	Special study conducted for rapid assessment of the soil erosion issue about the time conservation compliance plans were to be fully implemented
1996	NRI special study`	To measure changes in cropping patters and conservation practices made in response to the 196 farm bill and record high commodity prices	Same as 1995 erosion update study with an increased number of states, counties and PSUs	4,000 PSUs 11,600 Points	Same as 1995 erosion update study	Imagery and cartographic resources; land cover/use; irrigation; conservation practices; field definition; earth cover; cropland and non-cropland areas	USDA leaders and policymakers were interested in determining farmers' response to the so-called "freedom to farm" provisions of the 1996 farm bill; this study provided a baseline from which to measure farmers' response in subsequent years
1997	NRI special study	To measure changes in cropping patterns that might have been made in response to the 1996 farm bill	Same as 1996 NRI special study with an additional increase in the number of states, counties, and PSUs	6,000 PSUs 17,400 Points	Same as 1995 erosion update study	Highly erodible land; land cover/use; cropland and non-cropland areas; conservation practices; USLE; WEQ	A study conducted to determine changes in land cover/use (crop/no crop) following enactment of the 1996 farm bill

Year	Inventory	Objective	Sample Design	Sample Size	Estimation	Data Topics	Comments
1998	NRI special study	To measure the change in the amount of cropland between the 1997 and 1998 cropping seasons and to measure increases and decreases in the use of selected conservation practices, including those in the National Conservation Buffer Initiative	Same sample as the 1997 NRI special study	6,000 PSUs 17,400 Points	Same basic procedure as the 1995 erosion update study with more control cells	Cropland and non-cropland areas; conservation practices; water bodies; streams shoreline characteristics; highly erodible land; ownership; Conservation Reserve Program(CRP) participation; land cover/use; irrigation; USLE; WEQ	A study requested by USDA leaders to determine any changes in cropland acres from 1997 to 1998 and to measure adoption of buffer strip practices following creation of USDA's National Conservation Buffer Initiative
1999	NRI field study	To compare USLE and RUSLE technologies; collect data for input to carbon sequestration models; examine technologies and protocols for continuous NRI process	A subsample of counties and PSUs from states that were in the 1998 NRI special study and a sample of counties and PSUs from all remaining states	4,900 PSUs 14,000 Points	A study of procedures; no formal estimates produced	Ownership; land cover/use; soils; USLE; RUSLE; conservation practices	The 1999 special study was a first test of technologies and procedures to be used in an annual or continuous natural resource assessment process

The 1996 special study

A new farm bill was to have been enacted in 1995. That legislation was not passed by the Congress and signed by the president until 1996, however. Given the "freedom to farm" provisions of this bill, which had been debated extensively by members of Congress and which gave farmers across the country more latitude in what crops they could plant under USDA's commodity program rules, NRCS officials chose to undertake a special NRI study that looked at what changes in cropping patterns this new law and the higher commodity prices at the time might bring about. Specifically, the study sought to look at changes in selected land cover/use, changes in the extent and intensity of crop production, and changes in soil conservation practices on the nation's farms. The study also established a baseline for cropping conditions prior to evaluating the full impact of the new farm bill on farmers' cropping practices.

This special NRI involved about 4,000 PSUs and 12,000 points from the NRI sampling frame (Table 5). Those PSUs and points were located in nearly 400 counties. Three-quarters of the PSUs, again selected by staff at the Iowa State University Statistical Laboratory, were from the 1995 erosion update study, which permitted year-to-year comparisons of cropping patters.

Trained teams of NRCS employees once again collected the data, but in this study all data, for the first time, were recorded on PDAs. Those devices enabled team members to download data from a central server regarding the location of PSUs and points and what data were collected at those PSUs and points in prior inventories. All data for the 1996 special inventory were derived from aerial photographs, entered into the PDAs, then uploaded to the central server.

In another first for such inventory activity, this particular study was completed in cooperation with the

National Agricultural Statistics Service (NASS) and the Economic Research Service (ERS). Using a joint sample of about 1,100 NRI points, those two USDA agencies conducted interviews with the farmers involved about management practices used on fields where points were located—information that was later combined with physical and biological characteristics of the points as a means of determining conservation success and remaining areas of concern.

A short summary report of this inventory was prepared: "The 1996 National Resources Inventory Special Study—An Analysis of Agriculture's Response to New Legislation and Market Conditions." The report received no widespread public distribution, however.

The 1997 special study

The 1997 NRI special study, completed on top of the broader, every-five-year NRI, was largely a repeat of the 1996 special study. NRCS officials were interested in what changes in cropping patterns were prompted by the 1996 farm act and its "freedom to farm" provision.

A subsample of PSUs and points was again selected from the national NRI sampling frame—about 6,000 PSUs and 18,000 points in 541 counties (Table 5). Data elements included specific examination of land cover/use as a means of determining changes in cropping patterns, along with highly erodible land determination information, conservation practices installed or adopted, and factors for computing soil erosion by both wind and water.

In many respects, findings from this special study got lost in the shuffle between the larger NRI conducted in 1997 and this more meager effort.

The 1998 special study

The 1998 special NRI represented a continuation of the annual inventory activity initiated in 1996, with an added twist. USDA in late 1996 created what was called the National Conservation Buffer Initiative. This outreach initiative was designed to acquaint farmers and other land owners and managers across the country with conservation buffer practices and encourage greater use of these practices to achieve a range of natural resource management objectives, including soil erosion control, water quality improvement, and fish and wildlife habitat enhancement.

The 1998 special NRI looked once again at changes in cropping patterns in response to provisions of the 1996 farm bill, but it also attempted to measure the extent to which farmers and others might be adopting conservation buffer practices in response to the USDA initiative. In addition, this study inventoried the use of various irrigation practices, including the type of irrigation systems used and the sources of irrigation water.

As in the 1997 special study, about 6,000 PSUs and 18,000 points were included in the 1998 NRI sample (Table 5). Trained teams once again collected data from aerial photographs and entered those data on PDAs, which permitted the data to be uploaded to a central server.

As with the preceding annual studies, little emphasis was placed on public release of the data and resulting information derived from analysis of those data. NRCS officials used the data and information internally, however, for planning and program management purposes.

The 1999 NRI special study

A commitment to pursue a continuous NRI process by agency leaders in 1998 led in 1999 to the first of two special studies that would collect baseline data to plan and implement that process. Those data were collected at what were referred to as "core" sample sites—sites that were to be subsequently sampled on an annual basis as the continuous NRI evolved.

Between 4,000 and 5,000 PSUs and about 14,000 points were included in the 1999 study (Table 5). Those PSUs and points were located in 444 counties in all 50 states, the Caribbean Region, and the Pacific Basin.

Data elements included many of the same items from prior NRI work, including land cover/use, ownership, and other data. Data were also collected to evaluate comparatively two prominent soil erosion prediction tools: the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE). Those data included field slope and related soils information, crop rotation information, and details on the conservation practices in place.

Given that the 1999 special study was a test of technologies and procedures for the continuous NRI, the data gathered and their subsequent analysis were used almost exclusively in house as a basis for future inventory work.

The Annual or Continuous NRI

An annual or continuous NRI process, first floated as an idea in the late 1980s, encouraged by agency leaders in the mid-1990s, and officially endorsed by those leaders in 1998, became a reality in 2000. That year the second baseline study was conducted that established a foundation for what has become an ongoing inventory activity designed to produce long-term trend information while permitting the acquisition and analysis of data on specific aspects of natural resource status and condition. The annual or continuous NRI also was intended to smooth out the natural resource inventory workload from year to year for agency employees and promote greater efficiencies in data collection and quality assurance. It was intended as well to result in a data base that provided estimates similar to those from previous NRIs and allow NRCS officials the opportunity to increase the breadth of inventories and analyses supported by the NRI.

An internal memo issued in June 1998 to NRCS leaders outlined the mission of the continuous inventory as follows:

"The traditional 5-year inventory cycle served us well. It allowed us to meet our Congressional mandate to assess the status, conditions, and trends of soil, water, and related resources on the Nation's non-Federal lands on a regular basis. It has given us powerful, detailed information on natural resources and their trends over nearly 20 years. However, in order to address today's broader spectrum of rapidly evolving natural resource issues, we need a more dynamic, flexible mechanism for collecting resources data. The traditional 5-year NRI cycle, with its pronounced up-and-down production effort, is an inefficient way of doing business and limits our readiness to perform specific topic studies requiring short turn-around times.

"A continuous inventory approach will allow us to collect data on a regular basis in order to perform annual updates on topics of greatest concern to USDA, NRCS, and our customers. Credible, high quality, timely information provided by a continuous inventory will be critical to providing the scientific basis for agricultural and environmental program and policy development, implementation, and evaluation. Additionally, the continuous inventory will provide information essential for strategic planning and performance measurement.

"The continuous inventory will feature an annual inventory of a subset of the 300,000 Primary Sampling Units (PSU's) nationally. Our current target is for 80,000 PSU's, of which a core set of approximately 45,000 PSU's will be inventoried every year and the remaining 35,000 PSU's will be selected on a rotational basis with varying frequencies. In addition, special ad hoc studies that focus on current issues of interest may also be conducted utilizing sub-samples of the 300,000 PSU's. Topics of local interest may be pursued through complementary efforts to collect and assimilate additional data for smaller areas. Local area participants will be part of the process in defining needs and protocols and providing resources and funding."

The transition to an annual NRI was to occur over several years. It was anticipated that several years of inventory work would be needed to approximate the statistical reliability of the final every-five-year NRI conducted in 1997.

In the first of the series of annual or continuous NRIs, conducted in 2000, baseline data were gathered on about 42,000 PSUs (Table 6). Those data were used to establish the statistical basis for annual NRI work in subsequent years.

The Annual NRI, 2001-2012

In the annual or continuous NRI, NRCS officials sought to accumulate data and information about the status and condition of soil, water, and related natural resources and trends in land use, land conversion, soil erosion, conservation practice application, and wetland protection and conversion. This information was seen as necessary for progress reports to the administration and Congress, for strategic planning purposes, and to assess program performance. Technologies and protocols useful in making the transition to a continuous NRI were also studied further, as were statistical estimation procedures.

Data collection to meet the objectives of the continuous NRI began in earnest in 2001 (Table 6). The core sample of 42,000 PSUs was observed, along with a rotating sample of about 31,000 PSUs not observed since 1997. The PSUs were located in all states, except Alaska, and the Caribbean Region.

The rotational PSUs involved in this and later annual NRI activities were not sampled every year. Some rotational PSUs are sampled more frequently, while others are sampled less often depending upon the characteristics of the PSUs. For example, does that PSU contain urban land or cropland or wetland?

The data elements involved in the 2001 NRI were much the same as in prior inventories: the amount of land in farmsteads, built-up areas, and rural transportation; ownership data; Conservation Reserve Program contract information; soils data; land

cover/use; irrigation-related data; conservation practice application; wetland status; salinity; and factors needed to calculate soil erosion by wind and water. A list of resource concerns existing at each point was also constructed.

All data collected in the 2000 and subsequent continuous NRI efforts, including 2001, were extracted from aerial photographs via photo interpretation by specialists within NRCS. Data gatherers also have access to field-office records, soil survey information, and other materials available within the agency. Statistical estimation procedures were then used to expand the data to conform to known land acreages and related information. The resulting NRI data base, like all prior NRI data bases, thus represents a series of estimates regarding any of the factors involved. The statistical precision of those estimates depends entirely upon the number of samples involved in a particular region, the characteristics of the natural resources in a region, and what sampling procedure and statistical estimation procedures were used. NRCS scientists report a margin of error for all NRI results. Generally speaking, the annual NRI data collected thus far are statistically reliable at the state and national levels.

The 2002 annual NRI essentially duplicated the 2001 effort, except that data were collected on only about 51,000 PSUs and 150,000 points. The shortfall in PSUs and points examined was the result of a last-minute time and budget constraints. Data elements remained similar to those in 2001.

In 2003, data collection mirrored that of the two prior years, and the number of PSUs and points examined returned to near the planned number of 73,000 PSUs and 219,000 points. Data elements were largely the same as in 2001 and 2002 as well.

Further time and budgetary constraints on NRI work were confronted in 2004 when only data from the core sample of 42,000 PSUs were collected. This resulted in a decision to combine the work from 2004 with that conducted in 2005. Data from the rotating sample of 31,000 points that should have been collected in 2004 was collected in 2005, and that data was combined with the core sample data from a year earlier as a 2004-2005 data base. Data elements once again largely duplicated those in the earlier annual NRI work.

A similar combination of data occurred as a result of split collections in each of 2006 and 2007. The data elements involved in those collections again remained consistent with those in the earlier annual inventories. From 2008 – 2012 the sample has remained consistently around 72,000.

Throughout the annual NRI activities, an effort has been made to maintain and protect data collected at each PSU and point from 1982 on, thus preserving the trend data as an important component of the overall NRI work. More recent annual inventories also have sought to test certain on-site data collection protocols, for example, procedures for gathering agronomic information, and using new assessment tools, such as digitized materials and geospatial inventory and monitoring techniques.

The Annual NRI—range emphasis

Among the objectives of the continuous NRI process outlined initially was the potential to undertake special inventories relating to emerging natural resource management issues. While range-related issues were not new to agency personnel by any means, increasing concern about the lack of data on the status and condition of the nation's rangeland prompted NRCS leaders to request about the turn of the century that some special focus be given to this particular issue. As a result, beginning in 2003, NRI administrators initiated a multiyear examination of PSUs that likely included rangeland.

Prior to 2003, NRI staff conducted a series of rangeland pilot studies to test rangeland data collection protocols. Those studies were conducted on PSUs and points that were not part of the NRI sampling frame, and the data collected during those pilot studies are not included in the NRI rangeland data set that has been accumulated in more recent years.

Beginning in 2003, staff at the Iowa State University Statistical Laboratory drew a sample of PSUs each year from the core and rotational samples included in the annual NRI (Table 6). Sample selection was based on the likelihood that at least two points within a PSU were rangeland, based on earlier observations of aerial photography used in the annual NRI. In general, about 60 percent of the sample PSUs selected each year was from the core sample and the remaining 40 percent was from the rotational sample:

2003 – 618 PSUs (all from the rotational sample)
2004 – 2,369 PSUs (966 from the rotational sample, 1,403 from the core sample)
2005 – 2,311 PSUs (987 from the rotational sample, 1,324 from the core sample)
2006 – 1,933 PSUs (905 from the rotational sample, 1,028 from the core sample)
2007 – 1,319 PSUs (1,292 from the rotational sample, 27 from the core sample)
2008 – 2012 1,400 PSUs

With the exception of ownership information, which was determined in advance of any other data collection, all rangeland data in all years were collected on site. Protocols for on-site data collection remained essentially the same across the ten years of record.

Among the data elements included were ecological site information, gully erosion, rangeland health, noxious and alien plants, evidence of disturbance, conservation practices present and needed, and resource concerns (see Table 6 for a more complete list).

NRI staff members analyzed 2003-2008 data for a report released in 2010.

Table 6: A summary of natural resource inventory activities conducted by the Natural Resources Conservation Service, 2000-2007

Year	Inventory	Objective	Sample Design	Sample Size	Estimation	Data Topics	Comments
2000	Annual NRI	To gather baseline data at core sample sites (42,000 PSUs); these data were then used during the statistical development of the 2001 annual NRI database	NRI sampling units have been established across all parts of the nation using a stratified two-state, unequal probability area sampling scheme. The first-stage sampling unit, or primary sampling unit (PSU), is an area/segment of land; the second-stage sampling units are points located within the PSUs. The national "foundation" or framework sample consists of about 300,000 PSUs and 800,000 sample points. Data are collected for both the first- and second-stage sampling units using remote sensing (photo interpretation), supported by onsite field investigation.	Core sample of 42,000 PSUs nationally.	Two-phase estimation using 1997 as the first phase; imputation for some nonobserved segment data	Farmsteads, built-up areas, rural transportation and water areas; ownership; CRP contract information; soils; land use; irrigation; conservation practices; wetlands; salinity; USLE factors; WEQ factors; resource concerns	The 2000 NRI was a second step in testing technologies and procedures to be used in conducting annual or continuous natural resource assessment process.
2001-2003	Annual NRI	To provide reports to Congress on the status, condition and trend of land use, land conversion, soil erosion, conservation practice application, and wetlands to provide information to formulate agency strategic planning target and assess performance; to examine and protocols to further the agency's transition to fully	Same sampling design as used in 2000	Core sample of 42,000 PSUs and rotating samples of 31,000 PSUs in each of three years not sampled since 1997; 49 states and Caribbean Region.	Similar to 2000 annual NRI; Imputed dated for years not observed in panel	Farmsteads, built- up areas, rural transportation and water areas; ownership; CRP contact information; soils; land use; irrigation; conservation practices; wetlands; salinity; USLE factors; WEQ factors; resource concerns	Data were ultimately gathered on about 70,000 PSUs in 2001

Year	Inventory	Objective	Sample Design	Sample Size	Estimation	Data Topics	Comments
		operational phases of continuous inventorying and monitoring, including institutions for monitoring using instructions for monitoring using nationally consistent and high quality aerial photography, use of digital imagery with development of appropriate inventorying and monitoring tools and procedures, and development and testing of statistical estimation procedures that will become a vital part of the continuous inventory process					
2003-2012	Annual NRI-range emphasis	To collect data on the status, condition, and trends of rangeland, which was perceived as being underemphasized, if not neglected, in prior NRI work; these inventories were conducted via field studies as opposed to photo interpretation	Three points within each PSU are randomly selected so viewing points in numerical order prevents bias; point 1 is visited; if range, data are collected; if not, point 2 is visited; if range, data are collected; if data are collected for points 1 and 2, data collection is complete; if not, point 3 is visited; if range, data are collected	About 600 PSUs were included in the first year's inventory, 2003; 2,400 were examined in each of the subsequent four years; 1,400 per year thereafter.		Ownership, land cover/use, landscape and soils information, ecological site information, gully erosion active cutting, apparent rangeland trend, rangeland health (17 indicators), noxious and invasive/alien plants, disturbance (26 past and present indicators), conservation practices(14 practices present and needed: sets of applied practices vary by state) resource concerns (22 concerns, began recording in 2004), soil surface stability line point	A similar survey of pastureland is planned once the rangeland survey has been completed, which will give NRCS a more comprehensive picture of the status and condition of grazing land resources nationwide

Year	Inventory	Objective	Sample Design	Sample Size	Estimation	Data Topics	Comments
						transects for canopy gaps (basal gaps recorded only for points identified for ecological site development), cover density and height, species composition by weight, (for woody and herbaceous plants)	
2005 - 2006	Annual NRI	To collect 2004 and 2005 data using photo interpretation for an annual observed core sample (42,000 PSUs) and a rotating sample (31,000 PSUs) each year; to incorporate new resource assessment tools using digital materials and further developing geospatial inventory techniques, monitoring tools, and data collection procedures	Same sampling design used as in 2000	42,000 core sample PSUs, 31,000 rotating sample PSUs, 2,400 PSUs included in assessment of rangeland (60 percent from core sample, 40 percent from rotating sample)	Two-phase type estimation with GLS estimates as controls; imputation to 1997 size data set; calibration of new data collection procedures	Farmsteads. built-up areas, rural transportation and water areas; ownership; CRP contact information; soils; land use; irrigation; conservation practices; wetlands; USLE factors; WEQ factors; resource concerns	Additional data collected relating to RUSLE2 for future use
2007-2012	Annual NRI	Same objectives as 2005 annual NRI for 2006 and 2007 conditions	Same sampling design used as in 2000	42,000 core sample PSUs; 1,400 PSUs included in assessment of rangeland.	Similar to 2005 annual NRI	Built-up areas, rural transportation and water areas; ownership; CRP contract information; soils; land use; irrigation; conservation practices; wetlands; USLE factors, RUSLE2 inputs; WEQ factors; resource concerns	

The NRI in retrospect

With the experience of several CNIs and the Potential Cropland Study behind them, along with the encouragement of important congressional edicts, SCS officials sought to initiate an NRI process in 1977 with the construction of a permanent statistical sampling frame that could be used periodically to provide credible information on the status and condition of soil, water, and related natural resources. The prospect of acquiring trend-line data and information on land use, land cover, and other data elements was paramount as well.

In the 30 years since, the NRI has become an iconic natural resource inventory activity. It not only has provided valuable information on the status and condition of natural resources on nonfederal land, but also has prompted important public policy proposals, aided the administration of conservation programs within USDA, facilitated wide-ranging analyses of trends in land cover and use, and permitted scientists, both within and outside of USDA, to answer a whole series of "what if" questions relevant to conservation policymaking and program delivery.

Data Collection: PSUs and Points

How many PSUs and points are involved in each NRI, of course, determines a number of things, not the least of which is the statistical reliability of the resulting data set. And while the statistical sampling frame has been one relative constant over the 35 years of resource inventories conducted under the NRI umbrella, that sampling frame has been used in a variety of ways to ascertain the status and condition of soil, water, and related natural resources on the nation's nonfederal land and establish trends in the use of those resources.

The NRI sampling frame, as it now exists, evolved largely from the sampling design and frame used in the earlier CNIs. The 1977 NRI, for example, involved 70,000 PSUs (or segments as they are now called) first used in the 1958 CNI. Two or three points were selected in each PSU, depending upon the size of the PSU, and a new procedure for selecting points within certain PSUs was adopted. Added emphasis was given in the 1977 NRI to accounting for acres in farmsteads, built-up areas, small streams, and water bodies. A new procedure for determining the total inventory or control acres also was adopted.

That first NRI, referred to initially as the 1977 Erosion Inventory, established the basis for the greatly expanded 1982 NRI mandated by the Rural Development Act of 1972 and the Soil and Water Resources Act of 1977. The 1982 NRI involved a greatly expanded sample of PSUs—321,000—to meet national needs; another 44,000 PSUs were selected in a limited number of states that opted to undertake local-area inventories. The expanded national sample frame enabled SCS scientists to assemble a data set statistically reliable at the substate or major land resource area (MLRA) level.

The aforementioned tension that developed between the national SCS staff and staff members in state and local offices over NRI-related workload issues during the 1982 NRI forced agency leaders to pare back their data collection effort for the 1987 NRI. That year, only 108,000 PSUs were examined, 4,000 of which were new PSUs, not included in the 1982 sampling frame. Data for nearly a third of the PSUs were collected by examining aerial photographs as opposed to the traditional field visits. Statistical procedures used in 1987were then modified so the results from this smaller sample of PSUs and points could be reasonably compared to the 1982 data.

In 1992, SCS leaders chose to expand the NRI sample to 300,000 PSUs and 800,000 points. This particular inventory involved a large subsample of the PSUs included in the 1982 NRI, including all of the PSUs examined in the 1987 NRI. A small number of new PSUs also were added to improve sampling procedures in certain areas. Statistical procedures were used to enhance the 1987 NRI data set for PSUs examined in 1992 but not in 1987, and procedures were once again implemented to achieve a degree of comparability in the 1982, 1987, and 1992 data sets.

The 1997 NRI involved the examination of the same 300,000 PSUs and 800,000 points used in 1992.

It was in the 1990s also that SCS/NRCS leaders began to use the NRI sampling frame in more creative ways to obtain snapshot inventories relating to specific soil, water, and environmental management issues. Those special studies, beginning with the wetlands survey in 1991 and progressing through five additional studies completed during the remainder of the decade, used subsamples of PSUs from the national NRI sampling frame to obtain data and information helpful for policymaking and program management purposes.

Those subsamples of PSUs generally were small, ranging from about 3,000 PSUs included in the 1995 erosion update study to 20,000 PSUs selected for the 1991 wetlands study. The subsamples of PSUs drawn for each study were in states and counties where

land use and study focus most appropriately matched, for example, areas of the country where wetlands predominated or highly erodible cropland was most pervasive.

Evolution of the NRI, particularly the up-and-down nature of the workload associated with conducting the periodic inventories between 1977 and 1997, led in 2000 to initiation of what is now called the annual or continuous inventory process. Driven in large part by attempts to smooth out budget and manpower requirements from year to year, the annual NRI, according to NRCS officials, is intended to continue the process of accumulating "relevant, timely, and scientifically credible information on natural resources and the environment" and create an "interagency ecosystem-oriented process for inventory, monitoring, and assessment." Over time, this new approach is to continue to provide the important trend-line data and information contained in the 1982, 1987, 1992, and 1997 NRIs and at the same time give agency officials the opportunity to gain periodic snapshots of specific natural resource conditions, much like was done in the series of special studies conducted in the 1990s.

The annual NRI process, as designed, involves a core sample of 42,000 PSUs and 116,000 points that are examined each year. A rotating sample of 31,000 PSUs and 93,000 points is then selected and examined annually to complement the core sample. All of those PSUs and points are from the national NRI sampling frame.

Time and budget constraints altered the conduct of the continuous NRI in its first seven years. For example, only the core sample of PSUs and points was examined in 2000. Then, in 2004 and 2006, budgetary and other constraints again limited the number of PSUs and points examined to those in the core sample only. As a result, data were collected the following years, 2005 and 2007, respectively, at PSUs and points included in the rotating sample only; the data for 2004-2005 were then combined, as were those from 2006-2007, to achieve one year's data set in each case.

The upshot of this approach to data collection is to produce an NRI data set as of 2012 that will approximate the data sets produced by the 1982, 1987, 1992, and 1997 NRIs.

As mentioned earlier, the precision of NRI statistical estimates varies depending upon the number of samples involved in a particular inventory activity, along with the specific sampling procedure used and the statistical estimation technique. The scientists involved in NRI inventories design their statistical methods to address specific situations. Estimation goals change and new issues arise as more data are acquired. The approaches now used to develop estimates based on photo interpretation have evolved over time to address trending issues and new statistical methodologies.

Estimates of a particular data element or resource condition can always be calculated at a lower geographic level, for example, at a state or substate level, as opposed to a national or regional level, but the standard error accompanying such estimates may be large indeed. Research is currently underway to achieve statistical reliability for county-level substate estimates in future photo-interpretation study releases.

The Data Elements

During the first four decades that SCS existed, the primary focus of agency employees was on the control of soil erosion by wind and water as a means of protecting the productivity of the nation's agricultural industry. In the 1980s and 1990s, in large part because of the agricultural industry's excess productive capacity, a transition occurred. That transition moved the focus of SCS/NRCS employees' work on a day-to-day basis from protecting the land's productive capacity to the simultaneous production of multiple environmental benefits, such as air and water quality improvements, wetland protection, enhanced fish and wildlife habitat, and carbon sequestration.

Agency leaders viewed the 1977 NRI as the first comprehensive and nationwide survey of soil erosion. Specific data elements were included that could be used in the Universal Soil Loss Equation and the Wind Erosion Equation to estimate soil erosion levels (Table 4). As in the earlier CNIs, data elements on land use and conservation treatment needs were also included.

The list of data elements included in the 1982 NRI expanded significantly over what was included in 1977. The 1982 NRI established what might be considered a core set of data elements that were examined in all subsequent NRIs. It is this core set of data elements for which trend-line information now exists (Table 4).

A set of "derived variables" also resulted from the 1982 inventory (Table 4). Those variables initially included estimates of soil erosion by both wind and water. In later NRIs, soil erosion indices and several habitat and other environmental indices were likewise added.

The data elements included in the special NRI studies conducted in the 1990s, of course, were determined by the purposes of those specific studies, and the continuous NRI work to this point has focused largely on the core set of data elements needed to maintain the integrity of trend-line information, along

with the set of data elements being collected to determine the status and condition of rangeland.

Agency leaders, as part of their ongoing natural resource appraisal and strategic planning exercises, have largely determined which specific data elements were included in the series of NRIs conducted to date. But external interests have sometimes proved instrumental in constructing the lists as well. Scientists with the Economic Research Service and academic institutions, for example, worked closely with SCS and NRCS officials in the 1980s and 1990s to collect specific data elements that would facilitate policy analyses and program evaluations.

Data Collection Technologies

Each NRI begins with the development of an elaborate set of instructions. Those instructions explain why a particular inventory is being conducted, what specifically is to be examined, and how the data are to be collected and recorded.

Initially, data collection efforts involved field visits only. Data were recorded in pencil on worksheets that were subsequently passed up to state offices, then national offices for aggregation and analysis. This approach relied largely on the capacities of staff in agency field offices across the country to complete the data collection activities in a timely, accurate fashion, and it was this workload on those local office staffs during the conduct of the 1982 NRI that generated the tension that developed between personnel in the agency's national office and staff members at state and local levels. The result was a much less ambitious NRI activity in 1987 and consideration of alternative ways of gathering data. That year, numerous states opted to use trained teams of personnel, rather than field-office employees, to collect NRI data in the field, and nearly a third of the data collected overall was extracted from aerial photographs. For the first time also, data from worksheets were entered into computers at the state-office level. This beginning of the transition to use of computers also expanded the agency's ability to share NRI data with the public.

Aerial photography was used much more extensively in the 1992 NRI, and advances in computer hardware and software permitted more timely processing of data. Quality control also improved as a result. In addition, all 1992 NRI data were digitized for the first time, expanding dramatically the capacity for analysis of that data by scientists both within and outside of USDA.

About this same time, extensive discussions occurred with other federal natural resource agencies about the prospect of coordinating inventory activities and creating data bases that might be more compatible, thus expanding the potential for analyses. At one point a high-level interagency task force spent considerable time and effort contemplating such coordination. Little substance resulted from this activity, although NRCS leaders used the discussion as a basis for commissioning a blue ribbon panel of experts in 1995 to offer recommendations for improving data collection and analysis within the agency.

It was in the mid-1990s, in conjunction with the 1997 NRI and the NRI special studies being conducted about the same time, that paper worksheets gave way to use of hand-held PDAs, which reportedly increased the efficiency of data collection and improved data quality and consistency. PDAs enabled the downloading of information about PSUs and points from a central server and the uploading of data collected. A series of 21 inventory collection and coordination sites and 151 data collection offices also were established as part of the 1997 NRI, along with a "help" desk that was charged with answering questions and coordinating technical responses from agency specialists and Iowa State University statistical experts. More extensive use was made of remote sensing, GIS, and photo-interpretation technologies. Field visits occurred only if acceptable aerial photographs were unavailable. Still to be answered are questions surrounding what application satellite imagery and the developing sensor and related technologies might have in the conduct of the NRI.

With the advent of the annual or continuous NRI in 2000, interpretation of aerial photography became the exclusive means of data collection, save for the field studies necessary to complete such special studies as the rangeland inventory begun in 2003. Use of aerial photography dramatically reduces the cost of obtaining valuable natural resource data. The downside to using this technology is that some conservation practices, subsurface drainage, for example, simply cannot be seen on photographs of any type. If such practices are important to the inventory work planned, field studies will be required. Over time, NRCS scientists intend to combine field-input data with data based on photo interpretation to improve estimation of such variables and their qualitative nature.

After the turn of the century also, NRCS leaders chose to create three remote sensing laboratories to facilitate more efficient collection and processing of NRI data. Those laboratories replaced the inventory collection and coordination sites and data collection offices established several years earlier. The laboratories are staffed with permanent employees, including disciplinary experts, who spend full-time on NRI data collection and processing chores. This staffing approach has eliminated the need to periodically train

staff to do NRI-related work that is not part of their normal day-to-day activities.

Analyses and Outreach

The comprehensive nature of the 1982 NRI piqued the interest of policy experts and technical specialists in using the data for a variety of policy, program, and related analyses. Once trend-line information became available, particularly following the 1992 NRI, scientist within and outside of SCS/NRCS sought to link this information with soil interpretations and other data in more robust analyses of soil and water conservation issues. Such linkages were greatly enhanced by the development of mathematical models that facilitated answers to a long list of "what if" questions. For example, SCS scientists in the early 1990s devised a series of maps using NRI data that showed the potential for nitrate and phosphorus pollution on cropland across the United States. Similar analytical and modeling exercises began in the 1980s at USDA's Economic Research Service and numerous academic institutions. More recently, such modeling exercises have underpinned the ambitious Conservation Effects Assessment Project (CEAP) undertaken by NRCS in 2003. Leaders in several states, including Missouri and Oregon, likewise have used NRI data in the administration of conservation cost-share and agricultural land protection programs.

The focus of analyses using NRI data also has expanded dramatically in the past decade or two. Originally, the emphasis in the NRI was on land productivity, conservation treatment needs, land use, land cover, and other factors related to agricultural production. NRI data, for example, were used in the 1980s to map prime and unique farmland. Now, points of emphases include land use change, particularly land conversion; wetland gains and losses, carbon accounting and sequestration on agricultural land; evaluation of conservation policy and program effectiveness; and trend information, especially how much a particular data element or elements have changed over time.

The sharing of NRI data and results of internal analyses by SCS/NRCS scientists with interested researchers and the public was given considerable impetus in the mid-1980s by the National Academy of Sciences. A panel of scientists assembled by that institution encouraged SCS to make NRI data more accessible and useable by researchers both within and outside of USDA, and participants in a subsequent symposium sponsored by the academy offered ideas on how NRI data might be used more extensively (see box on "Important NRI literature").

Those academy sponsored activities raised questions about the confidentiality of NRI sample-site details. This issue has become much more contentious in the past decade, and NRCS in 2001 adopted a policy that essentially prohibits the release of any specifics with regard to sample-site locations. This limitation could constrain the use of NRI data for certain public policy and program analyses.

A Collaboration with the National Agricultural Statistics Service (NASS)

When NRCS undertook its ambitious Conservation Effects Assessment Project (CEAP) in 2003, agency scientists sought, via simulation, to answer a series of critical "what if" questions regarding conservation needs and how to address those needs most effectively and efficiently. The mathematical model used for those simulations, however, required the combination of biophysical data, such as location and soils, with management data, such as cropping systems and conservation practices used, and economic information. The NRI, of course, provided the biophysical data, but not the management and economic information.

As a result, NRCS scientists, from 2003 through 2006, collaborated with National Agricultural Statistics Service researchers on a nationwide social science survey that provided the necessary data and information to facilitate the CEAP modeling effort. A series of elaborate questionnaires was devised and used each year by NASS scientists to collect the needed information on a field basis at each NRI point. Among the data and information collected were conservation practices in use, cropping histories, management practices applied, whether a farm had a conservation plan applied, evidence of wildlife presence, and personal information about farm operators. The biophysical data from the NRI were then combined with the social science survey data in a way that enabled the modeling effort to proceed.

Participation in the NASS surveys was voluntary, and NASS officials have kept secret any proprietary information collected.

This collaboration has prompted hope among NRI data users that Common Land Units (CLU) might become the basis for linking information from the NRI with information from the Farm Service Agency (FSA) and NASS. A suggested first step might be for NRCS, FSA, and NASS to relate the data they collect to the CLU structure. This could greatly enhance capacity for simulations like that completed in recent years by NRCS and NASS.

In addition to sharing much of the NRI data with the research community, SCS/NRCS officials have from time to time undertaken extensive public outreach activities. Following release of 1982 NRI data, for example, SCS leaders encourage the agency's state offices and conservation districts to package and widely circulate results important in a particular state. In fact, financial support was offered to conservation districts to undertake such activities.

Outreach activities have since ebbed and flowed, however. A series of *USA Today* "factoids" produced using 1992 NRI data were distributed widely across the country to newspapers, farm magazines, and other print media. After release of 1997 NRI data, a CD containing those data was assembled and made available to researchers. Agency leaders also directed that state office personnel post appropriate national and state results on their websites as their primary outreach activity. Some state office leaders took the directive to heart and assembled extremely informative web pages.

A review of all NRCS state-office websites in early 2008 showed, however, that little updating has occurred since 1997. A very few state leaders have posted what NRI data have been released in more recent years, mainly estimates of soil erosion on agricultural land as of 2003, but most users, or potential users, must still rely on 1997 data. That presents a dilemma for even NRCS program administrators who long ago began to factor NRI results into the formulas they use to dispense conservation program funds to states from year to year.

New Uses for NRI Data

Any list of new uses for NRI data might have some limits, but that list likely extends far beyond what utility SCS or NRCS officials have extracted from the inventory activity to date. And that list hinges first and foremost on maintenance of what might be termed the foundation NRI—those periodic inventories that have established a wealth of trend-line information on the status and condition of soil, water, and other natural resources; changes in land use and land cover; and so forth. This information has proved indispensable to those NRCS officials who must justify the public's investment in conservation on nonfederal land to members of Congress and others who influence the policy process, to those agency leaders who make decisions on conservation priorities and funding allocations among states, and to those individuals within the agency who have responsibilities for strategic planning and performance measurement.

While a great deal of emphasis has been placed in the past on using the NRI for conservation needs assessment purposes, far more could likely be done to document where specific conservation and environmental problems exist on the American landscape and just how severe those problems are; what types of conservation practices might most effectively be used to address those problems, along with the cost of doing so; and what options exist to deploy available personnel and funds to address those issues in the most effective manner. New environmental indicators could be incorporated into NRI data collection as well to address emerging issues. For example, the nation continues to lack comprehensive, useful information about the health of riparian areas.

Some history exists with respect to use of the NRI as a framework for simulation. Economic Research Service economists long ago tapped the NRI data bases for important analyses of land use conversions generally, wetland conversions, and questions relating to USDA conservation program performance. SCS/NRCS scientists likewise used NRI data bases for simulations of potential pollution problems. More recently, agency scientists, in collaboration with researchers from the Agricultural Research Service and academic institutions, initiated much more ambitious simulation exercises as part of the CEAP activity. The potential to extend this type of analysis remains significant, however.

Finally, there remains enormous potential to combine NRI data with data sets generated by other agencies in ways that enhance the value of all the data sets.

In Conclusion

Hugh Hammond Bennett had the foresight to undertake the National Erosion Reconnaissance Survey in the 1930s. The resulting impact on public policy was profound. Fortunately, Bennett's successors in SCS and NRCS realized the value of continuing such natural resource inventory work, first, in the form of the CNIs and, later, as the NRIs. The data and information generated from those activities clearly have enhanced the agency's ability to articulate the need for and value of a national soil and water conservation program and to justify a significant and continuing public investment in that program. Conservation program administration also has improved as a result. The challenge for NRCS seemingly is to maintain the integrity of the NRI sampling frame and use that sampling frame not only as an ongoing natural resource inventory tool, but also extend the value of the NRI and its outputs for more sophisticated conservation needs assessment and simulation purposes.

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