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A Resources Conservation Act Report

Interim Appraisal and Analysis of Conservation Alternatives

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This report is a publication of the Natural Resources Conservation Service (NRCS). As the Department of Agriculture's lead conservation agency, NRCS works in partnership with the American people to conserve and sustain natural resources on private lands.

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USDA/NRCS

A Resources Conservation Act Report

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Overview

In 1977, Congress passed Public Law 95-192, the Soil and Water Resources Conservation Act, which addressed the importance of conserving soil and water resources on private and other non-federal lands. The Act directed the U.S. Department of Agriculture (USDA) to develop a national soil and water conservation program and to periodically assess the condition of the nation's soil, water and other natural resources.

Since then, USDA has issued several reports that assess the condition of and trends in soil, water and related resources. The results guide the department's soil and water conservation priorities and have been the basis for improvements in the nation's overall conservation efforts.

In 1982, responding to extensive public comments that strongly favored linking USDA benefits with conservation goals, the Department introduced the concept of cross compliance in the national conservation program. Congress subsequently incorporated cross-compliance provisions for highly erodible lands and for wetlands in the 1985 farm bill.

In 1989, the program update focused on critical resource problems and on the need to strengthen conservation partnerships. Conservation priorities included reducing the damage caused by excessive soil erosion on rural lands and protecting the quality of surface and ground water against harmful contamination from non-point sources. Conservation provisions in the farm bills of 1990 and 1996 incorporated many of these priorities.

This report, "A Resources Conservation Act Report: Interim Appraisal and Analysis of Conservation Alternatives," describes conditions and trends in soil, water and other environmental resources based on the most recent work of USDA's National Resources Inventory, Census of Agriculture and other reliable government and non-government sources. It discusses conservation needs identified by USDA, conservation partners and numerous land users through discussions at public hearings and other forums and during deliberations over proposed legislation and policy.

The report identifies technical assistance and financial incentives to accomplish different resource conservation objectives based on analysis of possible conservation initiatives. The initiatives include reducing erosion on all cropland, implementing a cropland stewardship proposal, accomplishing two million miles of buffers for the nation's waterways, enrolling 250,000 additional acres per year in the Wetlands Reserve Program, investing $65 million per year in the Farmland Protection Program and expanding the Conservation Reserve Program to 45 million acres. Overall results indicate that there are significant opportunities to improve soil, water and other environmental conditions into the future.

Partnerships with state, local and tribal governments, conservation districts and landowners form the core of USDA's conservation programs. The Department's expert technical assistance, available to landowners who request help, is the basis for program successes. Economic incentives for conservation practices also play a vital role in the conservation programs.

People and Resources

The human element — agriculture's number one resource

The United States produces the safest, healthiest, most abundant and least costly food and fiber products on Earth. Consequently, the nation has the capacity to feed not only its own people but also millions of others. Given the pivotal role of the United States in a world where concerns about food supplies and development of natural resources are becoming increasingly prominent, it is in the country's national security and economic interests to maintain a strong, dynamic agricultural sector.

Central to a healthy agricultural system are the nation's millions of land users, many of whom work the land through family-owned or family-held corporations and partnerships (Figure 1 and Table 1). These farmers, ranchers and other landowners are backed by state and federal food-safety regulations and food-health inspection systems in their efforts to produce safe and healthy food and fiber products. And they know best that their success depends on the condition and quality of the land's soil and water resources. Their active cooperation is essential to conserve high-quality land and water resources that, in turn, are key to healthy urban and rural communities and viable wildlife habitat as well as many other environmental values.

LAND FACTS

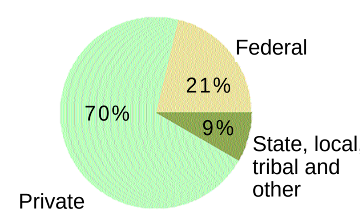
Almost 1.5 billion acres (about 76 percent) of land in this country outside Alaska are owned by private individuals and state, local and tribal governments. Most of that amount is "working land" — cropland, pastures, rangeland and private forest tracts.

See Appendix A for more land facts.

Keeping land, water and air resources healthy is one of the greatest conservation challenges facing this nation in the foreseeable future.

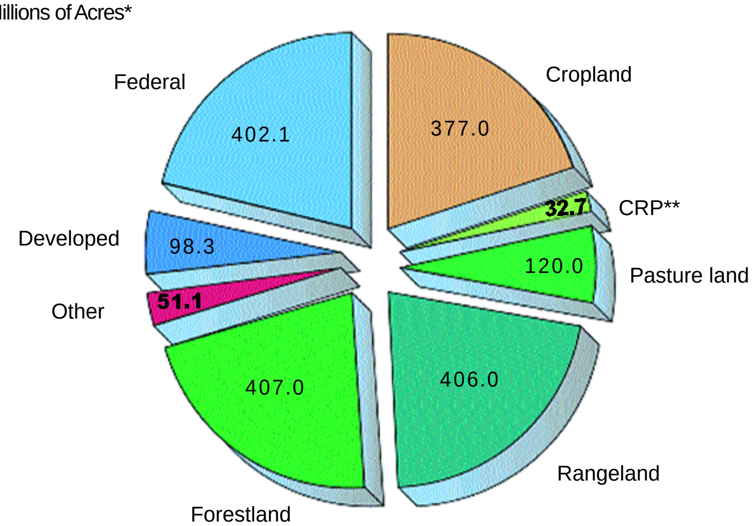
FIGURE 1.

Percent of U.S. land ownership



How the land is used

Millions of Acres



*Non-federal Land: 1,491.1 million acres, including conterminous United States, Hawaii, Puerto Rico and U.S. Virgin Islands.

**Conservation Reserve Program Land

Source: USDA, Natural Resources Conservation Service 1997 National Resources Inventory Revised December 2000

Changing social and economic conditions

The total amount of land in farms, which peaked at about 1.2 billion acres in 1950, declined to a little more than 930 million acres in 1997 (Appendix A; Note: in this discussion, “farms” includes ranches). But the amount of land on U.S. farms used for crops has remained about the same since the 1920s.

The number of farms in the United States has steadily dropped over the years, from 6.5 million in the 1920s to less than two million in 1997. The average size of farms increased from about 300 acres in 1959 to approximately 470 acres today.

Most — more than 99 percent — of all U.S. farms remain as family-owned, family-held corporations or family partnerships. Non-family corporations own only 0.05 percent of this country’s farms.

Economic forces have played a lead role in the declining number of farms. The nation’s overall farm balance sheet looks deceptively strong because of non-cash assets and ongoing or emergency federal payments. But these factors mask the true financial difficulties faced by many agricultural operations. According to the National Agricultural Statistics Service (NASS), the ratio of prices that farmers receive for their crops today compared to what they spend on production is 40 percent of what it averaged between 1910 and 1914.

USDA statistics indicate that the average farm household income in 2000 was $64,658, slightly higher than non-farm household income. Only $4,600 of that income came from on-farm activities, however. The average net income from farming on small farms is actually negative. It is non-farm income that brings the total farm family income to near community averages.

More than half of U.S. farms, accounting for just 14 percent of all farmland, average less than $10,000 in sales a year. About 23 percent of all farms, accounting for half of farm acreage, have sales between $50,000 and $500,000 a year, but the number of these middle-sized farms is dropping. The 70,000 farms with sales of more than $500,000 a year account for 56 percent of total farm sales.

One of the most important social factors currently influencing traditional uses of land and water resources, including farming, ranching, forestry, wildlife habitat and drinking and irrigation water, is the conversion of land for housing and commercial development.

Between 1960 and 1990, metropolitan-area populations grew by 50 percent, while the amount of developed land for housing and commercial enterprises rose 100 percent. The National Home Builders Association forecasts an expansion of 1.3 to 1.5 million new homes per year through 2010. If current trends continue, these will be larger homes on larger lots located further from the central cities (HUD 2000).

Metropolitan expansion has spilled over onto adjacent lands to such an extent that populations in suburban counties are growing much more rapidly than in core cities. This pattern may prove especially hazardous to the best farmland. Roughly 50 million

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acres — or one-fifth — of prime cropland are within 50 miles of the 100 largest U.S. cities.

As urban and suburban populations increase and metropolitan areas continue to encroach on the surrounding countryside, financially strapped farmers, owners of private forest tracts and other landowners may well be enticed by attractive prices that developers offer for the land.

TABLE 1.
Today's farmers and ranchers

	1987	1997	% change
Full-time farmers and ranchers (no off-farm employment)	844,476	755,254	- 10.6
Farmers and ranchers who work off farm 200 days or more a year	737,206	709,279	- 3.8
Average age of all farmers and ranchers	52	54	+ 3.8
Operators under 25 years old	35,851	20,850	- 41.8
Operators 25 to 34 years old	242,688	128,455	- 47.1
Female	131,641	165,102	+ 25.4
African American	22,954	18,451	- 19.6
American Indian	7,134	10,638	+ 49.1
Spanish/Hispanic/Latino	17,476	27,717	+ 58.6
Asian or Pacific Island	7,900	8,731	+ 10.5

Adapted from the 1997 Census of Agriculture (NASS 1998)

Farming and ranching continue to be difficult industries for young people to enter because of high capital expenditures for land, the cost of production and initial outlays for equipment. Today, there are fewer people farming and ranching who are less than 35 years old than at any time in the history of U.S. agriculture. The average age of farmers and ranchers, currently 54, keeps rising. The number of part-time farmers and ranchers is also increasing.

In recent years, the number of women who operate farms and ranches continued to rise. The number of African American farmers and ranchers decreased, while the number of Spanish/Hispanic/Latino, Asian-American and American Indian farmers and ranchers increased.

Conservation partnerships

Urban sprawl, erratic prices for crops, the ups and downs in international trade — all and more contribute to the decisions that farmers, ranchers and forestland owners must make every day.

Locally led conservation efforts emphasize the importance of local communities and landowners in identifying and addressing natural resource needs and opportunities.

They do not have to make those decisions alone. Motivated during the Great Depression and Dust Bowl years, individual landowners have joined local, state and tribal officials and the federal government in forging partnerships to improve the quality of the land's soil and water resources.

Locally selected and governed soil and water conservation districts are central to the partnerships. For six decades, the districts have served as the fundamental link among state and federal agencies and landowners. Agreements between the conservation districts and USDA and government-to-government agreements with tribes spell out the responsibilities of the partners.

Since the inception of the conservation districts, USDA and the conservation partners have built a solid base of conservation programs and technical expertise in soil, water and other environmental issues. In many areas, the partnerships include state and local natural resource agencies, watershed associations, environmental organizations and communities. The programs and technical assistance developed and delivered through the partnerships incorporate a voluntary, incentive-based approach that is designed to minimize burdens on landowners and maximize conservation of natural resources.

Together, landowners, local and state advisors and USDA's technical specialists conduct risk management assessments and tailor conservation programs suited to each individual's needs through "whole-farm" management that takes into account the larger environment where the farms and ranches are located. Emphasis on whole-farm management is based on the belief that the benefits of sound land stewardship flow beyond the property lines of farms, ranches and private forest tracts. What is good for soil and water on the nation's working lands is also good for the land

One size does not fit all

On each farm, ranch or forest tract, technical assistance from conservation partnerships focuses on the best mix of a wide range of solutions. The site-specific solutions might include reduced tillage and efficient irrigation practices, efficient use of nutrients, effective crop and grazing rotations, placement of land in easement and reserve programs and planting of vegetated windbreaks or grassed buffers along waterways.

Economic incentives, including cost-share initiatives and financial assistance, play a vital role in the conservation programs, as does expert technical assistance.

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user, and it usually translates into cleaner water and air for nearby communities and wildlife habitat.

As the industrial base of agriculture changes, emerging issues face the conservation partnerships. The Agriculture Fact Book (USDA 1997) indicates that many farms are turning into large-scale, high-tech, specialized businesses, at least partly because of the rising influence of farm-management firms and corporate contracts for farm products (especially in the livestock industry).

This trend is important to conservation of natural resources, and it is altering the relationships among farmers and conservation planners in the field. The challenge is to devise sound land and water conservation strategies that serve an increasingly complicated mix of larger high-tech operations, traditional low-tech and part-time farmers, the growing number of female and minority farmers and other land users across the nation.

Partnerships at work: Stuart Farm

Stuart Farm in Stratham, New Hampshire, sits on the banks of the Squamscott River, which is a major tributary of the Great Bay Estuary. The long history of this farm, now a working dairy, earned the site a place on the National Register of Historic Places, but it is also known for the willingness of its owners to experiment with and practice new conservation tactics.

In the 1970s, Stuart Farm, state partners and the local conservation district completed a shrub planting on the farm to benefit the wild turkey. Now the mature stand is a major draw for hunters and photographers.

In the 1980s, Stuart Farm was one of the first farms in New Hampshire to establish a rotational grazing system, again in cooperation with partners, and thus provided a tangible example of the benefits of sustainable farming.

In 1994, a partnership consisting of Stuart Farm, federal and state agencies and Ducks Unlimited pooled resources to restore ten acres of severely degraded salt marsh. An old tide gate that had completely choked tidal flow to the marsh was removed and a culvert installed to reintroduce tidal flushing. The tidal flow was restored, and within the first year invasive species such as phragmites, purple loosestrife and narrow-leaf cattail were eradicated. Feeder fish and commercial fish species such as herring have returned to the tidal creeks. The success of this pilot effort resulted in expansion to 500 additional acres.

USDA conservation programs

USDA maintains a number of programs to address conservation and environmental needs that are identified by private landowners, state and local governments, conservation districts, tribes and other federal agencies. The programs include technical assistance, financial incentives and research and educational services. Program delivery is accomplished, as described above, through partnerships with state and local governments and conservation districts and government-to-government agreements with tribes.

The principle agency for delivery of direct conservation technical assistance is the Natural Resources Conservation Service (NRCS). Major programs for financial assistance include the Conservation Reserve Program of the Farm Services Agency and NRCS's Environmental Quality Incentives Program, Wetlands Reserve Program, Wildlife Habitat Incentives Program and Farmland Protection Program.

Essential to success of conservation program delivery are USDA's research, educational, resource information and technology development programs. NRCS and the department's Agricultural Research Service, Economic Research Service, Forest Service and Cooperative State Research, Education and Extension Service carry out these programs.

Recent USDA expenditures for major conservation programs are summarized in Figure 2 on page 7 and Table 2 on pages 14 and 15. The following descriptions highlight some of the principal USDA technical and financial assistance programs devoted to conservation and environmental concerns.

Conservation Technical Assistance Program (CTA)

The primary purpose of Conservation Technical Assistance is to assist land users, communities, units of state and local governments, tribes and other federal agencies in planning and implementing conservation systems to reduce erosion, improve soil and water quality, conserve wetlands, enhance fish and wildlife habitat, improve air quality and pasture and range conditions, reduce upstream flooding and improve woodlands.

CTA is USDA's largest single technical assistance program. Since 1935, NRCS has provided private landowners and local communities with essential direct technical assistance to help solve soil erosion and related natural resource conservation problems through conservation districts under Mutual Agreements signed by the Secretary of Agriculture, state governors and conservation districts and government-to-government agreements with tribes.

Assistance is available to land users who voluntarily apply conservation practices and to those who ask for technical assistance to help them comply with local, state or federal laws and regulations.

To develop effective conservation systems at the local level for soil, water and related resource problems, the CTA delivery system is founded on science-based technology.

People and Resources

Employees are trained through formal and on-the-job training, technical guides, manuals and handbooks to better assist land users. Approximately 8,000 technical employees from engineering, resource economics, agronomy, animal husbandry and soils and plant science backgrounds provide conservation technical assistance to about one million private landowners and communities every year.

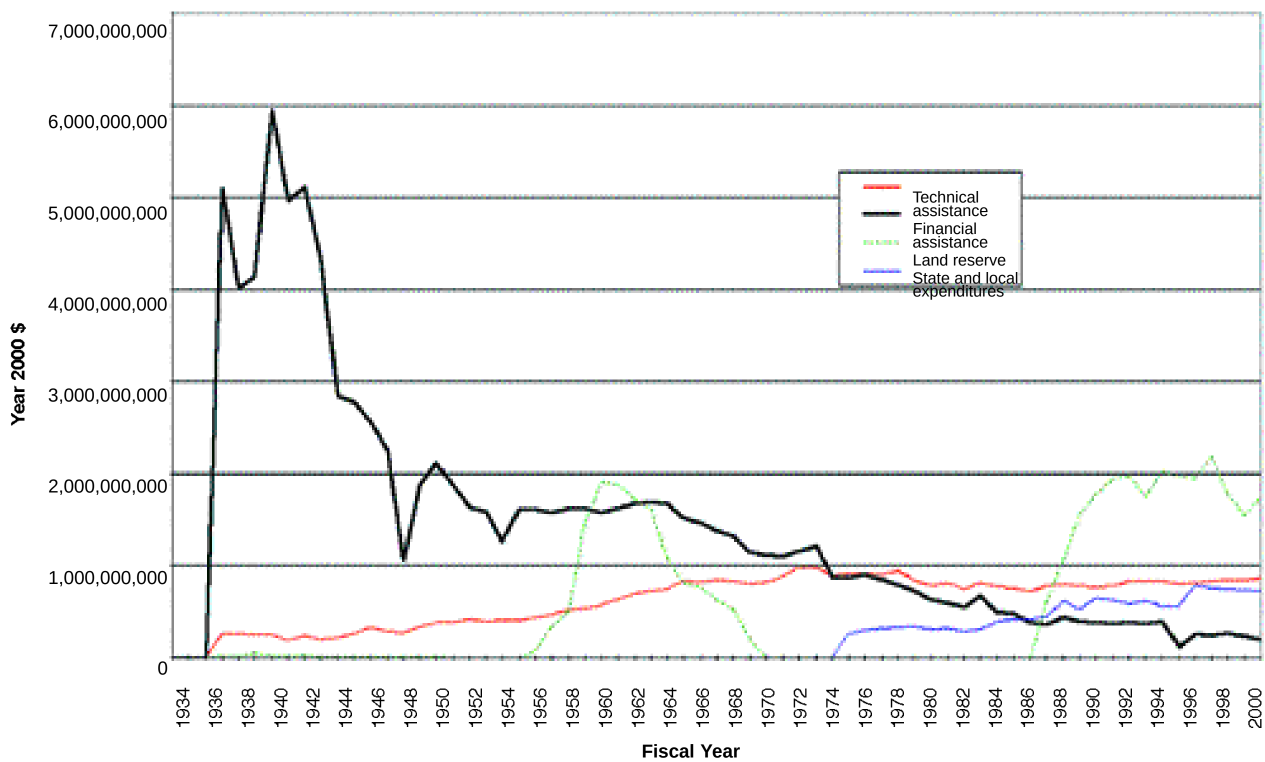
Environmental Quality Incentives Program (EQIP)

The Environmental Quality Incentives Program is a voluntary conservation program for farmers and ranchers who face serious threats to soil, water and related natural resources. EQIP provides technical, financial and educational assistance in priority areas where significant natural resource problems exist. In general, priority areas are defined as watersheds, regions or areas of

FIGURE 2.

Major USDA conservation expenditures, 1934-2000

Funding for technical assistance, financial assistance, land reserves, state and local governments



In the early 1940s, federal investments in financial and technical assistance to agriculture topped $6 billion (constant year 2000 $). Combined financial and technical assistance along with land reserve incentives totaled $3.5 billion in 2000.

The National Association of Conservation Districts (2001a) reports that state and local funding for conservation on private lands grew from almost nothing in the 1930s and 1940s to more than $1.3 billion in 2000 and that private sector contributions now exceed $1 billion.

special environmental sensitivity or where significant soil, water or related natural resource concerns exist. These concerns could include soil erosion, water quality and quantity, wildlife habitat, wetlands, forestland and grazing lands.

EQIP is implemented through a locally led process involving State Technical Committees and local working groups that direct the program to meet the most serious resource concerns.

EQIP offers 5- to 10-year contracts that provide incentive payments and cost sharing for conservation practices called for in site-specific conservation plans. Landowners develop the plans in cooperation with local conservation districts and NRCS. The plans specify the manner in which the planned conservation systems will be implemented, operated and maintained on enrolled acres.

Applications for participation in EQIP are ranked according to the environmental benefits achieved weighted against the costs of applying the practices. Plans to treat priority resource concerns at a sustainable level receive higher rankings. Total cost-share and incentive payments are limited to $10,000 per person per year and $50,000 for the length of the contract. Contracts average about $7,500.

Strip cropping in Wisconsin.

Since EQIP began, agricultural producers have entered into 82,200 EQIP contracts totaling approximately $613,336,000. At least 50 percent of these funds will target natural resource concerns related to livestock. The remaining balance focuses on irrigation water management and efforts to reduce soil erosion, improve water quality and enhance wildlife. In addition, approximately $19 million has been expended on activities to educate farmers about the need for installation and management of conservation practices.

Conservation Reserve Program (CRP)

Congress initiated the Conservation Reserve Program in Title XII of the Food Security Act of 1985. The Food, Agriculture, Conservation and Trade Act of 1990 extended the program as did the Federal Agriculture Improvement and Reform Act of 1996. CRP is a voluntary cropland retirement program administered by the Farm Services Agency with a current maximum enrollment of 36.4 million acres.

CRP is USDA's single largest conservation financial assistance program. It provides farmers an annual rental payment on land enrolled through 10- to 15-year contracts. The enrolled land is placed in permanent cover, and parcels are selected based on the magnitude of the likely environmental gain relative to rental payments. Environmental gains from enrollment in CRP include wildlife habitat improvements, improved water and air quality and soil productivity and carbon sequestration.

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Conservation Reserve Enhancement Program (CREP)

The Conservation Reserve Enhancement Program was authorized in the Federal Agriculture Improvement and Reform Act of 1996. It is operated by the Farm Services Agency through a state-federal conservation program. CREP addresses specific state and nationally significant water quality, soil erosion and wildlife habitat issues related to agriculture. The program offers financial incentives beyond those in CRP to encourage farmers and ranchers to enroll in 10- to 15-year contracts to retire land from production. Currently, 15 states — California, Delaware, Illinois, Maryland, Michigan, Minnesota, Missouri, New York, North Carolina, North Dakota, Ohio, Oregon, Pennsylvania, Virginia and Washington — participate in CREP. Arkansas, Iowa and Kentucky are expected to establish programs in 2001. Seven other states have submitted proposals for participation.

Farmland Protection Program (FPP)

The Farmland Protection Program is a voluntary effort that helps farmers keep their land in agriculture. The program provides matching funds to state, local and tribal governments with existing farmland protection programs to purchase conservation easements. The statutory goal of the program is to protect between 170,000 and 340,000 acres of farmland.

As of April 2001, 63,710 acres of mostly prime, unique, statewide or locally important farmland on the urban fringe have been permanently protected from conversion to nonagricultural uses, with more acres to be protected pending closure of additional easements.

Since FPP's inception in 1996, 19 states have received more than $33.5 million in FPP financial assistance. Remaining funds have supported technical assistance for landowners to process easements and develop and implement conservation plans. To date, FPP conservation easements have been granted on approximately 367 farms, with an estimated easement value of $126.5 million (average cost per acre — $1821). For every federal dollar, an additional $3 has been contributed by participating state and local governmental entities.

Any local or state agency, county or group of counties, municipality, town or township, soil and water conservation district or American Indian tribe or tribal organization that has farmland protection programs to purchase conservation easements for the purpose of limiting conversion to nonagricultural uses can participate. To be competitive, applicants must have pending offers with willing landowners. Individual landowners apply to the state, tribal or local government programs to participate in FPP. To date, all acquired easements and proposals for acquisition are in perpetuity.

Cooperating entities process the easement acquisition and hold and manage the acquired easements. The federal share for any easement acquisition is limited to the maximum of 50 percent of the purchased easement price, not to exceed the fair market value. A contingent remainder right must be incorporated in each easement deed to protect the federal investment.

Current demand for the program far exceeds available funds, by nearly a 7:1 ratio.

Wildlife Habitat Incentives Program (WHIP)

The Wildlife Habitat Incentives Program was initially authorized in 1996 and first funded in 1998. It is a voluntary program that consists of technical and financial assistance to eligible participants for creating or maintaining habitat for upland and wetland wildlife, threatened and endangered species, fish and other wildlife species in an environmentally beneficial and cost-effective manner. The purpose is to create high-quality wildlife habitats that support wildlife populations of local, state and national significance. The goals of WHIP relate to the overall USDA goal of achieving healthy and productive lands.

WHIP emphasizes wildlife and fishery habitats that are identified by local and state partners in each state, habitats and wildlife species that are experiencing declining or significantly reduced populations and conservation practices that are beneficial to fish and wildlife and that may not otherwise be funded.

Any practice that NRCS determines is necessary to create important habitat for a target species is eligible. Priorities are established at the state level. Examples of practices authorized under WHIP are native grassland restoration and management, management of field-edge habitat for wildlife, restoration of riparian areas and establishment of aquatic habitat.

Cost-share payments pay eligible participants up to 75 percent of the cost of installing conservation practices. Conservation districts, NRCS and other partners provide technical assistance. Wildlife Habitat Development plans are prepared to identify the cost-share practices that will be installed as well as the operation and maintenance requirements for the life of the agreements, which last from 5 to 10 years.

When WHIP was first established, state estimates of need exceeded the available funds almost four to one. Demand is expected to increase as the program becomes more broadly known.

Forestry Incentives Program (FIP)

The Forestry Incentives Program is a voluntary program that provides technical and financial assistance to landowners in their efforts to accomplish tree planting, timber stand improvements and other related practices on non-industrial private forestlands. The purpose is to increase the production of sawtimber and pulpwood while simultaneously ensuring effective management of natural resources.

Currently, state foresters provide technical assistance. They are supported by FIP funds allocated to the U.S. Forest Service by NRCS. The state foresters are responsible for the technical phase of planning and installing practices. Tree planting, forest stand improvement and site preparation for natural regeneration can be funded through cost sharing up to 65 percent of the cost. The maximum payment is $10,000 per landowner in a given fiscal year.

FIP outlays were $10.2 million in fiscal year 1989, serving 5,048 program participants. In fiscal year 1998, the corresponding numbers were $6.1 million and 3,863 participants. In fiscal year 1998, requests from across the country for FIP funds exceeded the actual allocated amount by 300 percent.

Forest Stewardship Program (FSP)

The Forest Stewardship Program, administered by the Forest Service in conjunction with state forestry agencies, supports the sustainable management of non-federal forestland. The primary goals are to: (1) assist forestland owners in achieving sustainable forest management through planning and implementation of riparian restoration, wildlife habitat enhancement, forest stand improvement and other aspects of forest management; and (2) improve supplies of high-quality, genetically improved tree seed and planting stock for reforestation.

Private forestlands produce more than 60 percent of the U.S. domestic timber supply. However, only about 10 percent of private forestlands are covered by forest management plans. On a voluntary basis, private forestland owners can take advantage of FSP's technical information and assistance to develop multi-resource plans that establish the basis for future management, protection and improved practices. State forestry personnel or private forestry consultants work with forestland owners to prepare the plans. A recent survey of participants indicated that more than 80 percent are carrying out their multi-resource plans and that both technical and financial assistance have been a significant factor in their ability to do this.

Another service of FSP is the nursery component that supports more than 55 state forest nurseries that produce about 30 percent of the total forest seedling supply in the United States. State nurseries are the primary source of native species tree seedlings for reforesting private forestlands and in planting trees that enhance ecosystem integrity.

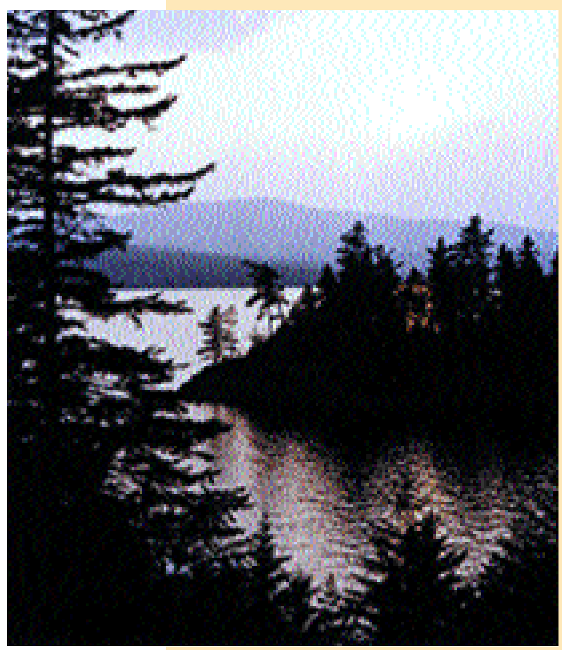
Demand for the program outstrips available funds by nearly 4 to 1.

Forest Legacy Program (FLP)

Through conservation easements and other mechanisms, the Forest Legacy Program assists state and private forestry programs in protecting private forestlands from conversion to non-forest uses. The primary emphasis is to reduce forest fragmentation and loss of forested landscapes.

Based on the premise of "willing seller/willing buyer," FLP is completely voluntary and nonregulatory.

To maximize the public benefits it achieves, the program acquires partial interests in privately owned



Nearly 1,300 acres of private forestland along Cupsuptic and Mooselookmeguntic lakes in Maine have been protected through a conservation easement funded by the Forest Legacy Program.

land through conservation easements. The federal government may fund up to 75 percent of the cost of the easements. These easements allow landowners to continue to manage the land for forestry uses while restricting development of the land.

Private forestland within state-designated Forest Legacy Areas is eligible for program participation. To be considered, a landowner is required to prepare a multiple resource management plan as part of the conservation easement acquisition.

Current demand for the program exceeds available funds by a 3:1 ratio.

Urban and Community Forestry (UCF)

Urban and Community Forestry helps people in urban areas improve natural resource management of trees and forests in urban areas and community settings.

Administered by the Forest Service, UCF assists selected cities, towns and communities to assess, retain and protect their natural environments as well as to develop and distribute scientific information about protecting, managing and maintaining community forest resources.

Planning, demonstration projects and technical assistance are aimed at retaining and placing trees, forests, urban parks, green spaces and related vegetation to: reduce (1) air, water, soil and noise pollution; (2) energy use; (3) heat island effects; and (4) stormwater flooding. The program demonstrates and delivers state-of-the-art urban ecological assessment and other technologies and awards grants to cities and towns for the purpose of building capacity to protect and improve their natural environments.

Community grants are made available on a matching basis. Nearly four dollars' worth of donated private funds and in-kind services match every federal dollar spent through the program. More than 10,000 communities and 7,000 volunteer organizations participate in the program each year. The number of requests for federal assistance and grants exceeds the capacity of the existing program by eight fold.

Wetlands Reserve Program (WRP)

The Wetlands Reserve Program addresses wetlands, wildlife habitat, soil, water and related natural resource concerns on private lands through technical and financial assistance to eligible landowners. The goal is to achieve the greatest wetlands function and value, along with optimum wildlife habitat, on every acre enrolled in the program. At least 70 percent of each wetlands and upland area will be restored to original natural conditions to the extent practicable. The remaining 30 percent of the project areas may be restored to other than natural conditions. For example, rather than restore a bottomland hardwood site to all trees, a portion of the site could be restored to an emergent marsh condition if the landowner or agency wanted to create habitat for certain wildlife species. This flexibility allows landowners to achieve their objectives while maximizing benefits to wildlife.

WRP concentrates on enrolling marginal lands with a history of crop

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failures or low yields, restoring and protecting values on degraded wetlands, maximizing benefits to wildlife, achieving cost-effective restoration with a priority on benefits to migratory birds, protecting and improving water quality and reducing the impact of floods.

To be enrolled, lands must be restorable and suitable for wildlife benefits and meet any of the following eligibility criteria:

- wetlands degraded by farming, pasture or timber production,
- lands adjacent to restorable wetlands that contribute significantly to wetlands functions and values,
- previously restored wetlands that need long-term protection,
- upland areas needed to buffer the wetlands area or that contribute to a manageable easement boundary,
- riparian areas that link protected wetlands or
- certain lands that have been substantially altered by flooding.

NRCS and its partners have restored more than 700 acres of salt marsh in New Hampshire. The Wetlands Reserve Program provided a significant portion of the funding for this cooperative effort.

TABLE 2.
USDA conservation expenditures by program activity, FY 1994-2001

Activity/program ($ Million)	1994	1995	1996	1997	1998	1999	2000	2001
1. Technical assistance, extension, and administration:								
Natural Resources Conservation Service (NRCS) programs—								
Conservation Technical Assistance (CTA)	523.2	500.0	538.9	529.2	541.8	548.1	567.4	619.3
Great Plains Conservation Program (GPCP)	9.3	9.1	0.0	0.0	0.0	0.0	0.0	0.0
Resource Conservation and Development (RC&D)	28.3	30.4	29.0	29.4	34.4	35.0	35.3	41.9
Watershed Surveys and Planning	24.4	23.5	14.0	14.0	11.2	10.4	10.4	10.8
Small Watershed Program	10.9	10.5	0.0	0.0	0.0	0.0	0.0	0.0
River basin surveys	13.5	13.0	0.0	0.0	0.0	0.0	0.0	0.0
Watershed Protection/Flood Prevention (PL566 and 534)	77.9	70.0	81.4	72.8	50.0	59.8	61.7	66.3
Colorado River Salinity Control Program	5.5	3.9	0.3	0.0	0.0	0.0	0.0	0.0
Forestry Incentives Program (FIP)	1.3	0.7	0.0	0.0	0.0	0.0	0.0	0.0
Water Bank Program (WBP)	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wetland Reserve Program (WRP)	3.5	8.8	6.0	12.0	17.7	12.8	14.6	14.3
Environmental Quality Improvement Program (EQIP)	0.0	0.0	6.5	20.0	38.0	36.9	37.0	42.0
Wildlife Habitat Incentives Program (WHIP)	0.0	0.0	0.0	0.0	5.0	4.5	0.0	2.4
Farmland Protection Program (FPP)	0.0	0.0	0.6	0.1	0.7	0.0	0.0	0.7
Conservation Farm Option (CFO)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal NRCS	673.8	646.4	676.6	677.5	698.7	707.4	726.4	797.7
Farm Service Agency (FSA) programs—								
Agricultural Conservation Program (ACP)	11.7	6.0	4.5	0.0	0.0	0.0	0.0	0.0
Conservation Reserve Program (CRP)	4.7	5.3	7.2	38.8	67.1	50.9	35.0	35.0
Emergency Conservation Program (ECP)	1.0	1.8	2.4	4.8	1.5	2.5	4.4	5.7
Rural Clean Water Program (RCWP)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FSA salaries & expenses, conservation	67.6	62.8	62.8	62.8	62.8	62.8	62.8	62.8
Subtotal FSA	85.0	75.9	76.9	106.4	131.3	116.2	102.2	103.5
Extension Service (ES) conservation activities	32.2	32.2	31.7	31.7	29.6	29.3	19.8	19.7
Forest Service (FS) programs—								
Forest Stewardship	25.8	25.9	23.4	23.4	23.9	29.4	29.8	32.8
Economic Action Programs	15.5	16.0	14.5	17.2	11.5	17.5	20.2	42.7
Forest Legacy Program	6.9	0.0	3.0	2.0	4.0	7.0	24.9	59.8
Pacific Northwest Assistance	16.4	17.1	16.0	16.8	15.0	8.8	7.9	0.0
Urban and Community Forestry	27.0	28.3	25.5	25.5	26.8	30.2	30.9	35.6
Forestry Incentives Program (FIP)	0.0	0.0	1.2	0.6	0.6	1.5	0.5	0.0
Subtotal FS	91.7	87.3	83.6	85.4	81.7	94.5	114.2	180.6
Subtotal Tech. asst., ext., and admin.	882.7	841.8	868.8	901.0	941.4	947.5	962.6	1,101.6
2. Cost-sharing for practice installation:								
FSAprograms—								
Agricultural Conservation Program (ACP)	183.0	94.0	70.5	0.0	0.0	0.0	0.0	0.0
Conservation Reserve Program (CRP)	14.5	3.7	1.2	11.0	96.1	114.9	132.7	0.0
Emergency Conservation Program (ECP)	24.0	21.2	27.6	90.3	27.0	81.6	61.3	70.3
Rural Clean Water Program (RCWP)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stewardship Incentive Program (SIP)	10.9	12.1	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal FSA	232.4	131.0	99.3	101.3	123.1	196.4	194.0	70.3
FS Stewardship Incentives Program (SIP)	17.9	18.3	4.5	4.5	6.5	0.0	0.0	0.0
NRCS programs—								
Environmental Quality Incentives Program (EQIP)	0.0	0.0	123.5	180.0	162.0	137.1	139.6	157.1
Colorado River Salinity Control Program	8.2	0.6	2.4	0.0	0.0	0.0	0.0	0.0
Forestry Incentives Program (FIP)	11.5	6.0	5.7	5.7	5.7	14.8	4.8	0.0
Great Plains Conservation Program (GPCP)	16.4	6.1	0.0	0.0	0.0	0.0	0.0	0.0
Wetland Reserve Program (WRP)	7.4	9.9	8.0	14.2	0.0	13.4	41.4	25.3
Wildlife Habitat Incentives Program (WHIP)	0.0	0.0	0.0	0.0	25.0	15.5	0.0	10.1
Conservation Farm Option (CFO)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal NRCS	43.5	22.5	139.6	199.9	192.7	180.8	185.8	192.5
Subtotal Cost-sharing	293.8	171.9	243.4	305.7	322.3	377.2	379.8	272.7

People and Resources

TABLE 2.

USDA conservation expenditures (continued)

Activity/program ($ Million)	1994	1995	1996	1997	1998	1999	2000	2001
3. Public works project activities (NRCS):								
Emergency Watershed Protection	133.2	290.6	59.1	186.7	80.0	82.2	69.4	87.8
Flood Prevention (operations)	22.9	0.0	6.0	6.0	7.5	7.8	3.3	5.5
Resource Conservation and Development (RC&D)	4.6	2.5	0.0	0.0	0.0	0.0	0.0	0.0
Small Watershed Program (operations)	106.9	0.0	34.0	34.0	45.0	39.8	41.3	49.4
Subtotal NRCS public works projects	267.6	293.1	99.1	226.7	132.5	129.8	114.0	142.7
4. Rental and easement payments (FSAand NRCS):								
Conservation Reserve Program (CRP)	1,728.8	1,711.7	1,710.0	1,659.7	1,594.9	1,319.7	1,342.8	1,538.4
Water Bank Program (WBP)	7.4	0.9	0.7	0.0	0.0	0.0	0.0	0.0
Wetland Reserve Program (WRP)	86.9	78.8	58.0	73.0	211.8	118.1	105.6	111.8
Farmland Protection Program (FPP)	0.0	0.0	14.4	1.9	17.3	0.0	0.2	16.8
Conservation Farm Option (CFO)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal rental and easement payments	1,823.0	1,791.4	1,783.1	1,734.6	1,823.9	1,437.8	1,448.6	1,667.0
5. Conservation data and research:								
Agricultural Research Service	76.7	75.5	76.0	73.5	74.7	74.5	75.4	79.0
Cooperative State Research Service	48.0	50.1	42.8	60.2	64.4	67.0	62.3	60.1
Economic Research Service	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Forest Service (forest research)	195.0	193.5	177.9	179.8	187.9	213.2	217.7	245.1
National Agricultural Library (water quality)	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2
NRCS programs—								
Soil surveys	73.9	72.6	76.2	76.4	76.4	78.3	78.3	78.2
Plant materials centers	8.9	8.1	8.9	8.8	8.8	9.0	9.1	9.1
Snow surveys	5.8	5.6	5.9	5.8	5.8	6.0	6.0	6.0
Subtotal NRCS	88.6	86.3	90.9	91.1	91.1	93.3	93.4	93.3
Subtotal conservation data and research	413.7	410.7	392.9	409.8	423.3	453.3	454.3	482.7
USDA total	**3,680.8**	**3,508.9**	**3,387.4**	**3,577.8**	**3,643.5**	**3,345.5**	**3,359.4**	**3,666.7**

Source: Derived from material provided by the Office of Budget and Program Analysis (OBPA) and the administration's budget request submitted February 2000.

The Current Landscape

Soil and water are inextricably bound together in most landscapes: thus soil quality is one of the factors that impacts water quality.

Despite many changes in this country's environment and agricultural sector over the years, the United States retains a rich heritage of natural resources and environmental attributes. This section of the report surveys a number of those resources and attributes and discusses issues and concerns related to their conservation and use. The current most comprehensive review of status, condition and trends can be found in Agricultural Resources and Environmental Indicators (Economic Research Service 1997 and 2000).

The soil resource

The United States is blessed with an abundance of productive land, having more than twice the world average of arable land per person. The basis for this productive land is the soil resource. Prime farmland refers to land that has soils with optimal characteristics for crop and forage production. More than 50 percent of U.S. cropland, or about 212 million acres, is considered prime (NRCS 2000a).

The traditional measure of the state of the soil resource has been the potential for and the extent and severity of soil erosion by wind and water. For example, 104 million acres of U.S. cropland, or about 27 percent of the total, is considered "highly erodible," meaning it is subject to potentially damaging soil erosion if not managed properly.

Many traditional conservation programs have been oriented toward preventing soil erosion or mitigating its past impacts. However, research and practical experience in responding to societal demands for commodities such as clean and abundant water, clean air, open space and recreation opportunities demonstrate that more than erosion control is required to maintain a healthy, productive soil resource.

Soils vary in their ability to support crop, forage and timber production; store floodwaters; purify and renew water supplies; and absorb, buffer and transform chemicals and waste. The term "soil quality" is used as a measure of how well a soil performs the above functions.

High-quality soils contribute to myriad benefits from the land — from healthy forestlands, grasslands, wetlands and backyard gardens to a rich heritage of scenic landscapes and wildlife habitats in addition to productive agricultural land.

For agricultural land users, high-quality soil may mean soils that have maximum ability to absorb rainfall and store water needed for crop growth, thus reducing the risk of flooding during storms and ensuring greater resilience to the effects of drought. When used for disposal of agricultural, municipal or industrial waste, healthily functioning soils may mean a greater capacity to purify

Benefits of healthy soil

- improved water quality
- improved air quality
- improved land productivity
- greater resistance to effects of drought and floods
- greater energy efficiency
- enhanced ability to mitigate climate change

The Current Landscape

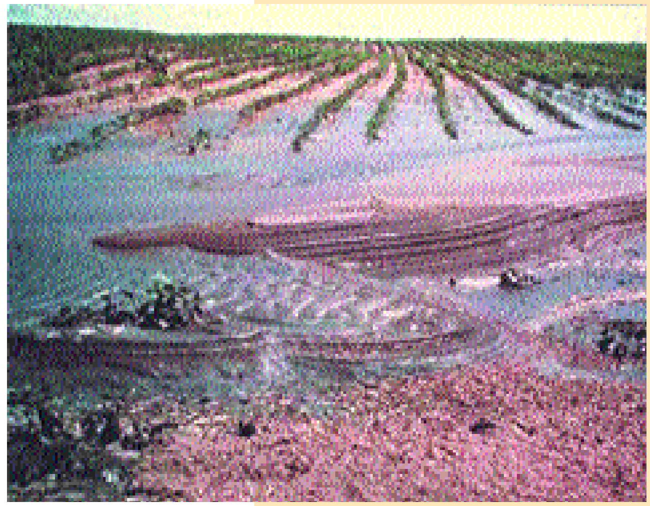
those wastes, resulting in better protection of ground and surface water. High-quality soils resistant to degradation have a greater potential to store carbon as soil organic matter (Lal et al. 1998).

Sound stewardship of the soil resource offers opportunities to maintain the functional capacity of soil — its "quality." Poor land-use practices, on the other hand, can initiate a cycle of soil quality degradation through erosion, compaction, acidification, salinization and other forms of soil deterioration.

Conditions and trends

Soil erosion. One of the major processes that can lead to a decline in soil quality is soil erosion by water and wind. Soil erosion and accelerated sedimentation — often brought about by bringing marginal soils under cultivation or by unwise management of land already under cultivation — are degrading landscapes around the world. These debilitating processes alter natural hydrologic and sedimentation regimes that developed over thousands of years. History has shown that these alterations can be so severe that the entire human population of a region may have to abandon the land and migrate elsewhere.

Soil erosion has been a traditional concern in the United States. Some



Eroded soil material deposited in fields can have adverse impacts on crop production.

Types of soil erosion

Sheet and rill erosion occurs when rainfall and water runoff initially remove a fairly uniform layer or sheet of soil from the surface of the land. Eventually, small channels (rills) form as rainwater collects and flows over an unprotected soil surface.

Concentrated-flow erosion can follow on the heels of sheet and rill erosion. Left unchecked, rills may enlarge and deepen into small channels that, when filled with sediment from adjacent land, are called ephemeral gullies. If the channels continue to enlarge and cannot be filled in with material from adjacent land or obliterated through tillage, a condition known as classic gully erosion develops. It can permanently damage the land. Another form of concentrated-flow erosion is streambank erosion, which often stems from unchecked sheet and rill or gully erosion in uplands and the absence of streamside vegetation.

Irrigation-induced erosion refers to water erosion that results from sprinkler or surface irrigation for agricultural production. It can take the form of sheet and rill or concentrated-flow erosion.

Wind erosion also removes soil. It can, in extreme cases, create huge dust clouds that suspend unacceptable levels of particulates in the air, in addition to damaging the soil.

Soil from corn-soybean rotation in Alabama.Non-tilled soil (left) normally has a darker color and more uniform granular structure than tilled soil (right), primarily because of the greater soil organic matter content in non-tilled soil.

erosion caused by water and wind will always occur as part of the natural cycle. But the natural process of soil development can renew and sustain the soil if society does not place demands on the soil resource that are beyond its capabilities. For most deep soils, an erosion rate less than four to five tons per acre per year is considered a sustainable level of soil erosion. This acceptable or sustainable level is termed the soil loss tolerance, or "T," value. Even at such sustainable rates, however, sediment from eroding lands may lead to decreased water quality in some areas.

Over the past several decades, U.S. agriculture has made significant strides in reducing erosion on cropland through management practices such as conservation tillage, crop rotations, contour strip cropping and use of grassed waterways. Landowners also participate in USDA easement and reserve programs that target lands most susceptible to erosion, provide incentives for conservation and help offset costs associated with such measures.

Several USDA programs make land resource inventory information available to landowners and managers for their use in making soil conservation decisions. The National Resources Inventory (NRCS 2000a) provides information on the extent of land degradation from processes such as erosion and salinization. This enables assessment of the status and condition of the U.S. land resource base, including soils, at any given point in time.

The National Cooperative Soil Survey, a partnership of state, local and federal agencies, provides information about basic soil characteristics in the landscape and their long-term behavior under particular types of use and management, including food, forage and timber production; waste management; and residential and commercial development.

These tools can be used to develop a picture of the health of the land. The information is useful in deciding what must be done to prevent or reduce land degradation, maintain productivity and restore degraded lands to full productivity.

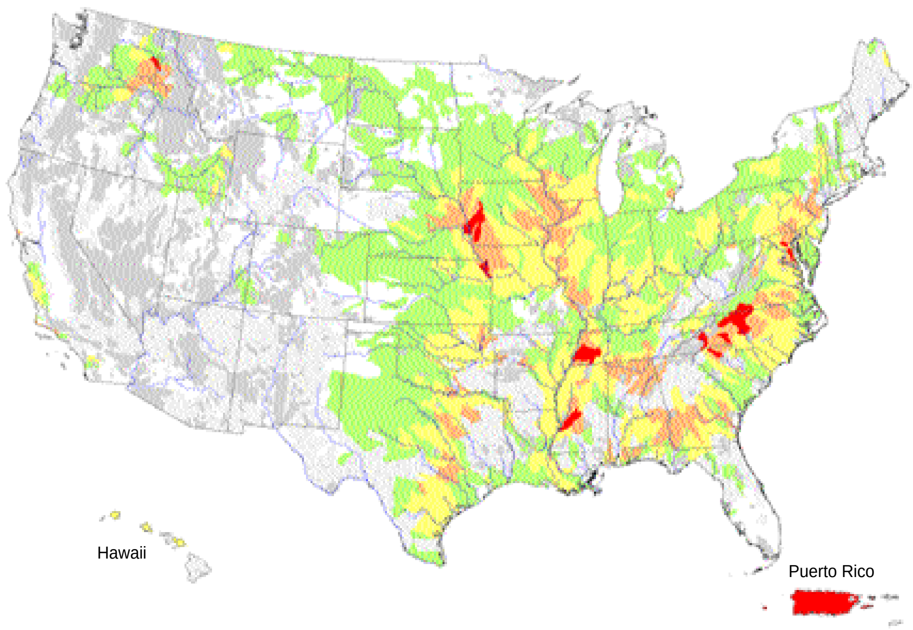
Approximately 170 million acres — 40 percent of all cropland — were eroding at greater than acceptable ("T") levels in 1982 (NRCS 2000a). By 1997, that amount had been reduced to about 108 million acres, or 28 percent of total cropland acreage at that time (Figure 3). However, even with these reductions in erosion, it is estimated that additional U.S. cropland might benefit from management aimed at enhancing soil quality, as outlined below.

Tillage, soil management and soil quality. The potential for decline in the health or overall quality of the soil resource because of processes other than erosion is also a soil resource issue. Because soil quality has a number of facets and is difficult to measure directly, it is not as

The Current Landscape

FIGURE 3.

Average annual soil erosion by water (MAP 1) and wind (MAP 2) on cropland and CRP land, 1997



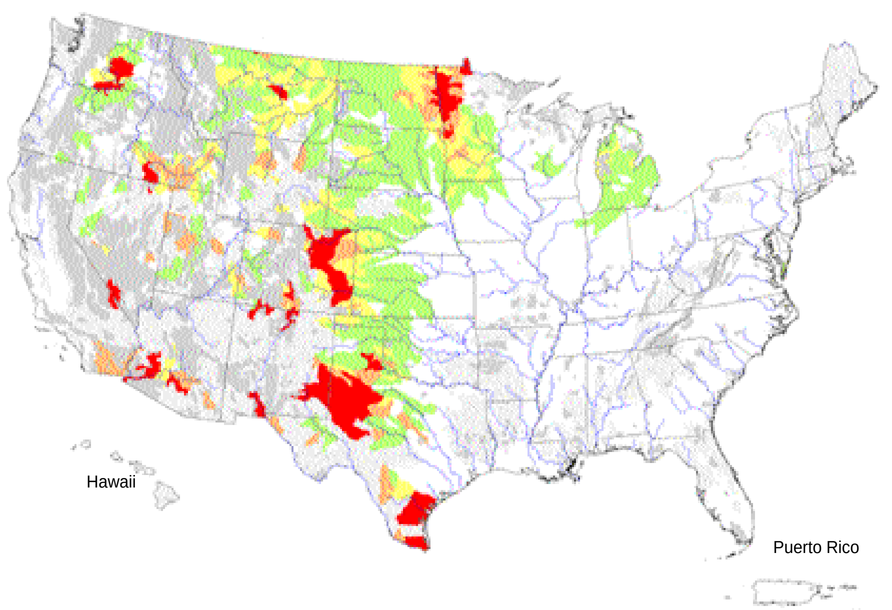
MAP 1

Tons/Acre/Year

- 8 or more
  4.6% of erosion
  0.8% of watersheds
- 5 to 8
  19.6% of erosion
  5.9% of watersheds
- 3 to 5
  36.0% of erosion
  15.2% of watersheds
- 1 to 3
  34.5% of erosion
  27.2% of watersheds
- Less then 1
  4.2% of erosion
  18.2% of watersheds
- Less then 5%
  Cropland and CRP
  1.1% of erosion
  32.7% of watersheds
- 95% or more
  Federal area

Data unavailable for the following regions: Alaska and the Pacific Basin including Guam, Northern Marianas and American Samoa.

Forty-one million acres are eroding by water at a rate above five tons/acre/year. The national water erosion rate averages 2.5 tons/acre/year. Total soil erosion equals 1,000 million tons. Data are only displayed where cropland and Conservation Reserve Program (CRP) land are five percent or more of the total area. Gully erosion is also excluded from the analysis. Watersheds are defined as U.S. Geological Survey Hydrologic Cataloging Units (8-digit). Source: NRCS 2000a



MAP 2

Tons/Acre/Year

- 8 or more
  40.9% of erosion
  3.2% of watersheds
- 5 to 8
  13.1% of erosion
  2.6% of watersheds
- 3 to 5
  18.7% of erosion
  5.2% of watersheds
- 1 to 3
  22.3% of erosion
  12.5% of watersheds
- Less then 1
  3.4% of erosion
  43.8% of watersheds
- Less then 5%
  Cropland and CRP
  1.6% of erosion
  32.7% of watersheds
- 95% or more
  Federal area

Data unavailable for the following regions: Alaska and the Pacific Basin including Guam, Northern Marianas and American Samoa.

Forty million acres are eroding by wind at a rate above five tons/acres/year. The national wind erosion rate averages 2.0 tons/acre/year. Total soil erosion equals 840 million tons. Data are only displayed where cropland and Conservation Reserve Program (CRP) land are five percent or more of the toal area. Watersheds are defined as a U.S. Geological Survey Hydrologic Cataloging Units (8-digit). Source: NRCS 2000a easy to quantify as soil erosion. Thus it is difficult to assess its impact at broad scales over extensive areas as can be done with soil erosion.

A natural consequence of cultivating any soil is decomposition of the soil organic matter. This in turn may impact the soil's overall tilth (or workability), its fertility and biological activity and its ability to store adequate water for plant growth, depending on use and management.

Over the years, the level of organic matter in agricultural soils has declined as a consequence of conventional tillage methods. Figure 4 illustrates trends in soil organic matter in the U.S. corn belt since the advent of widespread soil cultivation. It shows a decline in soil organic matter that continued into the 1950s to about 53 percent of the 1907 level — the level present at the start of widespread conversion of

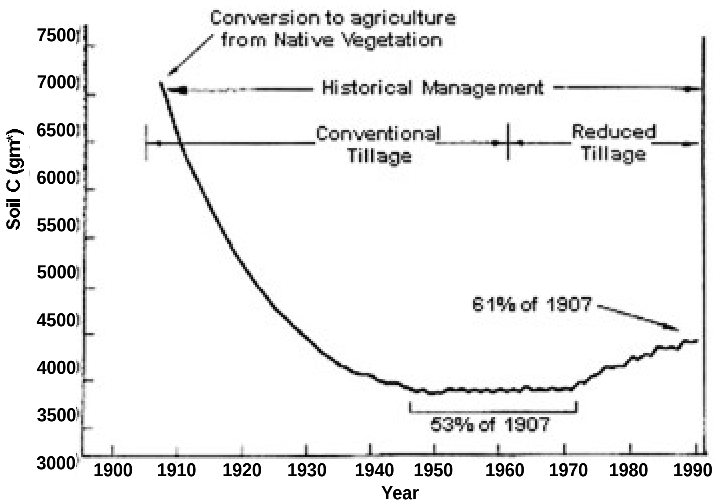
Off-site fate of eroded soil*

- Of the 377 million acres of working U.S. cropland, 28 percent is eroding at rates great enough to have adverse impacts on long-term soil productivity and overall soil quality.
- About three-quarters of the soil eroded by water in a typical farm field, however, is deposited as sediment in the same field from which it eroded. Upon deposition, the eroded soil material causes the soil surface to crust and seal in low areas of the field, resulting in ponding and irregular distribution of nutrients.
- Uneven crop productivity in the field leads to inefficient water and nutrient use, which causes excessive soil nutrient buildup, runoff or deep percolation, all of which can adversely impact water quality.
- Of the approximately one-quarter of soil material from sheet and rill erosion that actually leaves farm fields, most — about 60 million tons annually — is deposited in local streams and waterways of small watersheds. There, it disrupts streamflows, affects streambank stability and accelerates siltation of lakes, reservoirs, ponds and wetlands.
- The relatively small proportion of eroded soil that eventually leaves watershed outlets, estimated at about 14 million tons a year, may carry excessive levels of nutrients and pesticides to larger water bodies such as the Gulf of Mexico and the Chesapeake Bay, contributing to regional water quality problems.
- It is difficult to quantify the off-site fate of soil material lost through wind erosion. But in severe cases, blowing soil contributes to the level of particulate matter in the air, damages fences and other infrastructure through abrasion and drifts over roads where it increases maintenance costs and poses a travel hazard.

*Estimates of sedimentation are from a broad-scale national analysis using NRI-derived sheet and rill water erosion data (NRCS 2000a) coupled with NRCS-assigned sediment delivery ratios for areas in the conterminous United States approximating 2nd-code hydrologic units.

FIGURE 4.

Soil organic carbon pool in U.S. soils and loss from cultivation



Simulated total soil carbon changes (0- to 20-cm depth) from 1907 to 1990 in the central U.S. corn belt. Adapted from information in Lal et al. 1998.

native grasslands and forestlands to cropland in the United States. It also shows gains in soil organic matter to about 61 percent of the 1907 level starting in the 1970s — a time frame that coincides with the onset of adoption of conservation tillage systems by U.S. corn and soybean farmers.

The level of soil organic matter has been proposed as an indicator of soil quality because of organic matter's importance in soil structure, nutrient cycling and biotic activity.

Conservation tillage systems, because they leave crop residue at the soil surface, have the potential to build up soil organic matter in the critical surface layer of the soil, as compared to conventional tillage systems. By estimating the potential for build-up of soil organic matter as a function of crop residue cover derived from NRI data (NRCS 2000a) and modeling the impact of various tillage systems,* it appears that about one-third of the approximately 269 million acres of U.S. cropland not experiencing excessive (greater than "T") erosion might benefit from management systems aimed at enhancing soil quality.

Data from the Conservation Technology Information Center show that in 2000, some form of conservation tillage was practiced on about 37 percent of cropland in the United States, meaning that those lands had more than 30 percent residue cover on the ground after planting (NACD 2001a). This use of conservation tillage has mostly occurred since the early 1980s.

* Results of Environmental Policy Integrated Climate (EPIC) model simulations identify a critical soil C and V factor that correlates with accretion of soil organic matter over a 30-year period under a variety of cropping systems. Query of 1997 NRI cropland data for soil erosion rates <T and where critical C factor is met are used to derive estimated acreage.

Adoption of no-till practices has risen significantly in recent years. No-till is a form of residue management where a new crop is planted directly into the residue-covered soil from the previous crop; there is no additional tillage or seedbed preparation. In 1990, about 16.9 million acres were being managed with no-till systems. By 2000, that number had increased to 52.2 million acres (NACD 2001a).

Soil salinity. Soil salinity is a resource concern in some portions of the United States. Many soils are naturally saline, but some become saline through improper use and management. Naturally saline soils are a result of several factors such as the nature of the underlying geology, natural patterns of water flow in the landscape that favor salt accumulation and drier climates where evapotranspiration exceeds precipitation and thus favors salt accumulation.

Non-saline or slightly saline soils can become so affected by increased salinization that it threatens the productivity of cropland and grazing land. On cropland, this can come about through non-uniform or excessive irrigation and inadequate drainage. Such practices raise water tables in irrigated cropland, causing salts to rise to the root zone of crop plants and impair productivity. Excessive levels of salts in irrigation return flows can even impact water quality in streams and lakes, affecting recreation, aquatic habitat and industrial and drinking water uses.

Saline seeps are another form of salinization. Seeps are saline areas of the landscape that expand over time, taking more and more land out of production. Seeps are usually found on grazing land or fallow cropland in semiarid or arid climates. They are often a response to periods of increased precipitation coupled with management that has altered or changed native vegetation and water-use patterns in the landscape.

According to data in USDA's National Resources Inventory, 3.4 million acres of cropland and 0.9 million acres of pastureland have the potential to be impaired through soil salinization. The same data also suggest that about 1.5 million acres of U.S. agricultural lands are currently affected by salinity.

Preventing salinization and its attendant off-site impacts and restoring productivity to lands damaged by salinization often requires action over wide areas such as entire irrigation districts or river basins. For example, salinity control work under USDA's Environmental Quality Incentives Program assists in the improvement of irrigation systems and management of irrigated lands to reduce salt loading from both natural and irrigation-induced sources to the Colorado River and its tributaries.

The Current Landscape

The water resource — quality issues

Although limited in some places, U.S. surface and groundwater resources provide sufficient water for most domestic, municipal, industrial and agricultural uses as well as for most fish, wildlife and environmental purposes.

These water resources are vulnerable to pollution that can degrade water quality and make the water unsuitable for some uses. The degree to which that happens depends in part on how land is used and managed.

Since the passage of the Clean Water Act in 1972, the nation has concentrated on controlling pollution from industrial and domestic discharges that are called point sources of pollution. Recently, there have been increasing concerns about controlling water pollution from nonspecific or diffuse sources, known as non-point sources.

Although conservation techniques, including many that protected water quality, were in effect on farms and ranches long before the Clean Water Act, agriculture has been at the center of non-point source concerns.

Conditions and trends

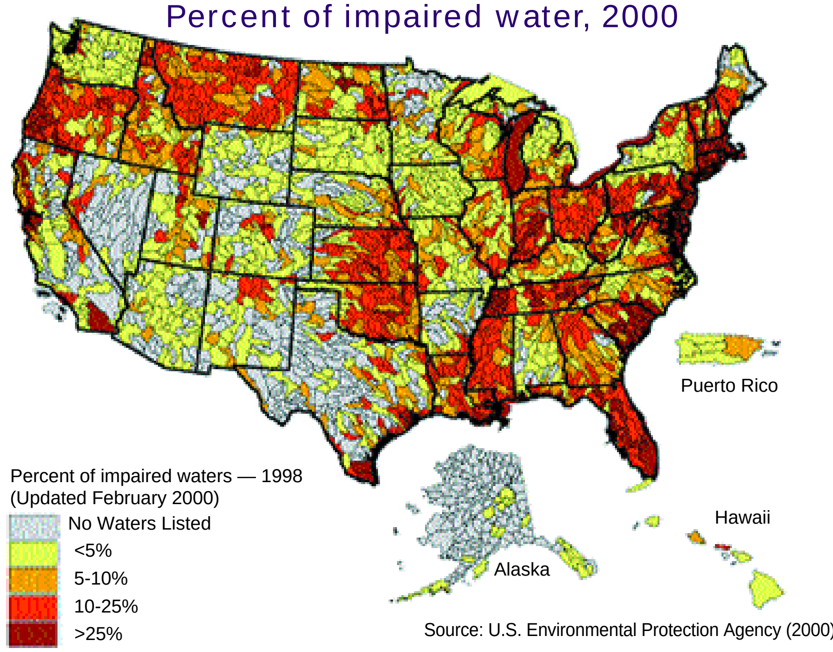
There are no reports or studies that fully describe the health of all waters in the United States. The U.S. Environmental Protection Agency makes periodic reports to Congress based on assessment reports from states, territories, tribes and interstate commissions. Findings from EPA's 1998 Water Quality Inventory and the 2000 Atlas of America's Polluted Waters report indicate the following (Figure 5):

- Of the 23 percent of the nation's rivers and streams that were assessed, 35 percent were impaired for one or more of three primary uses (drinking, fishing and swimming).
- Of the 42 percent of lakes, reservoirs and ponds that were assessed, 45 percent were impaired.
- Of the 32 percent of the country's estuaries that were assessed, 44 percent were impaired.

According to EPA, more than 20,000 individual river segments, lakes and estuaries are impaired with one or more pollutants from all sources. Approximately 218 million people — the majority of the U.S. population — live within 10 miles of the impaired waters. EPA reported that the principal pollutants causing water quality

FIGURE 5.

Percent of impaired water, 2000



Source: U.S. Environmental Protection Agency (2000) problems include nutrients, sediment, metals and pathogens.

Most states and jurisdictions identified agriculture as a leading source of many of these pollutants. Studies by USDA, the U.S. Geological Survey, numerous federal and state agencies and other public and private research institutions have also documented agriculture's impacts on water quality.

The impact of agriculture on water quality should be considered in the context of the amount of land supporting agricultural activities. About 900 million acres, or 41 percent of the continental United States, are on farms and ranches. Through their stewardship of the land, farmers and ranchers can help ensure safe drinking water, clear-flowing streams and clean lakes, wildlife habitat and scenic landscapes.

Where best agricultural management practices are not used, nonpoint sources of pollution from agriculture can occur. Several effects are described below.

Sediment effects. Sediment is eroded soil deposited on the land and in streams, rivers, drainageways, and lakes. Sediment degrades water quality by increasing turbidity and transporting attached nutrients, pesticides, pathogens and toxic substances. It clogs waterways, reservoirs, estuaries and harbors, thereby reducing the use of these water bodies and often requiring expensive clean-out, maintenance and repair.

EPA reports that sediment is the most common pollutant affecting assessed rivers and streams and that agriculture is the leading source. As documented in local soil surveys, soils have varying degrees of erosion potential and capacity to allow sediment movement in streams. Because pesticides and nutrients can attach to soil particles, reducing soil erosion through on-farm conservation techniques can improve the condition of surface water and groundwater.

Nutrient effects. Nutrients are fundamental to life. Plants and animals need certain amounts of nutrients to grow and reproduce. Insufficient amounts of certain nutrients may stunt growth or cause death, while in some environments, excessive amounts of certain nutrients can cause unnatural or excessive growth or death.

In agriculture, nutrients — mainly nitrogen, phosphorus and potassium — are applied to promote plant growth. If they are applied inappropriately or in excessive amounts, they

Good soil quality enhances water quality

As described in the soil section of this report, there can be a relationship between soil quality and water quality in many landscapes. Good soil quality produces good water quality in several ways. Soils rich in organic matter and biological activity promote infiltration over excessive runoff and can be more resistant to erosion.

Organic matter also has an affinity for some of the chemicals used in agriculture production, binding the residuals to the soil and preventing them from running off or leaching. Healthy soil supports biological activity that can degrade pesticides and pathogens before they can migrate from the land to the water.

When soil quality is poor, the potential is greater for loss of soil and chemicals from farm fields.

Improving soil quality through reduction in soil erosion, increases in soil organic matter content and decreases in compaction and acidification promotes improvement in the condition of surface water and groundwater, in conjunction with sound management practices.

can be transported to surface water or groundwater.

Nitrogen is added to soils from commercial fertilizers, animal manure, legumes such as alfalfa and soybeans and from atmospheric deposition. Some soils with sufficient clay content slow down leaching of nitrates through the soil, enough to retain nitrogen near the surface and keep it available for plant uptake. Other soils, particularly sandy ones, allow for rapid leaching and in some cases provide a pathway for excess nitrogen movement into stream systems and groundwater.

Nitrogen compounds in excessive amounts can accelerate eutrophication in surface waters, which depletes oxygen, kills fish and results in cloudy water with an unpleasant smell. Elevated concentrations of nitrate in drinking water pose a potential threat to human health, particularly among infants.

The phosphorus ion phosphate, while not as mobile as nitrate, tends to be carried on soil particles that move off the land. Recent studies show that phosphate can also leach to groundwater, especially where commercial fertilizers or manure have been applied to the land over many years. Phosphate can also contribute to eutrophication in fresh surface waters.

Irrigation effects. Irrigation has become more widespread as producers take advantage of productive soils in arid regions or attempt to offset the impacts of drought. Water quality can be degraded by irrigation systems that are not well designed or properly maintained and operated. Knowledge of soil properties such as those documented in soil surveys can reduce the risk of irrigation-induced pollution through proper design of irrigation systems.

Irrigation-induced erosion creates a sedimentation problem in some areas. There is also concern that deep-water aquifers will become contaminated with agricultural chemicals as the water used for irrigation percolates down and carries chemical residuals to aquifers.

Irrigation water's natural base load of dissolved mineral salts becomes concentrated as the water is consumed by plants or evaporated. Deep percolating irrigation water may also become contaminated through contact with shale or highly saline aquifers and the return flows convey the salts to the receiving streams or groundwater. As the same water is used over and over again and more water evaporates, the salinity level increases, and that can impair water quality.

Pesticide effects. Pesticides are used to control weeds, insects, rodents, diseases and other organisms that may reduce production of agricultural commodities. Since 1979, according to NASS surveys, the agricultural sector in this country has accounted for about 80 percent of all pesticide use each year.

Pesticides may contaminate water by leaching through the soil or as a result of being washed from the field surface in solution or adsorbed to soil or organic material into nearby water bodies. Only a small proportion of pesticides migrate from farm fields, however. In general, monitoring results show that most agricultural pesticides occur in low concentrations in surface water and groundwater, even in regions where agricultural use is high.

Farmers and ranchers are modifying their management practices by using more environmentally friendly pesticides, applying pesticides only when the pest is likely to cause economic damage to crop production and reducing their reliance on agricultural pesticides through integrated pest management techniques.

By practicing prevention, avoidance, monitoring and suppression of pests — either through cultural, physical or biological means — dependence on chemicals has decreased. According to NASS surveys, insecticide use per acre on corn dropped 52 percent from 1991 to 1999. Also by 1999, more than half of the corn and 80 percent of all cotton grown in the United States were produced using integrated pest management techniques.

Livestock and poultry manure effects. Livestock and poultry manures have the potential to degrade water quality because they contain nutrients, organic matter and pathogens. Also, the aggregate effect of odors and gaseous emissions from applying manure, the decomposition of dead animals and wet feed pose nuisance and public health problems.

These manures have emerged over the past several years as a major environmental issue. As the Congressional Research Service described the situation in a May 1998 report, "Social and political pressure to address the environmental impacts of livestock production has grown to the point that many policy-makers today are asking what to do, not whether to do something."

In 1999, EPA found that 35 states regulate large, concentrated animal feeding operations, and at least 36 states require manure management plans. Numerous counties and local governments have ordinances related to this issue. In response, national livestock and poultry producer groups have started initiatives to address manure-related environmental problems.

A USDA analysis using farm-level data from the 1997 Agriculture Census shows that the structure of animal agriculture has changed dramatically over the last two decades. Small and medium-sized livestock and poultry operations have been replaced by large operations at a steady rate. The total number of animals has remained relatively unchanged, but more of them are being confined and concentrated in the high-production regions of the country.

A major concern is that in some areas, livestock and poultry operations surpass the capacity of the land to assimilate manure nutrients. This means it is necessary to export the manure from the farm or ranch or find other manure uses.

There are more than 900,000 beef, dairy, hog and poultry animal feeding operations in the United States. About 3,300 have more than 1,000 confined animal units. USDA and its conservation partners estimate that up to 272,600 animal feeding operations will need assistance to develop comprehensive nutrient management plans

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over the next several years to address non-point source pollution issues.

At the same time, ongoing conservation partnerships in water quality projects across the country are helping to reduce the amount of harmful animal waste nutrients and other potential pollutants from agriculture that reach water bodies.

Examples include a 90 percent reduction in nutrient runoff in five West Virginia counties, the prevention of 4,500 tons of nitrates from entering the Suwannee River Basin in north central Florida every year and the participation of most local dairy farmers in the Skaneateles Lake Watershed Agricultural Program, which allows Syracuse, New York to boast the second-best drinking water supply in the nation (the glacial waters of Anchorage, Alaska are first).

Buffers enhance water quality

Conservation buffers are narrow strips of permanent vegetation — grass, trees and shrubs — planted to protect water bodies and other environmental and human-created elements on the landscape from the adverse consequences of agricultural production. Among the most common types are filter strips and riparian buffers, contour grass strips, crosswind trap strips, grassed waterways, field windbreaks, shelterbelts and living snow fences.

Some experts contend that a buffer of one kind or another might be appropriate for use on almost every farm or ranch. A 1993 report by the National Research Council's Board on Agriculture concluded that strategic placement of buffers on cropland and grazing land was among the most promising and cost-effective ways to protect soil and water quality.

A 1997 estimate of buffer needs by NRCS regional office personnel suggested that nearly 12 million acres of riparian (streamside) and upland buffers could be eligible for enrollment in the Conservation Reserve Program, an admittedly conservative figure. Assuming that only 20 percent of the 3.5 million miles of permanent and seasonal streams in the United States may require treatment with filter strips or riparian buffers, the amount of land that would benefit from these two buffer types alone is 15 million or more acres (depending on which assumptions are made regarding buffer width). This does not take into account additional buffers around or along other permanent water bodies such as lakes, drainage ditches and irrigation canals, nor does it account for any upland buffer needs.

Buffers are not the sole answer to water quality or other conservation challenges. They work best when integrated into comprehensive conservation systems that also incorporate practices such as conservation tillage, nutrient management and integrated pest management. However, buffers are time-tested technology that could be used more extensively to help landowners meet their stewardship goals.

Vegetated buffers build up soil organic matter and help stop sediment, nutrients and some pesticides from entering waterways. They also create riparian (streamside) habitat for wildlife. As of December 2000, approximately 1.4 million miles of conservation buffers had been enrolled in the Conservation Reserve Program continuous sign-up.

The water resource — quantity issues

Across the country, agricultural producers are faced with either too much water during flood conditions, too little water or not enough access to what exists during drought conditions and decisions about efficient irrigation. Competing interests — from increasing domestic, commercial and industrial uses to recreation and wildlife habitat — further complicate the situation.

Conditions and trends

Flooding. Floods have an immediate impact and the consequences are usually severe for the economy, the environment and human welfare. The floods that followed on the heels of hurricanes Dennis and Floyd in 1999, for example, exceeded $15 billion in damages. They also left a ravaged countryside — already suffering from drought — with tens of thousands of animal carcasses and the debris from flooded-out towns. Existing USDA small watershed dams provided flood protection for many communities during these storms and also mitigated the flood damages in communities that received the greatest amount of rain.

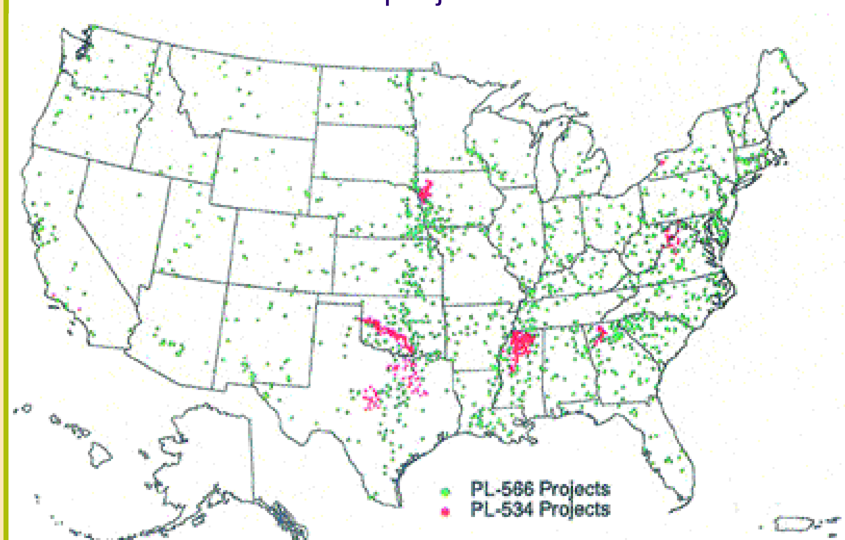
Watershed projects. In watersheds across this country, in Puerto Rico and in the Pacific Basin, USDA has assisted partners to develop or begin more than 2,000 water management plans covering 160 million acres. In watershed project areas (Figure 6), upwards of 15,000 separate land treatment measures have been applied on 30 million acres, contributing to environmental improvement, economic development and social well being.

USDA's authority for watershed projects stems from national laws dating back to the 1940s. Many of the original watershed projects sought to reduce flooding, improve water management and increase irrigation efficiencies. In the 1960s, high priorities were placed on projects that provided jobs to combat poverty and encourage rural development. Many of those projects established recreation areas.

In recent years, projects have focused on land treatment measures to resolve natural resource issues such as substandard water quality and loss of wildlife habitat. Landowners and USDA technical specialists plan the projects, which are based on the application of on-farm conservation management systems that are tailored to address specific resource objectives for a given watershed.

FIGURE 6.

Watershed project locations



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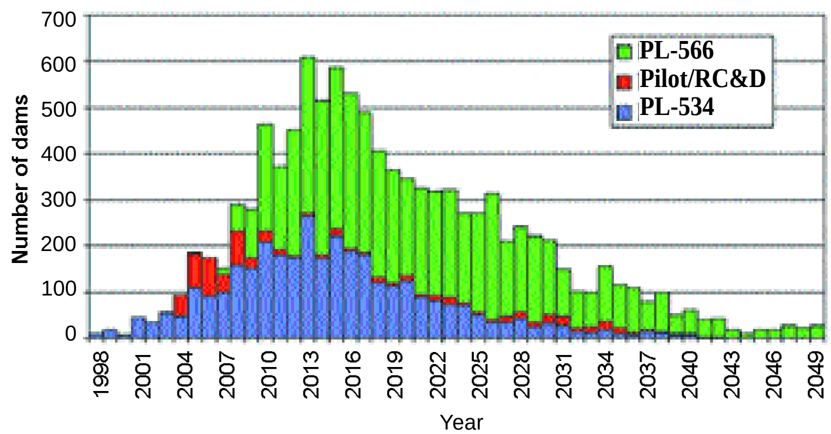
The projects represent a $14 billion investment and yield annual benefits of nearly $1 billion to rural communities from flood reduction and watershed protection. They have become an integral and irreplaceable part of the communities and the environment that they were designed to protect. There is currently a $1.4 billion unfunded federal commitment to approved watershed projects.

However, many existing projects are at or near the end of their 50-year planned life (Figure 7), and there is growing national concern that they may pose a public safety concern. A recent survey of known rehabilitation needs in 22 states revealed that more than 2,200 dams need rehabilitation at an estimated cost of more than $540 million (NRCS 2000b). Failure of 650 of these dams could threaten the health and safety of people downstream or disrupt local drinking water supplies.

FIGURE 7.

Dams per year at end of planned design life



Dams created under Public Law-566, Public Law-534, Pilot and under the Resource Conservation and Development Program. As this chart indicates, a large number of dams will come to the end of their planned design life from about 2010 to 2030.

Emergency Watershed Program. Watershed projects are proactive by design, and they are an important tool for consideration in risk-management decisions. They only cover a small portion of the United States, however. Congress established the Emergency Watershed Protection Program to help people and conserve natural resources by relieving imminent hazards to life and property caused by floods, fires, windstorms and other natural occurrences.

USDA administers the program. All projects undertaken — except for the purchase of floodplain easements — must be sponsored by a political subdivision of a state such as a city, country, general improvement district or conservation district.

Eligible work includes removing debris from stream channels, road culverts and bridges; reshaping and protecting eroded stream and river banks; fixing damaged drainage facilities; repairing levees (primarily agricultural) and other structures; reseeding damaged areas; and purchasing floodplain easements.

Drought. Every year, demand for water exceeds supply in some parts of the country, and other areas are beginning to experience water shortages. When drought occurs, those shortages may become critical and competition for water increases.

The more severe consequences of drought include huge economic losses in agriculture, shipping and other water-dependent businesses; drinking water shortages, particularly in small rural communities; and environmental stresses, including loss of or damage to wildlife habitat and downshifts in wildlife populations. Drought may also force tough decisions in regard to water allocations among competing interests such as fisheries, agriculture and communities.

In years when drought has occurred, USDA programs have helped to make the difference between a marginal and disastrous year. Farmers who irrigate have reduced their water applications by 4.7 million acre-feet of water each year (enough to cover the nearly 700,000 acres of Rhode Island with seven feet of water), primarily through adoption of management practices that conserve water and reduce the potential for soil salinity.

Wildfire is often more intense and widespread in areas affected by drought, and it can cause enormous damage to land resources and water quality. The huge fires across the western states, many of them in drought conditions, during 2000 cost billions of dollars in damages and suppression activities, eliminated wildlife habitat for many species and precipitated water quality concerns from sediment and mudslides.

Such conservation practices reduce the risk associated with drought, especially if improvement in soil quality has been a primary objective. Healthy soils absorb and store more water than do degraded soils.

A number of tools can assist in preparing for drought and floods, including USDA's SNOTEL and SCAN systems that provide real-time climate information and information concerning soil moisture and water yield conditions (see pages 32 to 33). Such tools are not widely available to all who need them. The majority of the landscape, which is still mostly rural and agricultural in nature, lacks both an adequate number of climate data instruments and real-time monitoring — a finding of the National Drought Policy Commission (2000).

Irrigation. According to NASS (1998), irrigated crops, while raised on only 16 percent of all harvested cropland in the country, account for 49 percent of total U.S. crop sales. In the West (including the 17 western contiguous states, Hawaii and Alaska), irrigated crops make up 72 percent of all crop sales.

For the past 20 years, approximately 43 million acres of cropland have been irrigated in the western states. While that figure has remained fairly constant, there has been a shift of about three million irrigated acres from the more arid Southwest and southern plains primarily to the less arid and more abundant groundwater areas of central and eastern Nebraska.

In addition, a five-million-acre net increase in irrigated farmland

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occurred over the past two decades, all of which is located east of the 100th Meridian where 12 million acres of cropland — an increase of 72 percent over 1980 levels — are now irrigated. Factors driving this increase are the potential for greater and more stable yields, opportunities for alternative crops and reduction of risks inherent in dryland farming areas.

Irrigation withdrawals as a share of total freshwater withdrawals in this country declined from 46 percent in 1960 to 40 percent in 1995, where they remain today. Most irrigation withdrawals occur in the West, where 44 percent of withdrawals are from on-farm, private or state-owned surface water supplies; 24 percent from Bureau of Reclamation surface water supplies; and 32 percent from groundwater.

On-farm wells are the primary source of water for irrigation in the East where groundwater depletion is becoming a major concern, particularly in the Mississippi Delta and Southeast. Over-use of groundwater also occurs in many areas of the Great Plains, Southwest and Pacific Northwest. Major impacts are high pumping costs, land subsidence, saltwater intrusion along coastal areas and loss of aquifer capacity.

Throughout the United Stated, irrigation for crops may have significant environmental impacts, including:

- Diversions from some streams impair aquatic communities and migration of anadromous fish.
- Return flows from irrigated areas may contain biocide residues, nutrients (phosphates and nitrates), total dissolved solids (salinity) and sediment and may reduce the quality of surface water and groundwater.
- Seepage from irrigation systems creates fish and wildlife habitat and recharges aquifers.

Irrigators continue to adopt and apply water management practices based on on-site soil and climate information that allow for more efficient use of water and a reduction in the magnitude of adverse environmental impacts. Since 1979, use of gravity systems decreased by 20 percent, while use of sprinkler and drip/trickle systems increased by 25 percent and more than 500 percent, respectively.

Other practices include a shift to crops that require less water, improved on-farm water-conveyance systems, precision field leveling, shortened water runs, surge flow, reuse of tail water, more precise water and soil moisture measurements and the conversion of high-pressure sprinkler systems to low-pressure systems.

These practices, along with shifts in irrigation to less arid climates, are having an impact. Since 1969, the national average irrigation application rate declined by 4.5 inches, or 20 percent. That is enough to offset the increase in irrigated acreage and maintain the total water applied near the level of 25 years ago. Farmers are simultaneously increasing yields of irrigated crops (for example, rice yields increased 1.2 percent per year over the last 30 years), making the conservation results in relation to water use per unit of agricultural product even more dramatic.

Water supply forecasting and soil moisture measurements

A number of tools are available to provide critical information needed in risk management for flooding, drought, cropping decisions and efficient irrigation. Among them are the following.

Snow survey. Snowmelt provides approximately 80 percent of the streamflow in the West. NRCS and its conservation partners currently conduct snow surveys in 12 western states and Alaska. Natural resource data from 1,100 manual snow measurement courses, 660 automated SNOTEL (SNOwpack TELemetry) sites, 575 stream gauges, 310 major reservoirs and 3,200 climate observation stations are integrated to create basin and watershed analyses and water supply forecasts using an automated database and forecasting system. SNOTEL is the only provider of this critical climate data from the major water yield (high elevation) areas of the mountainous West.

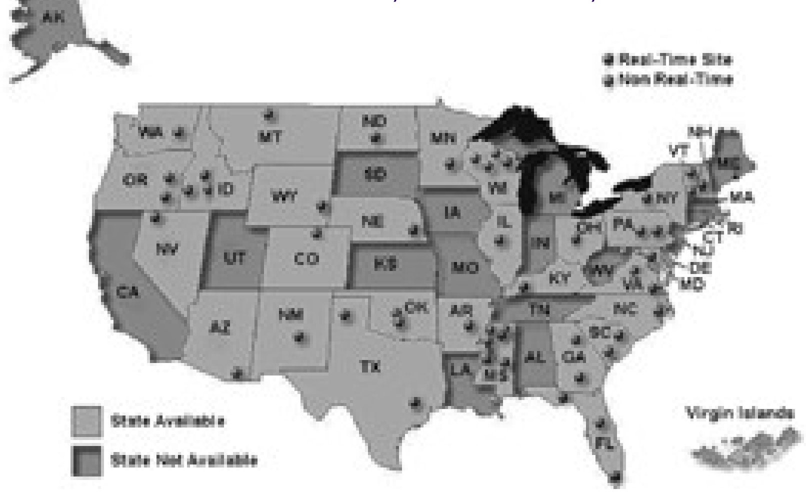
The SNOTEL data collection system plays a key role in irrigation water management, drought assessment and during flooding and other life threatening snow events. The SNOTEL network provides real-time precipitation, temperature and snowpack depletion information that improves current flood stage forecasts. This assists emergency management agencies in effective mitigation of drought and flood damages.

A major focus of program activities is to improve measurement precision, reliability, data quality, increased sampling frequency and timely data availability and to add additional sensors such as soil moisture, soil temperature, wind and solar radiation.

Water supply. USDA's National Water and Climate Center, in partnership with the National Weather Service, produces water supply

FIGURE 8.

SCAN Network, October 31, 2000



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forecasts monthly, January through June. During the 2000 forecast season, 7,580 seasonal water supply forecasts for 827 locations in 12 western states were issued to support water resource management. The forecasts are coordinated with and reviewed by several federal agencies and program collaborators, including the Bureau of Reclamation, Corps of Engineers, Bonneville Power Authority, state and local agencies, power utilities, irrigation districts, tribal governments, the Provincial Government of British Columbia, Alberta, the Yukon Territory and Mexico, to ensure the highest quality and accuracy.

Agricultural, municipal, industrial, hydropower and recreational water users are the primary recipients of these forecasts. Because of recent federal legislation related to endangered species protection, an increasing number of fish and wildlife management agencies also use the data.

SCAN. The Soil Climate Analysis Network (SCAN) supports drought monitoring, assessment of flood potential, crop risk-assessment and productivity models, watershed planning, weather forecast modeling, soils research, water balance monitoring and a wide variety of USDA global change activities. Conservation partnerships have expanded SCAN to 46 remote soil/climate stations operating in 30 states (Figure 8). When fully deployed, SCAN will provide nationwide coverage.

Soil Climate Analysis Network (SCAN) station in Dorchester, New Hampshire. This facility collects real time weather and snow pack data along with soil moisture, temperature and other soil temporal properties.

Air quality issues

Agricultural production can be a source of atmospheric pollutants such as particulates — dust-sized pieces of soil minerals, agricultural chemicals and plant and animal organic material — and greenhouse gases, including carbon dioxide, nitrous oxides and methane.

Farms and ranches may also contribute noxious odors from animal wastes and agricultural chemicals, and they can feed the processes that drive global climate change (increased atmospheric carbon dioxide, changing land-use patterns, weed and pest invasions and water availability).

While agriculture contributes to atmospheric pollutants, crops and livestock are also impacted by climate change and atmospheric ozone.

Conditions and trends

Because of the effects that agricultural producers and other owners of private land have on air quality, this issue is an important focus of USDA conservation programs and technical assistance. In the last three months of 2000 alone, partners in conservation districts across the country produced 23 group or area-wide plans — covering 109 million acres — that featured mitigation of air quality problems.

During that same time period, conservation measures that help address air quality were applied on 695,000 acres. Approximately five percent of

Conservation improves air quality

A number of conservation techniques on agricultural land that are usually designed to improve soil and water quality are also effective in mitigating conditions that can adversely effect air quality. Among them are:

- ✔ contour buffer strips
- ✔ contour strip cropping
- ✔ cross-wind ridges and strip cropping
- ✔ cover crops
- ✔ field borders
- ✔ hedgerows
- ✔ efficient irrigation
- ✔ residue management
- ✔ waste management systems

resource inventories and evaluations (primarily in the Midwest, Northern Plains and South Central regions) reflected air quality issues.

Other forward strides include formation of the first USDA Agricultural Air Quality Task Force in 1996. This group works to assess the extent to which agricultural activities contribute to air pollution, determine cost-effective ways for the agricultural sector to improve air quality and coordinate research on agricultural air quality issues to avoid duplication.

Particulate matter in the air has been linked with respiratory illness and is viewed as a growing public health concern. EPA has identified agricultural activities as significant sources of fine particulates. The agency estimates that fugitive dust from crop production totals 3.3 million tons annually and that, under current controls, these emissions will increase to about 3.8 million tons by 2005. EPA also projects that fugitive dust from livestock operations, now contributing an estimated 181,400 tons every year to the atmosphere, will rise to 193,400 tons a year by 2005.

In 1998, EPA identified fewer than 10 air quality non-attainment areas that included rural lands. In 2000, after additional surveys, there were more than 100 such rural areas, and EPA projects the number to rise significantly by 2002. (In non-attainment areas, air quality is below the limits set by Clean Air Act regulations.)

USDA's Agricultural Air Quality Task Force recommended voluntary, incentive-based compliance programs to address agricultural impacts on air quality. The group proposed that state air pollution regulatory agencies adopt such programs to reduce particulates from agricultural operations in non-attainment areas while sustaining long-term agricultural production.

These incentive-based programs would include both accountability and backstop provisions. The backstop provisions would be the means for states to regulate agricultural operations that do not comply with the agreed-upon plans.

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Climate Change

As a natural part of the earth's atmosphere, gases known as greenhouse gases such as carbon dioxide, water vapor, methane and nitrous oxides reflect heat to the earth's surface in much the same way that glass or transparent plastic help warm a greenhouse. Without them, the earth would be too cold for life as we know it.

Human activities such as burning fossil fuel for domestic and industrial purposes are increasing the amount of greenhouse gases in the atmosphere. Agricultural practices such as land conversion from grass, forest or wetlands to cropland, conventional cultivation, fertilization, and livestock production also release greenhouse gases.

Recent acceleration in the accumulation of these gases in the atmosphere is causing changes in temperature, precipitation and other aspects of climate. Figure 9 shows the increase in frequency of intense rainfall events in the United States, which increases the risk of flooding, water pollution and erosion. In 1995, a group of more than 2,000 of the world's leading scientists (the Intergovernmental Panel on Climate Change) concluded, "The balance of evidence suggests a discernible human influence on global climate." Since that time the evidence has increased.

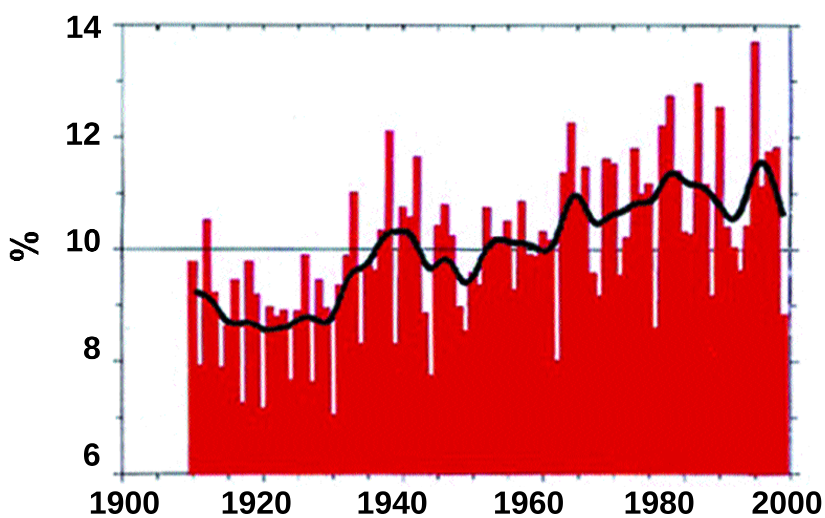
Computer models of future climate indicate that general atmospheric warming will be faster and greater than at any time in the last 10,000 years — indeed, since the dawn of agricultural societies. These changes in climate will likely affect everything from the length of the growing season and available water to pests and weed infestation. Agriculture can respond to global climate change by reducing its greenhouse gas emissions, adapting to the change and offsetting greenhouse gas concentrations in the atmosphere through carbon sequestration.

Agricultural producers may readily adapt to small, steady increases in temperatures or gradual shifts in water regimes by shifting to crops that are better suited to new climate regimes. Extreme weather events will require farmers to manage risk with, for example, a greater diversity of crop species.

Greater risk of drought, floods and ensuing erosion from wind or water can be ameliorated by increasing the soil's resilience through conservation techniques such as reduced tillage,

FIGURE 9.

Percent of United States experiencing extreme one-day precipitation events, 1909-2000



Source: Karl et al. 1996

rotations, cover crops and buffer strips. Still, the climate in some areas of the South may become too hot and dry to continue some crops, and other areas are likely to be inundated with water, making them unsuitable for agriculture. It is expected that farming for some crops may shift northward over time, where soil conditions are suitable.

Which changes are made and how they are accomplished will depend on the driving economic and ecological forces of the production system. Key actions in preparing for climate change are: (1) improve capabilities for predicting potential changes and their impacts and (2) develop the means to manage the risks.

Conditions and trends

On the global scale, agriculture accounts for about one-fifth of the annual human-caused increase in greenhouse gas emissions, primarily methane and nitrous oxide, but contributes only about four percent of global carbon dioxide emissions.

Methane (agriculture accounts for one-third of the U.S. total) is produced from the digestion of low-quality forage by grazing livestock and anaerobic storage of manure in concentrated feeding operations. Nitrous oxide (agriculture accounts for about two-thirds of the U.S. total) is produced as a by-product of the application of nitrogen fertilizers and manures to the land. Carbon dioxide production from agriculture (three percent of the U.S. total) is a result of practices that disturb the soil and accelerate the decomposition of soil organic carbon. Burning agricultural residues also releases carbon dioxide. The use of fossil fuels in farming operations, and the production of agricultural petrochemicals also directly and indirectly contribute to carbon dioxide emissions.

Agricultural practices that decrease greenhouse gas emissions offer multiple economic and environmental benefits. For example, reducing the number and intensity of field operations saves money, time and labor while reducing fossil fuel use, and in the case of reduced tillage, reducing soil organic carbon loss. Improved nutrient management and substitution of renewable organic nutrients (manures and composts) for fossil fuel-based nutrients reduce emissions while maintaining yields and addressing water quality issues. Better management of nitrogen fertilizers could result in a 15-percent to 20-percent reduction of nitrous oxide emissions from cropland, according to the U.S. Department of Energy. This means that fields lose fewer nutrients to ground and surface waters.

Methane recovery from manure storage systems may pay for itself within a few years because the methane can be used on the farm as a renewable energy supply. Methane emissions from grazing livestock can be reduced by 20 percent to 25 percent through improved grazing systems and increased individual animal and herd performance. Such systems also reduce operating costs and help keep water and air cleaner.

This nation has demonstrated a capacity to reduce emissions from agricultural systems through efforts

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such as the Ruminant Livestock Efficiency Program, AGSTAR, methane-capture pilot projects and the Nutrient Efficiency Program. Work is underway to develop, refine and use carbon inventory, measurement and prediction tools such as the Iowa Soil Carbon Management Project, CQESTR, CENTURY, EPIC and carbon probes. But much remains to be done to apply these systems on a broad scale.

Carbon Sequestration

Carbon is a component of carbon dioxide and methane, two of the most important greenhouse gases. Storing, or sequestering, carbon in soil as organic matter and in trees, shrubs and other permanent vegetation helps reduce the amount of carbon dioxide in the atmosphere. This is why soil and vegetation are sometimes called carbon "sinks."

Practices that increase the amount of soil carbon also reduce soil erosion and are generally associated with improved soil quality. As their organic carbon content increases, most soils are better able to hold and supply water and nutrients to growing plants. This increases the soil's resilience under stress, reducing the negative impacts of flooding and drought. More efficient irrigation and nutrient use are also possible, contributing to improved water quality and supply and sustainable productivity of the land.

Keeping crop residues on fields, maintaining vegetated buffers and using agroforestry practices improve air and water quality by reducing erosion and runoff. These practices enhance wildlife habitat and can provide additional farm income.

Farmers and ranchers have adopted many conservation techniques, usually for other benefits, that also increase carbon storage. These include reduced tillage or no-till cultivation systems; crop rotations that incorporate small grains, hay and legumes; planting of cover crops; minimizing or eliminating summer fallow; managing nutrients and irrigation efficiently and effectively; and adoption of improved livestock grazing management systems. Initial financial incentives in addition to outreach and education may be necessary to encourage farmers to increase their amount of carbon sequestration. Public assistance is warranted because of the multiple ancillary public benefits.

These and similar mitigation activities can reduce the amount of carbon in the atmosphere by somewhere between 90 and 300 million tons per year over the next 25 to 40 years (Lal et al. 1998, Follett et al. 2001). In total, reducing greenhouse gas levels through better management of agricultural production systems could offset total U.S. emissions by 10 to 15 percent, increase on-farm profitability and enhance environmental quality.

Sprawl, land use and planning

Sprawling development and land consumption patterns have accelerated changes across this nation's landscape. Many once-thriving city centers have experienced losses in business, industry and populace, while a growing population drives the continuing conversion of agricultural land for residential and commercial uses.

Thirty-three percent of the nation's farms and 16 percent of all farmland are located near metropolitan areas. These urban-influenced farm areas produce about one-third of the value of all U.S. agricultural products and control 39 percent of farm assets. This highlights two important issues. First, because there is significant production in urban-influenced areas, there is a need to address the unique conservation needs of these producers. Second, a significant portion of nation's prime agricultural land is at risk.

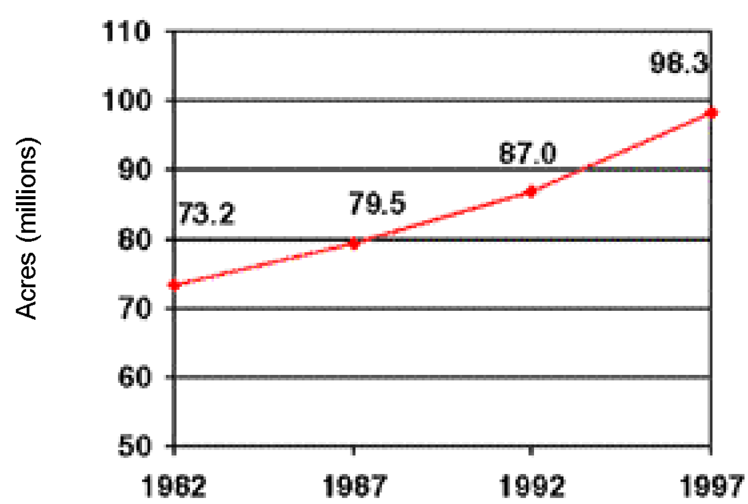
Conditions and trends

Sprawling city suburbs and "exurbs" have accelerated the conversion of farmland to other uses and have caused the development of working lands suited for other purposes. The National Resources Inventory (2000a) found that between 1982 and 1997, the amount of urban and built-up land increased by 26 million acres (Figure 10), an area roughly the size of Ohio. On average, 645,000 acres of prime farmland are converted each year to non-agricultural uses. About 45 percent of new construction between 1994 and 1997 occurred in rural areas, and nearly 80 percent of that bordered urban areas.

Of the more than 2.8 million acres of farmland being converted every year, two million are devoted to

FIGURE 10.

Cumulative trends in private land converted to developed areas



Source: National Resources Inventory (NRCS 2000a)

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housing. Nearly 94 percent of acreage converted to housing development is attributed to lots one acre or larger in size — 37 percent on lots between one and 10 acres and 57 percent on lots of 10 or more acres. Large-lot (10 or more acres) housing and increasing affluence have accelerated the conversion of agricultural land to non-agricultural uses. More homes on less acreage, called "splatter" development, typically encourage more sprawl, while large-lot housing development removes an inordinate amount of farmland from production.

The consequences of converting agricultural land to non-agricultural uses include the fragmentation of contiguous open land that results in degradation of wildlife habitat, an increase in automobile travel that results in the degradation of air quality and an increase in septic tanks and well-heads that threaten groundwater resources. Land conversion causes widespread impervious areas that increase the amount and intensity of storm water runoff, thus affecting flood and surface water quality. As well, conversion of grazing land near urban areas in the West has created increased fuel and fire hazards and contributed to recent wildfires.

The conversion of farmland to residential use also translates into higher public costs. Studies show that residential development contributes less in tax revenues than it consumes in public service expenditures (schools, utilities and roads). On the other hand, farmland, forestland and open space tend to contribute more in tax revenues than they consume in public service expenditures (Kelsey 1997).

Consequently, federal, state, tribal

Urban/rural interface and USDA

A recent National Association of Conservation Districts survey indicated that in 14 percent of its districts, at least half of the workload was associated with urban and development issues (NACD 2001a). The General Accounting Office (2000) reported 29 percent of cities and 37 percent of counties strongly supported technical assistance from the federal government regarding urban impacts on natural resources.

USDA technical assistance is available to help urban and suburban communities with a variety of conservation tasks such as managing storm water runoff and sediment control in developing areas. Through the Farmland Protection Program, the Department cooperates with tribal, state and local governments and landowners to protect strategically located prime farmland near urban areas.

These efforts are important because agricultural lands contribute to scenic beauty and community character in both urban and rural landscapes. They also provide many environmental benefits — from wildlife habitat to reductions in flood damages, increases in groundwater recharge and absorption of carbon and other greenhouse gases — that are beneficial in both developed and rural landscapes.

and local governments and landowners are acting to protect farmland. To date, 70,246 acres on 367 farms, with an estimated easement value of more than $126.5 million, have been permanently protected from conversion to non-agricultural uses through USDA's Farmland Protection Program. And there is a large unmet demand for additional assistance to local communities. American Farmland Trust estimates that more than half a million acres have not been enrolled in the Farmland Protection Program because of the lack of funding.

Many areas of the country are turning to planning as one way to address concerns about growth. Almost one-third of cities and counties responding to a General Accounting Office survey said they expected to increase their involvement in planning over the next five years (General Accounting Office 2000). Even states such as California, where planning is mandated by state legislation, maintain that existing land-use plans are outdated and that they lack requirements to thwart unplanned growth.

Every day across this country, housing and commercial development encroaches on agricultural lands.

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Wetlands

Wetlands ecosystems provide a variety of goods and services that are valued by society. These include filtering nutrients, trapping sediments and associated pollutants, providing fish and wildlife habitat, dampening floodwater runoff peaks, buffering shorelines from storm impacts, and producing food and fiber for human consumption and use.

Historically viewed as obstacles to productive agriculture and expanding development, wetlands systems are now protected at federal, state and local levels. Many wetlands protection programs specifically address whether human activities unnecessarily eliminate or severely degrade wetlands functions and thus impair their ability to deliver valuable goods and services to society at large.

For example, the Swampbuster provisions of the Food Security Act of 1985, as amended by the Food, Agriculture, Conservation, and Trade Act of 1990, make landowners ineligible for USDA program benefits if they convert wetlands for agricultural commodity production or, after November 28, 1990, if they convert wetlands to make agricultural commodity production possible (NRCS 1997).

The Federal Agriculture Improvement and Reform Act of 1996 provided landowners flexibility in complying with the wetlands conservation provisions of the 1985 Act. The 1996 Act allows landowners to remain eligible for USDA program benefits even if their actions result in conversion of wetlands as long as wetlands functions and values are adequately mitigated (determined by NRCS) and the mitigation meets certain conditions stipulated in the 1996 Act.

In addition, the 1996 Act extended the Wetlands Reserve Program to 2002, with an enrollment cap of 975,000 acres. The Agriculture Appropriations Act for fiscal year 2001 raised the enrollment limitation to 1,075,000 acres. Landowner efforts to restore wetlands on agricultural land resulted in 1,048,629 acres enrolled in the Wetlands Reserve Program as of March 2001 (NRCS Wetlands Reserve Program data).

In 1989, national policy, called “no net loss” of wetlands, was initiated to address the decline of wetlands acreage and functions. That policy continues to be the minimum target for federal agency programs and activities affecting wetlands.

Conditions and trends

The National Resources Inventory estimates there were 111,156,000 acres of wetlands on U.S. non-federal lands in 1997 (Table 3, page 42; NRCS 2000a). The total 1997 acreage of wetlands in the six NRCS administrative regions varied widely. Nearly 31 percent of that total was in the Southeast Region (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia and Puerto Rico). Six percent of that total was in the West Region (California, Hawaii, Idaho, Nevada, New Mexico, Oregon, Utah and Washington).

Approximately 59 percent of the national wetlands acreage existed on forestland and 16.5 percent on agricultural land (cropland, pasture land and land enrolled in USDA’s

Conservation Reserve Program; Table 4). Wetlands extent on forestland was greatest in the Southeast Region, although the East Region exhibited the greatest percentage of wetlands on forestland relative to the total wetlands extent within the region.

Nationally, there was a net loss of 162,800 acres of wetlands from 1992 to 1997, for an average annual net loss of 32,600 (+/-12,900) acres (NRCS 2000a). National gross wetlands losses of 506,000 acres were somewhat offset by gross wetlands gains of 343,200 acres on non-federal lands. These acreage gains resulted from restoration and creation activities and natural causes and as unintentional by-products of various activities (NRCS 2000a).

While wetlands extent is lowest in the urban and developed land class (Table 4), approximately 49 percent of the national gross loss was attributable to development between 1992 and 1997.

This was a change from historical patterns in which agricultural activities have been identified as the major cause of wetlands losses. As Figure 11 on page 44 shows, agricultural activities accounted for average annual losses of 398,000 acres of wetlands from 1954 to 1974 (Frayer et al. 1983) and 157,000 acres from 1974 to 1983 (Dahl and Johnson 1991). The average annual loss rate of 26,800 (+/-4,500) acres from 1992 to 1997 was the smallest average annual loss rate attributed to

TABLE 3.

Changes in wetlands acreage, 1992-1997

(NRCS 2000a; changes within NRCS administrative regions; numbers in parentheses = 95 percent confidence intervals of the estimates; data in thousands of acres)

	Region						
	East	**Southeast**	**South Central**	**Midwest**	**Northern Plains**	**West**	**Total**
1997 Acreage	14,262.8	34,377.9	18,884.9	27,032.1	10,183.3	6,415.0	111,156.0
Gross losses	-57.6 (+/-11.0)	-216.9 (+/-33.4)	-84.1 (+/-14.7)	-74.2 (+/-12.1)	-37.0 (+/-12.8)	-36.2 (+/-11.8)	-506.0 (+/-43.6)
Gross gains	15.4 (+/-5.1)	110.5 (+/-30.9)	78.4 (+/-10.9)	48.4 (+/-8.2)	34.3 (+/-8.0)	56.2 (+/-30.7)	343.2 (+/-46.6)
Net change	-42.2 (+/-12.1)	-106.4 (+/-46.9)	-5.7 (+/-18.3)	-25.8 (+/-14.6)	-2.7 (+/-15.2)	20.0 (+/-32.6)	-162.8 (+/-64.7)
Loss due to agriculture	-5.2 (+/-3.5)	-42.0 (+/-16.1)	-18.3 (+/-5.6)	-38.5 (+/-8.0)	-18.0 (+/-9.7)	-11.8 (+/-6.5)	-133.8 (+/-22.4)
Loss due to silviculture	-9.4 (+/-3.6)	-27.1 (+/-5.4)	-3.8 (+/-1.9)	-14.3 (+/-5.3)	-1.7 (+/-1.2)	-3.8 (+/-2.1)	-60.1 (+/-9.0)
Loss due to development	-38.7 (+/-7.9)	-125.8 (+/-20.6)	-49.9 (+/-12.1)	-21.3 (+/-7.3)	-1.4 (+/-2.6)	-10.4 (+/-7.0)	-247.5 (+/-27.3)
Loss due to miscellaneous activities	-4.3 (+/-4.5)	-22.0 (+/-15.4)	-12.1 (+/-5.7)	-0.1 (+/-0.2)	-15.9 (+/-7.7)	-10.9 (+/-4.9)	-64.6 (+/-19.3)

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agricultural activities reported to date (NRCS 2000a).

Losses resulting from silvicultural and miscellaneous activities were almost evenly divided and contributed less to overall wetlands losses than either development or agricultural activities (Table 3).

Gross wetlands losses and gains and net change in wetlands extent also varied among the six NRCS administrative regions (Table 3). Gross losses were greatest in the Southeast Region, comprising almost 43 percent of the national gross loss, and gross losses caused by development were also greatest in that region.

The nation has yet to achieve no net loss of wetlands acreage, but progress is evident. Analysis of changes in the status of wetlands between 1992 and 1997 in the six NRCS administrative regions shows that the West Region came closest to the no net loss goal with a net change of 20,000 (+/-32,000) acres, followed by the Northern Plains Region with a net change of -2,700 (+/-15,200) acres and the South Central Region with a net change of -5,700 (+/-18,300) acres. The other three regions all exhibited net losses.

Wetlands gains were greatest in the Southeast Region, but that region also had the highest net loss (Table 3; NRCS 2000a). The other four regions exhibited net losses.

While human activity has altered and degraded extensive areas of wetlands over a long period of time, wetlands restoration and enhancement have gained popularity and resulted in federal, state and local investments in restoration programs.

TABLE 4.
Wetlands acres by land cover
(NRCS 2000a; land cover type within NRCS administrative regions; number in parentheses = the percent of the total wetlands acreage for each land cover type; data in thousands of acres)

Region	Cropland, pasture land and CRP land	Rangeland	Forestland	Urban and developed land	Other land	Wetlands acreage
East	1,323.3 (9.2%)	0.0 (0%)	11,022.3 (77.2%)	218.9 (1.5%)	1,698.3 (11.9%)	14,262.8 (12.8%)
Southeast	2,269.0 (6.6%)	1,209.1 (3.5%)	25,719.0 (74.8%)	493.3 (1.4%)	4,687.5 (13.6%)	34,377.9 (30.9%)
South Central	3,599.9 (19.0%)	1,069.5 (5.6%)	10,071.6 (53.3%)	309.9 (1.6%)	3,834.0 (20.3%)	18,884.9 (16.9%)
Midwest	4,846.4 (17.9%)	0.0 (0%)	17,083.2 (63.2%)	251.8 (0.9%)	4,850.7 (17.9%)	27,032.1 (24.3%)
Northern Plains	4,083.9 (40.1%)	4,141.1 (40.6%)	339.1 (3.3%)	94.6 (0.9%)	1,524.6 (14.9%)	10,183.3 (9.1%)
West	2,236.8 (34.8%)	1,443.0 (22.4%)	893.3 (13.9%)	39.0 (0.6%)	1,802.9 (28.1%)	6,415.0 (5.7%)
Total	18,359.3 (16.5%)	7,862.7 (7.0%)	65,128.5 (58.5%)	1,407.5 (1.2%)	18,398.0 (16.5%)	111,156.0 (100%)

Thousands of acres of wetlands have been "restored," but many restored wetlands do not provide the same functions and values of the original wetlands.

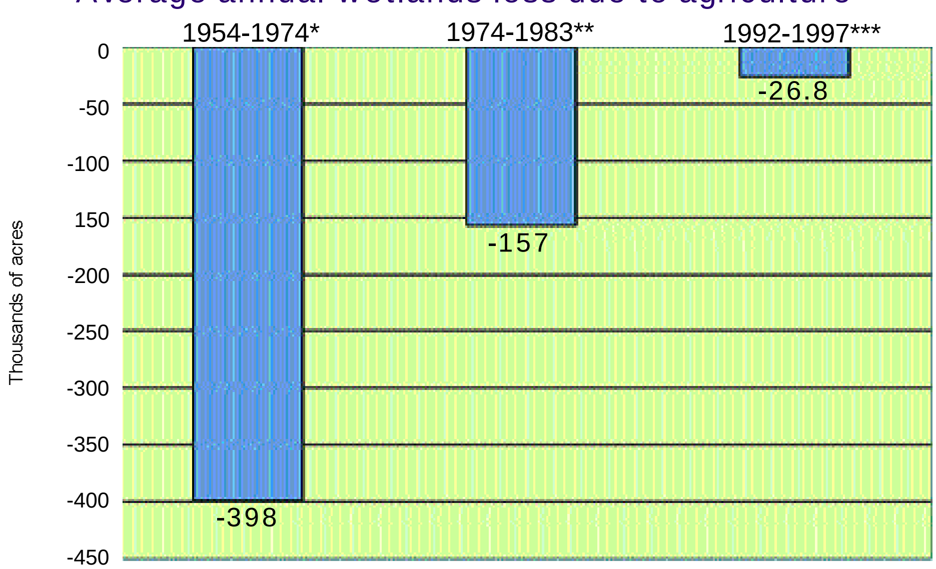
Restoration of wetlands functions is hampered by a lack of knowledge and understanding of the complexities inherent in wetlands ecosystems and their role in the landscape. Natural, unaltered wetlands ecosystems developed over long periods of time in landscapes where ecosystem and physical processes were highly integrated. Many wetlands restoration sites are located on former wetlands that no longer have the benefit of an integrated infrastructure because human activity has altered the landscape on a regional scale. This adversely affects the ability to replicate site-specific characteristics of former wetlands.

Expectations for wetlands restoration and the science of restoration are often at odds. Most restoration programs are short-term and conducted on a local scale. Meaningful restoration requires many years (possibly decades), long-term monitoring, adaptive management practices and attention to the regional landscape.

The lack of controlled experiments limits the knowledge of which restoration techniques successfully return wetlands functions to different levels. Monitoring and adaptive management practices serve as a safety net to document and ensure that former wetlands are in fact restored. Control of invasive species, maintenance of restored hydrology, revegetation and control of human disturbance are just a few of the management investments that must be made if wetlands and their functions are to recover.

FIGURE 11.

Average annual wetlands loss due to agriculture



*1954-74 data from Frayer et al. 1983
**1974-83 data from Dahl and Johnson 1991
***1992-97 data from NRCS 2000a [1997 NRI, which excludes federal lands]
See bibliography in full report for complete references.

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Grazing lands

Grazing lands constitute the largest land use on America's private lands. Grazing lands contribute significantly to the economies of many regions in the United States and play a key role in environmental quality.

Privately owned grazing lands, pastures and rangeland cover more than 500 million acres in this country. An additional 60 million acres of privately owned woodland and forestland also support grazing. Many of these lands provide abundant and clean water supplies in addition to livestock forage. They also improve the aesthetic character of the landscape, provide wildlife habitat and recreational opportunities and protect the soil from water and wind erosion.

Conditions and trends

Rangelands are managed as natural ecosystems to produce the benefits noted above, while pastures are managed more intensely — fertilization and irrigation to attain maximum forage production are common, for example. USDA technical assistance programs have helped to improve nearly 20 million acres of grazing land (Grazing Lands Conservation Initiative data). However, a number of critical resource concerns must still be addressed so that grazing lands can continue to provide diverse benefits.

Maintenance of appropriate plant cover (including natural plant communities) is a primary resource concern on grazing land in this country. Over-use of grazing lands and concentrated livestock numbers place stress on vegetation on grazing lands, particularly in riparian areas or during times of drought. Without proper grazing management — in addition to proper nutrient management on pastures — the quality and quantity of plant cover declines. This causes productivity losses, exposes the soil to damaging wind and water erosion and can impair water quality.

Because grazing land occupies such a large portion of the landscape, degradation of the vegetative cover on grazing lands can have a potentially significant impact on U.S. soil and water resources. It is estimated that about 280 million acres — more than 50 percent — of U.S. grazing lands may be susceptible to such degradation and in need of some form of conservation management (SRM 2000, Smith and Koala 1999). Approximately 50 percent of U.S. pastures, or 60 million acres, is on land that is subject to erosion and other soil limitations if adequate

Juniper and creosote bush invasion on rangeland.

Rangeland in Utah.

ground cover is not maintained (NRCS 2000a).

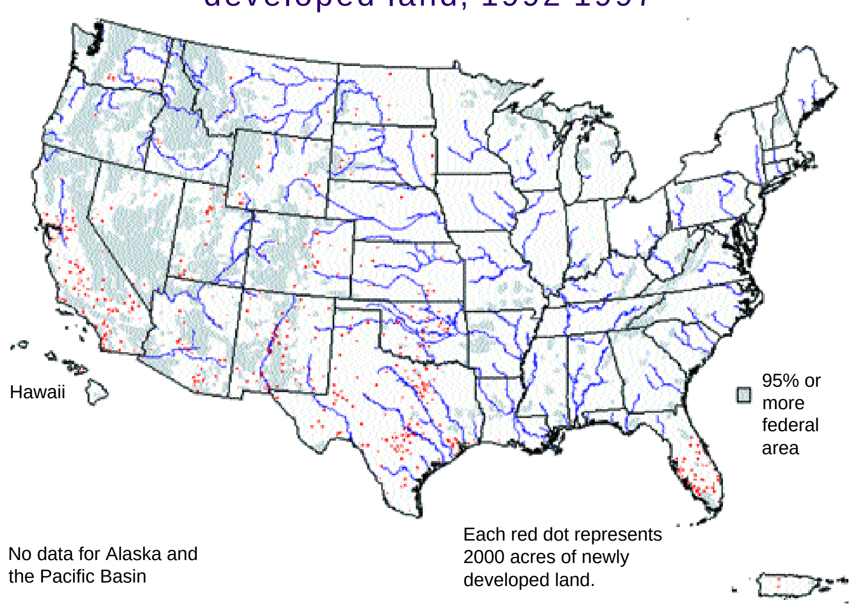
Establishment of invasive species on grazing lands is another resource concern, and it is gaining increased attention. Productivity of grazing lands declines and management becomes more difficult upon the invasion of non-native woody shrubs and trees, noxious weeds and plant species of low forage value. As invasive species take over a site and displace native or introduced forage species, landscape hydrology can be altered. This can adversely affect water quality and quantity, which increases the potential for soil erosion and the risk of damaging floods.

Some invasive species increase the risk of fire. Other impacts include loss of critical wildlife habitat and a reduction in the natural diversity of the landscape. Natural diversity is crucial to an ecosystem's ability to recover from stresses such as fire, drought or flooding.

Loss of grazing land through conversion to other land uses such as cropland and urban development also threaten grazing land resources. About 23 million acres of grazing

FIGURE 12.

Acres of rangeland converted to developed land, 1992-1997



Source: NRCS 2000a

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land were converted to cropland over the last 15 years, and about six million acres have been converted to urban and other uses (Figure 12; NRCS 2000a).

More than 90 percent of the original grasslands in a large part of the central United States have disappeared, mainly as a result of conversion to cropland to help meet the nation's food and fiber needs. Remnant grazing lands are the sole repositories of habitats that are critical to the existence of many species. They also represent reservoirs of biodiversity in landscapes affected by urban and agricultural development and the invasion of non-native species (see sidebar on Gray Ranch).

Conserving fragile landscapes and habitats — the Gray Ranch

The Gray Ranch is a 321,000-acre working ranch in the shrub-steppe country of southwestern New Mexico. Within its confines, the ranch captures a large portion of the environmental variability in the region and thus is representative of the region as a whole. The ranch contains grassland, shrubland and woodland; a variety of biophysical environments; and a high level of plant and animal species diversity. The ranch provides habitat and refuge for a large concentration of federal and state threatened and endangered species.

As part of its efforts to preserve the biological heritage of this country, the Nature Conservancy purchased the Gray Ranch — the largest purchase in the history of the Conservancy at that time. The ranch is now owned by the Animas Foundation, which has undertaken long-term research on the impacts of grazing and fire on the flora and fauna of the ranch.

Private forestland

Fifty-eight percent of this country's forestland is private land (Figure 13; Smith et al. In press), and 84 percent of that is in small non-industrial tracts owned by more than 10 million individuals. USDA analyses indicate that the amount of forestland has been relatively stable since the 1920s because losses of forestland to development and other land uses have been offset by reforestation and natural reversion of abandoned cropland and pastures to forest (USDA 2000a).

Small non-industrial forestlands currently produce 59 percent of the annual timber supply (Smith et al. In press). But these lands, when managed in a sustainable way, do much more than provide wood. They store carbon, shelter diverse wildlife, offer recreational opportunities and help cleanse the nation's waters.

FIGURE 13.
Percent of non-federal areas in forest, 1997

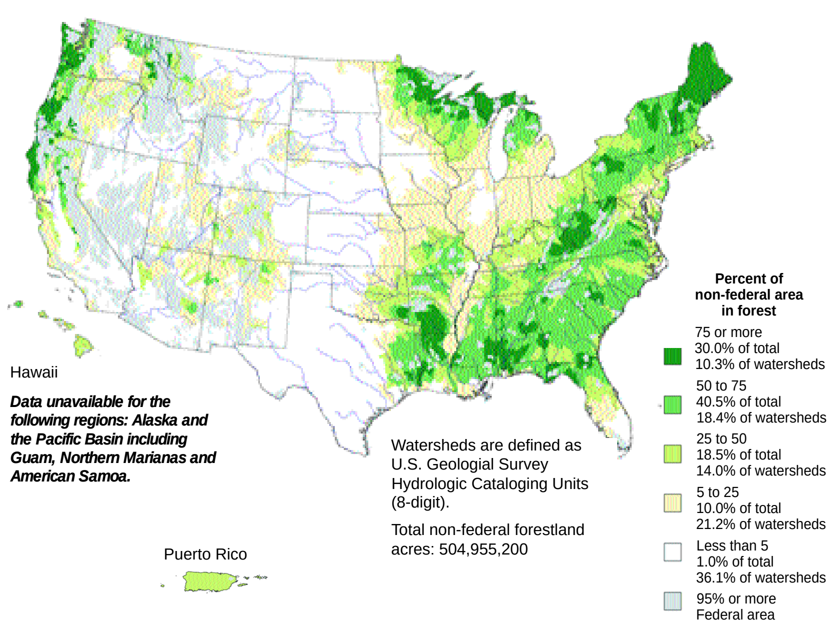
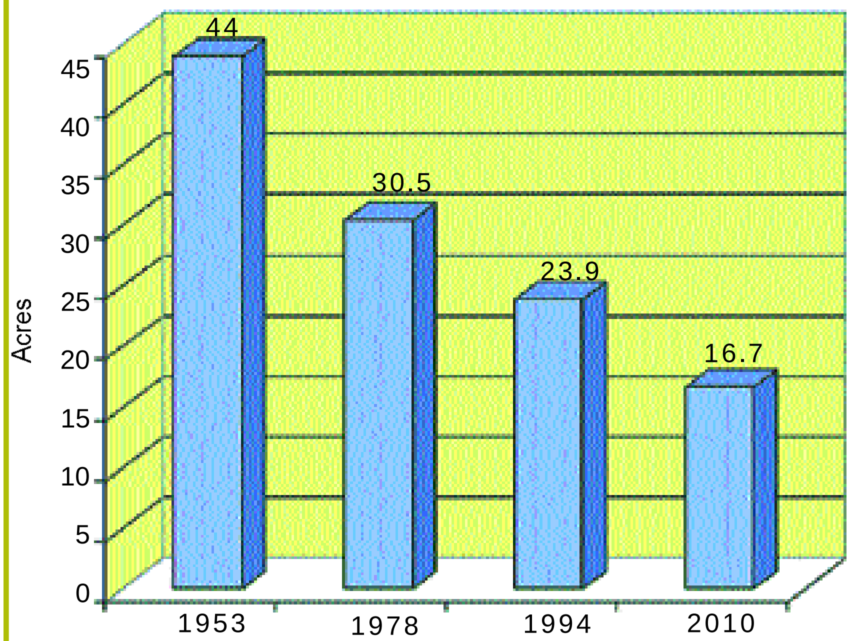


FIGURE 14.
Average size of forest parcels owned by individuals, 1953-2010



Sources: 1953-1994 estimates from Birch 1996, extrapolation to 2010 from Sampson and DeCoster 1997

Conditions and trends

While the forestland base is expected to remain relatively stable in the future, population increases will lead to greater conversion of forests for development purposes. Studies show that forestland is becoming increasingly fragmented as large- and medium-sized forest tracts are subdivided into smaller parcels owned by more people.

The average size of individual holdings is declining steeply. About 70 percent of all new forestland owners in recent years, for example, acquired parcels between 10 acres and 49 acres in size, many of which were formerly part of larger tracts (Birch 1996, Sampson and DeCoster 1997). The average size of all private non-industrial forests tracts dropped from 44 acres in 1953 to 24 acres in 1994 and is expected to drop to 17 acres by 2010 (Figure 14; USDA 2000a).

Every year, about 100,000 owners harvest 2.5 million acres of timber from parcels in the 10- to 49-acre size range. USDA estimates that nearly 15 million acres of small non-industrial forestland is subject to a timber harvest within the next few years (Sampson and DeCoster 1997).

Approximately 40 percent of private forestland would benefit from conservation practices. But only about 10 percent of private forestland acres are managed through conservation planning. One report indicates that owners of smaller tracts view forest management for conservation and timber as only occasionally necessary, primarily because of the lower economic returns and higher costs associated with managing small tracts (USDA 2000b). Increasingly, owners of these smaller parcels make the decision that it is not cost-effective for them to implement conservation techniques such as planting new trees, improving existing timber stands or facilitating natural regeneration of trees. Thus, smaller parcel sizes, increased management costs and landowner decisions have had an impact on the availability of timber from private land. These factors have also led indirectly to degradation of associated soil, water and air quality, as well as a reduction in habitat for certain wildlife species and an increase in fire hazards.

In most cases with small acreage parcels, timber harvest will be a once-in-the-ownership experience, which makes it likely that landowners will have little or no experience with various aspects of timber and resource management. Without experience or knowledge of forest dynamics, landowners may make expensive or damaging errors. A case in point is when a landowner purchases land and simply allows "nature to takes its course." In many such instances, invasive tree species, insect epidemics and wildfires have created detrimental forest conditions that harm the public. As a result, educational, technical and financial assistance for this growing constituency is critical to maintain forest health.

Public benefits are not the only benefits that accrue from proper forest management. A North Carolina study found that where consulting foresters were used, landowners' income from timber sales increased by 20 percent (Cubbage 1996, Sampson and DeCoster 1997).

As the population and the economy continue to grow, U.S. demand for domestic wood products is expected to increase. Historically, more than 88 percent of wood products used in this country have been produced domestically (Haynes et al. 1995). As demand for additional housing space grows and a cutback of timber supplies on national forests occurs, it becomes more likely that small forest tracts will be used for both non-timber and timber purposes. These factors make skilled timber harvest and long-term sustainability critical to the health of the U.S. economy and its natural resources.

In some regions of the country, voluntary cost-share and easement programs such as the Forest Legacy Program (see page 11) have proved to be effective in encouraging landowners to engage in forestry practices to cope with existing resource problems. The goal is to foster income that rewards landowners for the social, environmental and community benefits provided by sustainable management of their forest tracts.

Since 1978, owners of small forest tracts have cooperated with state forestry agencies and USDA to improve more than five million acres of private forestland through the Forestry Incentives Program (see page 11). In Fiscal Year 2000, there was only enough money in this program to fund about 50 percent of the applications received for cost-share projects.

Every year, about 100,000 landowners harvest 2.5 million acres of timber from parcels in the 10- to 49-acre size range. USDA estimates that nearly 15 million acres of small non-industrial forestland is subject to timber harvest within the next few years.

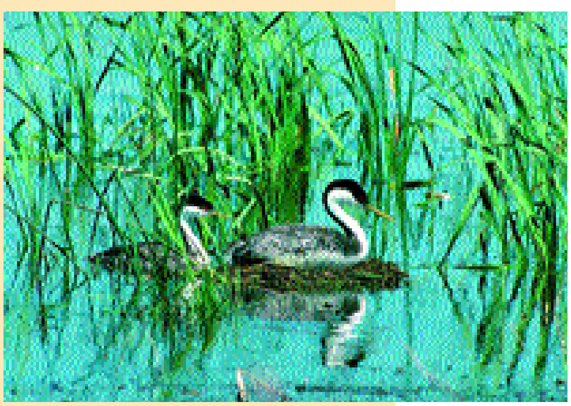
Depending on the amount of acreage they own, different landowners have different needs. USDA researchers have found that those with less than 10 acres generally request educational materials about proper tree care and wildlife. Those with holdings between 10 acres and 100 acres in size also request educational materials along with occasional technical assistance to help them with ecosystem planning and general forest and timber management. The Forest Stewardship Program (see page 11) provides the needed technical assistance to such landowners through forest management planning, restoration of riparian areas, wildlife enhancement and improved supplies of tree seed for reforestation.

Owners of 100-acre to 499-acre forestland tracts — who are traditionally assisted by USDA — often request both technical and financial assistance. Owners of parcels larger than 500 acres in size may hire their own forestry consultants, but still look for research assistance and tax incentives for timber management (Sampson and DeCoster 1997).

In a survey conducted by North Carolina State University, the majority of respondents favored some type of forestry incentives (Megalos and Blank 1997). Nearly 57 percent favored income or property tax incentives, while one-third would likely to participate in cost-share programs, green investment accounts and low-interest loans. More than 50 percent indicated a willingness to participate in on-site visitation by technical experts.

Wildlife habitat

Working lands in this country are the storehouse of many vibrant ecological communities, including wetlands and other aquatic habitats, riparian areas, forests and grasslands. Management of these lands plays a critical role in sustaining healthy fish and wildlife populations. How the land is used is the principal factor determining the abundance of wildlife species. There are multiresource consequences from land management decisions, whether lands are managed for multiresource objectives (economic agriculture, soil sustainability, water quality, wildlife habitat, etc.) or for a single purpose objective. The purpose of technical assistance to land users is to expand their vision for the conservation of the broad resource base (soil, water, wildlife and related resources).



Waterfowl benefit from conservation practices on agricultural lands.

A number of USDA programs (described more fully on pages 6 to 13) assist landowners to improve wildlife habitat on their lands, while other programs discourage practices that degrade wildlife habitat. The Wildlife Habitat Incentives Program provides financial incentives to develop fish and wildlife habitat. In 1999, approximately 720,000 acres — comprising upland, wetlands, riparian and aquatic habitats — were enrolled

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in this program, bringing the total number of acres in the program to 1,392,000.

The Conservation Reserve Program offers incentives to establish conservation cover on environmentally sensitive cropland and to carry out conservation practices such as riparian forests buffers, filter strips, hedgerows and grassed waterways. Enrolled lands provide food and cover for upland wildlife species and reduce sediment delivery to streams, which helps improve habitat quality for fish and other aquatic life. Currently, nearly 33.5 million acres are enrolled in the program.

The Wetlands Reserve Program provides incentives to restore formerly degraded wetlands to more naturally functioning conditions, with emphasis on high-quality wildlife habitat. As of March 2001, there were 1,048,629 acres enrolled in the program. Concomitantly wetlands conservation provisions discourage land users from converting wetlands for agricultural production.

Other conservation programs such as the Environmental Quality Incentives Program, Forestry Incentives Program and Farmland Protection Program hold the potential for substantial fish and wildlife habitat benefits.

Conditions and trends

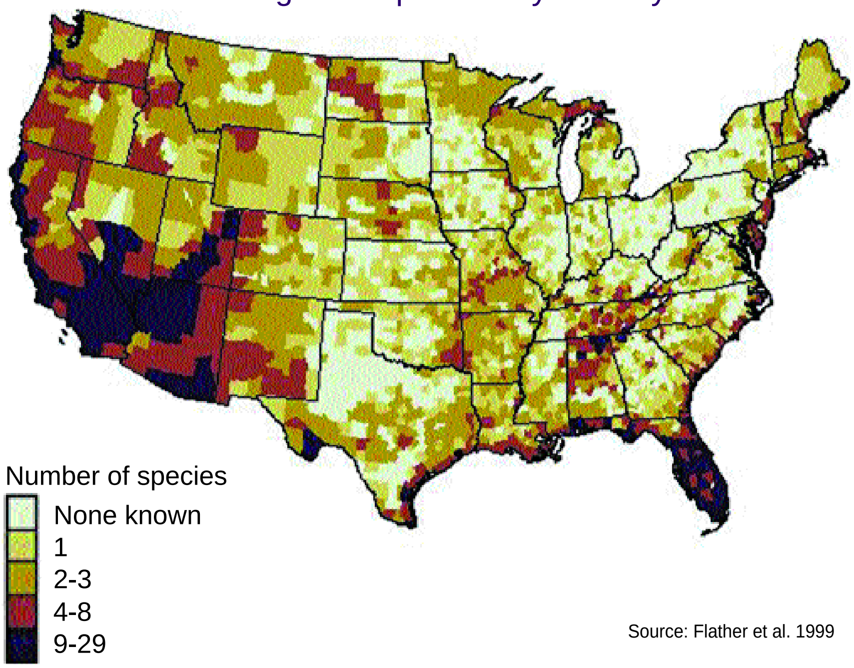
Management of land affects wildlife habitat in two principal ways. Some land management actions result in direct changes in land use (kinds of vegetation) while other actions result in changes in management practices. Changes in habitat quality and availability directly affect wildlife at both individual and population levels. Fragmentation and loss of habitat from urban and suburban development, intensive agricultural uses and the introduction of invasive species, among other factors, contribute to the decline in populations of many game and non-game species.

In many cases, these effects have resulted in the need to list declining species as threatened or endangered under provisions of the Endangered Species Act. Eighty-five percent of listed species are threatened or endangered because of loss and degradation of their habitat (Wilcove et al. 2000).

In the United States, there are now 1,234 species of plants and animals listed by the federal government as threatened or endangered (U.S. Fish and Wildlife Service 2000). While approximately 33 percent of known populations of threatened and endangered species occur on federal land, the majority of listed species occur on non-federal land (or water). The occurrence of threatened and endangered species is not uniform across the United States but is clustered in "hotspots" of species endangerment (Figure 15, page 52; Flather et al. 1999).

Grasslands represent an important habitat type providing crucial habitat for more than one-half of this country's nesting ducks, as well as many other grassland-dependent wildlife species. Grasslands used within their capability continue to support multiple activities such as livestock grazing in addition to wildlife habitat. When used beyond their capability, their

FIGURE 15.
Distribution of threatened and endangered species by county



Source: Flather et al. 1999

value as habitat diminishes. Pasture and rangeland habitats declined by 7.5 million acres from 1992 to 1997 (NRCS 2000a) as 6.1 million acres of pasture and 1.4 million acres of rangeland were converted to other uses. The change from 1982 to 1997 was a decline of 22.8 million acres — 12 million acres of pasture with rangeland accounting for the remainder.

During the period 1966 through 1996, there were also substantial declines in grassland and shrubland nesting birds. Twelve of 27 (44 percent) grassland nesting species and 26 of 85 (31 percent) shrubland nesting bird species exhibited significant decreasing population trends during this period (Flather et al. 1999).

The northern bobwhite (quail) is an example of a bird that has exhibited rangewide declines in abundance over the last three decades. Based on data from the USGS Breeding Bird Survey (estimating mean abundances over a minimum of three years within five-year windows centered on specific years), bobwhite distribution has undergone reduction and centers of abundance have become more fragmented (Figure 16). These declines in abundance are the result of direct habitat losses as well as degradation in quality of existing habitat. It is presumed that technological advances have made possible more intensive use of the land in addition to competition from other land uses.

Population trends for some species from 1985 to 1996 show signs of possible recovery. The proportion of grassland nesting birds with decreasing trends dropped to 22 percent and shrubland-nesting birds with decreasing trends to 19 percent (Resources Planning Act data on file with Flather and Brady). CRP has likely played an important role in the observed changes in the population trends of these two groups. In a summary of the literature, Heard et al. (2000) found that grassland bird abundance and nest density in midwestern CRP fields exceeded abundance and nest density in surrounding cropland habitats and that nesting success on CRP lands equals or exceeds that in alternative nesting cover.

Grassland habitats on land enrolled in CRP have also proven valuable to nesting waterfowl in the Prairie Pothole Region of the upper Midwest. For example, CRP lands in the Pothole area of North Dakota, South Dakota and Montana represent only six percent of the nesting cover in this area. But they account for 31 percent of all duck nesting activity (Heard et al. 2000). Studies show that between 1992 and 1997, those CRP lands contributed to a 30-percent improvement in duck production, or 10.5 million additional ducks (Heard et al. 2000).

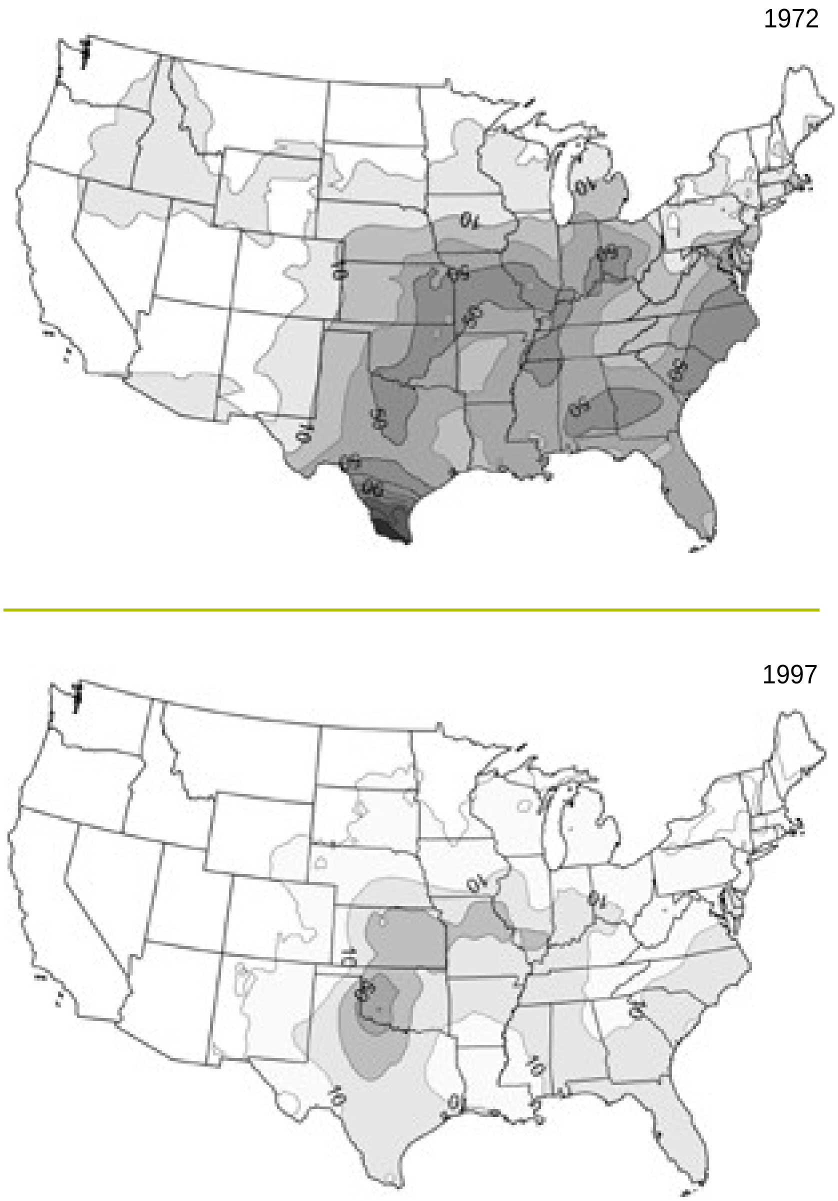
While such gains in grassland habitats can be attributed to CRP and other habitat conservation programs, they may also be offset by continued conversion of grasslands to other uses.

The structure and function of forests, riparian and wetlands areas on working lands support a broad diversity of terrestrial and aquatic wildlife species, many of which are listed as threatened or endangered. But these habitats have been affected by conversion to cropland and urban development, drainage, pollution, overgrazing and invasive species. In the eastern portion of the country, less than one percent of original old-growth forest remains, and 99 percent of grasslands and more than one-half of pre-colonial wetlands have been converted to other uses (Wildlife Management Institute 2001). While non-federal forest area has increased by 3.6 million acres since 1982, the additional acreage is not all suitable habitat. Forests that provide suitable wildlife habitat generally consist of a broad array of tree and shrub species adapted to the site. Stands planted to single species (for example, pines) for intensive cultivation generally result in poor habitat.

Approximately 2.7 million acres are enrolled in CRP in the southeastern states, with more than 62 percent of the total acreage dedicated to tree

FIGURE 16.

Distribution and relative abundance of the northern bobwhite, 1972 and 1997



Relative abundance was estimated from the USGS Breeding Bird Survey (BBS) based on three-year averages of each route within a five-year window centered on the year of interest. Contour lines represent the average number of bobwhites observed on BBS routes and were drawn at intervals of 0, 10, 30, 50, 70 and 90 bobwhites per route.

planting. However, much of this area is planted in monoculture pine stands, and potential wildlife benefits in the region remain unrealized (Heard et al. 2000). Wetlands restored through programs such as the WRP are making a significant contribution to wetlands wildlife conservation, particularly in areas of high enrollment such as the lower Mississippi Valley and are partially offsetting past losses of wetlands wildlife habitat (Heard et al. 2000).

Efforts such as the Wildlife Habitat Incentives Program, Conservation Reserve Program and Wetlands Reserve Program have done much to conserve and establish habitat for wildlife. However, they reach only a small proportion of the non-federal land base. Effective habitat management for wildlife is best achieved when integrated into the overall land management plan. Generally as soil-conserving measures increase, wildlife habitat quality also improves. Some soil conservation techniques directly benefit habitat quality in that they provide one or more critical habitat elements incidental to their erosion control function. Often, conservation technical assistance is all that is needed to change an economic enterprise into an ecologically sustainable operation with multiple resource benefits.

Improving America’s Conservation Efforts

Adoption of conservation techniques by many of this nation’s private landowners has helped reduce the impacts of food and fiber production on soil, water and air quality. Conservation of the land’s resources is an ongoing process, however. Much remains to be done to ensure the healthy soils and clean water and air needed to support urban and rural communities, a strong economy and important environmental attributes such as wildlife habitat.

As examples, 29.9 percent of working U.S. cropland is eroding at rates great enough to have adverse impacts on long-term soil productivity and overall soil quality. Agriculture production continues to contribute to water quality problems through sediment, inefficient irrigation, misuse of pesticides and seepage of excessive livestock and poultry nutrients. Air quality is affected by agricultural production — emissions from farm machinery, dust from cultivation and unpleasant odors from animal feeding operations. But agriculture also plays an important role in helping the nation achieve the so-far elusive “no net loss of wetlands” goal.

The nation has expressed a strong will to address conservation issues through federal legislation such as the Wilderness Preservation Act, National Historic Preservation Act, Soil and Water Resources Conservation Act, National Environmental Protection Act, Clean Water Act and Clean Air Act. Numerous states and localities have adopted environmental policy and land-use planning legislation. Public opinion polls continue to rate conservation of natural resources as a major concern.

To determine soil, water and related conservation needs and approaches to meet those needs, USDA drew from regulatory and legal requirements, its own expertise and the work and reports of other federal agencies, local conservation districts and state agriculture and forestry departments.

USDA examined the findings from a diverse array of agricultural-related entities and forums, including presidential and congressional commissions such as the National Drought Policy Commission and the Commission on 21st Century Production Agriculture; examined testimony from nationwide hearings of the House Agriculture Committee; and reviewed the results from national listening sessions of the Soil and Water Conservation Society and USDA’s Policy Advisory Committee. The Department also requested comments and information from approximately 60 agricultural and environmental interest groups.

Major conservation needs and recommendations for improvement from these sources are presented in this section, organized in three general categories: (1) enhance USDA technical assistance and service delivery; (2) improve research, development of technology and technology transfer; and (3) expand economic incentives for conservation.

Conservation of the land’s resources is an ongoing process. Much remains to be done to ensure healthy soils, clean water and viable habitat for wildlife.

Appendix B provides an overview of public attitudes and common themes running through many of the reports and publications used in preparation of this report and their suggestions for action.

1. Enhance USDA technical assistance and service delivery

USDA faces challenges in key aspects of its conservation programs. The Soil and Water Conservation Society, for example, held public meetings across the nation in 2000 with local and state leaders who are well versed in USDA conservation programs (Soil and Water Conservation Society 2000). In relation to the demand for technical assistance, the Society found, "Many more producers ask for conservation assistance than can be accommodated.... Participants expected the gap between demand for conservation assistance and its supply to widen over the next few years unless action is taken soon."

Furthermore, "Conservation programs currently work better for row-crop operations than for other types of farms and ranches. As a result, there was strong sentiment among many participants that large regions of the country do not receive their fair share of conservation assistance even though they face important conservation and environmental problems."

The National Drought Policy Commission reported concerns about equitable service delivery during hearings in 1999 and 2000, finding, "Many tribes noted the need for technical and financial assistance to plan and implement conservation measures.... They emphasized that this assistance must be easily and locally accessible to tribal members."

Overarching recommendations for improvement included calls for conservation technical assistance at the levels needed to achieve program goals. Several sources indicated the need to deliver research results and transfer technology in a more efficient manner; the need for increased electronic access to information; the need to increase USDA technical assistance in the areas of agronomy, soil science, engineering, wildlife and plant sciences; and the need for technical expertise in disciplines not currently represented in USDA's field-level workforce.

Additional recommendations include:

Overall improvements

- Foster broad-based approaches to natural resource management, including strategies that protect whole watersheds and ecosystems.
- Provide producers increased technical assistance to help them address increasing federal, state and local legislation and regulations.
- Provide interpretation for landscape analysis and new technologies for precision farming and surface geophysical measurements.
- Restore conditions in key watersheds to support ecological functions and beneficial water uses.
- Expand federal/tribal/state/local/non-governmental organization partnerships in support of state, tribal and federal natural resource goals.

The soil resource

- Improve control of excessive erosion through proven combinations of technical assistance,

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conservation compliance and conservation incentives.

- Create a national soil quality goal; for example, "By the year 2015, all lands will be eroding at a non-degrading level to the greatest extent possible."
- Promote practices that build up the level of soil organic matter on lands where soil erosion is not excessive. Such practices also help control erosion and protect water quality.
- Ensure that soil survey information is made available to previously underserved areas.

The water resource — quality issues

- Increase assistance to landowners for better management of nutrients and pesticides to reduce the risk of contaminating water resources. Help livestock and poultry producers reduce their potential for contributing to water quality and associated natural resource problems.
- Implement a system with national standards to assess watershed conditions.
- Provide more information to landowners concerning buffers, particularly their economic and operational benefits.

The water resource — quantity issues

- Update appropriate planning and application tools and increase assistance to implement innovative on-farm water management techniques such as off-stream storage and water harvesting to decrease irrigation's dependency on groundwater and stream flow.
- Encourage water management activities through enhanced support of federal/state/local coalitions that coordinate water quality goals and water quantity needs at all levels of activity.
- Conduct on-going hazard mitigation planning to help communities reduce their vulnerability to aging watershed projects through more comprehensive programs.
- Evaluate methods to determine when dams should not be rehabilitated but removed.

Climate change

- Using information and eduction, expose field staff, conservation partners and land managers to the basics of global climate change and principles of mitigation and adaptation.
- Establish a network of watershed-scale pilot projects to serve as demonstration sites for the development of information, technology, outreach and application.

Sprawl, land use and planning

- Identify science-based principles and criteria to help local communities manage growth and assist communities with land evaluation and area-wide planning.
- Improve guidance and create database tools to assist federal agencies in complying with the Farmland Protection Policy Act,

which requires NRCS to monitor federal agencies and provide them with technical assistance to hinder the conversion of agricultural lands to non-agricultural uses.

- Ensure that urban-influenced conservation districts receive technical assistance relating to soil information, storm-water management, erosion control and floodplain and wetlands protection.

Wetlands

- Continue assessment of wetlands through wet-soil monitoring to support ecosystem and landscape analysis of wetlands in degraded settings.
- Continue investigations and development of sub-aqueous soil mapping techniques in tidal and freshwater marshes.
- Continue development of hydric soil indicators for use in identifying wetlands.
- Conduct routine, multi-tiered assessments and monitoring for a sample of wetlands restoration and enhancement sites in different settings.

Grazing land

- Provide more technical assistance to landowners in applying the latest technology for grazing land management decisions.
- Encourage owners of grazing lands to consider diversification so that they and society can achieve multiple benefits from grazing lands.

Private forestland

- Promote reforestation after timber harvest to reclaim marginal or degraded areas, control erosion and capture the benefits of carbon sequestration.
- Increase technical assistance in the areas of forest education and forest management planning.
- Emphasize forest planning that meets the objectives of the landowners and responds to increasing public demands for water, recreation, wildlife habitat, timber, carbon sequestration and other public benefits from forestland.

Wildlife habitat

- Reduce the adverse effects of agricultural production practices on fish and wildlife populations through broader adoption of integrated pest management systems, conservation tillage, conservation buffers, effective nutrient management, water conservation and similar measures.
- Increase fish and wildlife habitat-oriented technical assistance to private landowners and managers during the conservation planning process.
- Expand partnerships with landowners, tribes, private organizations and public agencies to foster fish and wildlife conservation on private lands.

2. Improve research, development of technology and technology transfer

The Commission on 21st Century Production Agriculture Resources, echoed by the findings and recommendations of many other parties, identified research as a significant need for USDA conservation programs into the future. The Commission emphasized four research areas for improvement: providing voluntary incentive-based programs to enhance agriculture's positive contribution to air and water quality; developing a means to compensate producers who establish environmentally beneficial practices, with funding from a separate environmental program; establishing a baseline measure of agriculture's positive contribution to air and water quality; and focusing on priority issues including, but not limited to, carbon sequestration, control of greenhouse gases emissions, manure management and alternative fuels.

Other entities focused on the need to fill critical data gaps on the current status of watersheds and ecosystems and for better technology to monitor the effects that conservation practices and systems have on water quality and watershed health. Some pointed to the need for greater cooperation among USDA and private entities such as certified crop consultants who are engaged in assessing natural resource conditions and providing assistance to landowners.

USDA's Agricultural Air Quality Task Force noted several research needs to improve air quality. Foremost, data are currently inadequate to determine the effectiveness of control measures for agricultural operations. Observations must be augmented with reliable scientific evidence, particularly in regard to data that can quantify reductions in air quality associated with specific techniques and practices.

Additional recommendations for research and technology development and transfer include:

Overall improvement

- Develop new technologies and improved management practices that enable landowners to minimize the impact of their activities on the environment.
- Expand research in support of integrated, system-wide approaches to meet the ecological challenges of water quality and management.
- Ensure that education, extension and technology transfer activities encourage the adoption of more environmentally friendly practices.
- Deliver research results and transfer technology in a more efficient manner.

The soil resource

- Provide digital soil surveys to properly analyze watersheds and landscapes for their non-point source pollution potential and effects through ecosystem modeling.
- Conduct research and economic analysis on the potential to increase storage of carbon in the soil. Identify and validate carbon credits for agriculture and forest conservation practices.
- Research the use of carbon credit trading, which holds the potential to enhance soil quality

through the build-up of soil organic matter and help sequester carbon to reduce greenhouse gases.
- Provide statistical data and analysis on agricultural chemical uses, production methods, land productivity and integrated pest management practices and establish relationships with local soil and resource inventories.

The water resource — quality issues

- Conduct additional research related to the effectiveness of buffers at specific sites and for specific purposes to update practice specifications. Document results that can be achieved through the use of buffers on a watershed scale.

The water resource — quantity issues

- Increase USDA research for irrigation and related water resources activities to assure continued development and implementation of state-of-the-art water-saving technology.
- Incorporate digital soil survey and landscape analysis modeling in irrigation design systems.
- Conduct landscape modeling on a watershed basis for improved efficiency of water use.
- Assess the condition of all watershed dams as well as the population at risk, hazard classification and risk of failure across the nation. Provide geophysical measurement tools to measure sediment load and potential weaknesses in dam structures.

Air quality

- Define appropriate and effective particulate control measures that are economically and technologically feasible. Quantify particulate reductions resulting from each control measure.
- Develop accurate emissions inventories for agricultural operations.
- Support the priorities and funding for research recommended by USDA's Agricultural Air Quality Task Force.
- Conduct research to improve prediction models for downwind concentrations of particulate matter, develop the best sampling techniques for monitoring agricultural burning, determine emission factors, evaluate techniques for reducing harmful emissions from agricultural burns and create alternatives to agricultural burning.

Climate change

- Conduct research and economic analysis concerning the potential to increase storage of carbon in vegetation and soil.
- Develop quantitative use-dependent databases, including ecological site descriptions, for all soil mapping units and link them to spatial databases.
- Develop new risk management tools integrating support payments and private markets to underwrite adoption of conservation technologies at the farm level.
- Increase collaboration among NRCS and research institutions, including universities, the

Improving America's Conservation Efforts

Agricultural Research Service and others to refine and develop improved models, further improve measurement technologies and systems and improve understanding of the ecological processes that support agricultural production.

Sprawl, land use and planning

- Expand development and transfer of "green infrastructure" technology to manage storm water and control sediment.

Wetlands

- Research a comprehensive conservation approach to wetlands that takes into consideration the condition of the landscape as well as the treatments needed to maintain or improve wetlands functional conditions.
- Identify geographic locations in the current National Resources Inventory that continue to exhibit significant declines in wetlands acreage. Conduct a detailed examination of the causes of those declines and identify strategies to achieve the nation's no net loss of wetlands acreage goal on private lands.
- Increase the use of non-invasive geophysical measurement tools such as ground penetrating radar and electromagnetic induction to measure water tables, depth of peat material and deep-water sediment loads.
- Continue development of hydric soil indicators for use in identifying wetlands.

Grazing land

- Develop and improve treatments to assure the long-term productivity and ecological health of U.S. grazing lands.

Private forestland

- Develop strategies to minimize the impact of urban sprawl on forestlands.
- Provide research assistance on forest stewardship.
- Digitize and update soil surveys in forested areas to support more intensive uses.
- Expand development of new agroforestry technologies to treat waste, provide odor and visual screens, develop alternative crops, diversify incomes and improve productivity on limited acres.

Wildlife habitat

- Continue to restore and enhance aquatic habitats and improve current technology to achieve this objective.
- Improve technology and the capability to reduce the impact of invasive plant and animal species on native ecosystems and fish and wildlife communities.
- Develop mechanisms to minimize the impact of suburban sprawl and urban development on agricultural lands and the wildlife they support.
- Create effective methods to monitor the response of fish and wildlife populations to agricultural conservation practices and land management activities.

3. Expand economic incentives for conservation

Nearly all comments, identified needs and recommendations concerning future agricultural conservation efforts emphasized the need to continue or expand existing economic incentive programs and consider the creation of new incentives.

People focused on the ability of land easement and reserve programs, as well as other economic incentive-based approaches, to reward landowners for resource conservation practices. They called for extension and modification of existing programs, including increased funding and expanded eligibility. For example, USDA's broad-based conservation program, the Environmental Quality Incentives Program (EQIP), offers financial assistance for conservation practices based on the level of expected environmental benefits. Data indicate that demand for EQIP assistance is three to four times more than available funding.

The incentives just mentioned focus on future conservation efforts. But there is a growing interest in a new economic incentive that rewards private landowners for conservation goals that they have already achieved because of the secondary benefits (public goods) that have accrued from past resource conservation on private lands.

Among the recommendations were the following:

Overall improvements

- Provide financial and other incentives to landowners to practice good stewardship.
- Increase funding for the Environmental Quality Incentives Program.
- Emphasize federal/state/local partnerships in support of state and federal funding initiatives and devise a priority ranking system for watershed project rehabilitation.

The soil resource

- Expand reserve programs to retire highly erodible or other fragile lands while allowing agricultural and forest lands to maintain their productivity.

The water resource — water quality

- Within the Conservation Reserve Program: (1) refine statutory language and program administration to ensure flexibility in the use of buffers for achieving water quality and other conservation purposes at the farm or ranch level, (2) maintain the holdback acreage for buffers, (3) create financial incentives to encourage landowners to act collectively along a stream course or within a watershed and (4) make all agricultural land eligible for participation in the continuous sign-up.

The water resource — water quantity

- Expand pilot watershed rehabilitation projects.
- Fund rehabilitation through loans and cost-share assistance.

Improving America's Conservation Efforts

Air quality

- Develop a guidance document for agricultural producers to include control measures and estimated reductions of particulates associated with each abatement strategy.
- Assist local elected officials from soil and water conservation districts in administering voluntary air quality compliance programs.
- Develop state implementation plans, allocating credits based on the rate of participation (percentage of land mass and/or percentage of participants) and on yearly certification by conservation district officials.
- Forego record keeping and reporting requirements by participants beyond those already needed for participation in other USDA programs.
- Address smoke management using a two-tiered approach: Tier 1 — a voluntary program for areas where agricultural burning rarely causes or contributes to air quality problems, and Tier 2 — a more structured program for areas where agricultural burning contributes to violations of air quality standards or to visibility impairment in federal Class I areas.

Climate change

- Structure farm and ranch support programs to optimize all environmental benefits, including improvements in operation-level greenhouse gas balances, using pilot projects as models.

Sprawl, land use and planning

- Increase funding and enrollment of farmland in perpetual easements to slow development of prime farmland.
- Provide cost-share and direct payments to agricultural producers to strengthen the economic and ecological viability of farms, decrease the amount of land sold to developers and permit greater appreciation of rural landscapes through local cultural and heritage tourism programs.

Wetlands

- Increase enrollment of wetlands and associated uplands in the Wetlands Reserve Program.

Grazing land

- Create a grazing land or grassland reserve program.

A recent study (Environmental Defense 2001) based on USDA data found that inadequate funding of USDA conservation incentives prevents: (1) half of the farmers and ranchers seeking technical assistance to improve tillage practices or install streamside buffers from getting that assistance; (2) three out of four farmers seeking financial assistance to restore lost wetlands and woodlands, use less water or improve manure management from receiving that assistance; (3) more than 2,700 farmers hoping to restore 560,000 acres of wetlands from participating in the restoration program.

In addition, thousands of farmers in the path of sprawl offered to sell their development rights to USDA or state and local programs, but there were insufficient funds to accommodate them.

Private forestland

- Increase enrollment in forestry programs that emphasize reforestation and promote wise use of forest resources such as timber, carbon sequestration, wildlife habitat and recreation.
- Expand current cost-share and incentive programs to encourage owners of non-industrial private forestland to manage their lands for private and public benefits.

Wildlife habitat

- Increase financial incentives to farmers and ranchers for activities that help to maintain stable wildlife populations and increase populations that have experienced recent declines.
- Preserve habitat gains made through incentive programs by linking eligibility for financial incentives with basic conservation standards.
- Maintain existing and establish additional conservation programs and incentives to restore, protect and manage (over the long term) native communities such as wetlands, native grasslands and riparian areas.
- Create incentives such as Safe Harbor Agreements for landowners to improve habitat for listed and candidate threatened and endangered species and provide landowners assurances regarding future use of lands that support these species.

Analysis of Conservation Alternatives

Analysis of alternatives

The following analysis presents results from evaluation of different program alternatives. The alternatives are based on conservation needs and recommendations identified through public forums and discussions held during the year 2000 by entities and institutions such as USDA, the Soil and Water Conservation Society, the National Association of Conservation Districts and the Wildlife Management Institute.

The models used in the analysis and described below considered cropland, CRP lands, pastureland, federal and non-federal grazing lands, irrigation water use (surface and pumped sources) and labor (family and hired). Crops covered in the models include barley, oats, rice, wheat, corn, sorghum, soybeans, cotton, potatoes, hay, tomatoes, oranges, grapefruit, sugar beets and sugar cane. Livestock includes cattle, dairy, hogs, poultry and sheep.

The analysis involved use of the economic Agricultural Sector Model (ASM) for estimating baseline conditions in the U.S. agricultural sector and then comparing results with the baseline. The baseline model solution is calibrated so that its estimated resource and commodity market outcomes are consistent with the commodity market conditions for 2000 as reported in the USDA Agricultural Outlook Baseline (USDA 2000c). Additional resource availability and management conditions were calibrated to data for year 1997 using the Census of Agriculture and the National Resources Inventory.

Auxiliary models linked to and employed in this analysis include the Environmental Policy Integrated Climate model (EPIC; also known as the Erosion Productivity Impact Calculator) and the Hydrologic Unit Model of the United States (HUMUS), which provide estimates of soil erosion, sediment delivery, nitrogen, and phosphorus leaching and runoff at both the field and watershed levels of aggregation. Design and production of analysis products from the systems were developed by NRCS in partnership with USDA's Agricultural Research Service and Texas A&M University. (See Appendix C for a detailed explanation of methods, procedures and sources of data incorporated in the analysis.)

The analysis products contain regional-level information for natural resource program managers, legislators and policy officials to use in their deliberations about new and expanded conservation program proposals. Results from the analysis show significant potential for improvements in soil, water and environmental condition measures through sustained and enhanced voluntary incentives for agricultural producers.

The ASM model output was linked with the results from other modeling systems as well as agency technical staff workload and cost data to provide information such as the following at state, regional and national levels:

- changes in levels of commodity production, costs, income and social welfare measures;
- changes in crop acres and land uses;

- changes in the mixes of crops across soils, tillage types and conservation practices;
- changes in levels of production and income by region that can be related to farm size and demographic producer groups using Census of Agriculture data;
- changes in crop acres and land use to estimate water quality impacts for selected scenarios using the HUMUS model;
- crop acreage distributions and management information combined with the per-acre results from biophysical models to show a variety of economic and environmental impacts such as erosion, sediment, phosphorus and nitrogen losses to surface water and groundwater; and
- technical and financial assistance needs associated with each alternative.

In the analysis, the BASE scenario represented current programs and current conditions as approximated by the USDA baseline for 2000, the 1997 Census of Agriculture, the 1997 National Resources Inventory and Conservation Reserve Program and buffer program data as of September 2000.

The analysis estimated the impact of the following selected conservation alternatives above the BASE scenario:

Increase buffers to two million miles (BUF2): Simulate imposed enrollment of sufficient buffer acres to reach the two-million-mile goal under the assumption of current rules for CRP, installation costs and rental rates.

Expand the Conservation Reserve Program to 45 million acres (CRP45): Simulate imposed enrollment of acreage to expand the Conservation Reserve Program to 45 million acres under the assumption of continuing with current rules.

Initiate a Grazing Lands Reserve Program (GLR)
GLRa: Fund Grazing Land Reserve at $50 million annually, distributed proportionate to acres.
GLRv: Fund Grazing Land Reserve at $50 million annually, distributed proportionate to value.

Double the national acreage in mulch and zero till (TILL2X) from 37 percent to 74 percent of cropland.

Cropland Stewardship Proposal (CSP)
CSP1: Redistribute $5.57 billion in payments within each state to cropland and pasture land that already incorporate sustainable resource management systems.
CSP2: CSP1 plus simulate imposition of erosion control on remaining cropland to conservation compliance levels.
CSP3: CSP1 plus simulate imposition of erosion control on remaining cropland to sustainable resource management systems.

Analysis of Conservation Alternatives

Simultaneous BUF2, CRP45 and CSP2. Implementation of buffers, CRP45 and CSP2 simultaneously to capture economies.

Simultaneous BUF2, CRP45 and CSP3. Implementation of buffers, CRP45 and CSP3 simultaneously to capture economies.

Increase funding for the Farmland Protection Program to $65 million annually (FPP65).*

Double the Wetlands Reserve Program acreage by enrolling 250,000 acres annually for five years (WRP250).*

Increase funding for the Forestry Incentives Program by $38 million a year (FIP38).*

Increase funding for the Wildlife Habitat Incentives Program to $50 million annually (WHIP50).*

Reduce resource degradation (Figure 17)

Analysts combined the results for several alternatives to estimate the economic, environmental and program impacts that would accrue to reduce the rate of resource degradation. This alternative included program elements discussed in most of the public forums held during 2000 and in reports that were issued up through September 2000. The alternative includes achieving conservation compliance levels on all land at the CSP2 level, completion of two million miles of conservation buffers, enrolling 250,000 additional acres per year in WRP, slightly expanding FPP to $65 million and FIP to $38 million annually, establishing WHIP at $50 million annually, initiating a modest grazing land reserve and enrolling 45 million acres in CRP. These initiatives respond to the need to improve water and soil quality, reduce soil erosion, conserve marginal lands and wetlands, improve the condition of private grazing lands and provide economic incentives for land stewardship.

This alternative (and the one below to improve resource health) incorporate cost information with results of the analysis indicating that total costs to meet expected demand for conservation would be an additional $2.4 billion, while estimated environmental benefits totaled $7.4 billion.** The benefits are significant, and overall long-term social costs would be balanced by reduced degradation to soil and water resources and fewer environmental risks.

Additional financial incentives needed were estimated at $2.0 billion.

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* These alternatives were not explicitly modeled, but estimated impacts were developed based on program specifications and results of other scenarios.

** Estimated environmental benefits include soil, water, air quality and wildlife habitat benefits. The analysis presumes that additional acreage retired and conservation treatments are optimally located to maximize environmental benefits. Complete accounting and quantifiable estimates for all environmental benefits are not yet available in the literature. Of the benefit estimates that have been quantified for CRP, wildlife habitat accounts for just over 50 percent, water quality for 35 percent, soil productivity for 10 percent and air quality for 4 percent of the total. Recent analyses of national and regional benefits can be found in Claassen et al. (2001) and Feather et al. (1999).

Technical assistance needs amounted to an additional $737 million for the federal share and $189 million for the partner share, totaling $0.9 billion. The overall benefit/cost ratio was 3.2.

Improve resource health (Figure 17)

To improve resource health, analysts added sustainable resource management systems on all cropland at the CPS3 level to the initiatives used in the alternative to reduce resource degradation described above. This alternative addressed the highest level of conservation considered in the analysis.

The total social costs increased to $6.4 billion per year, with estimated environmental benefits of $10.7 billion. Additional financial incentives totaled $2.7 billion. Technical assistance needs amounted to an additional $1.8 billion for the federal share and $0.8 billion for the partner share, totaling $2.8 billion. Technical assistance costs rose substantially because of requirements for intensive resource management systems under this scenario. The overall estimated benefit/cost ratio was 1.7.

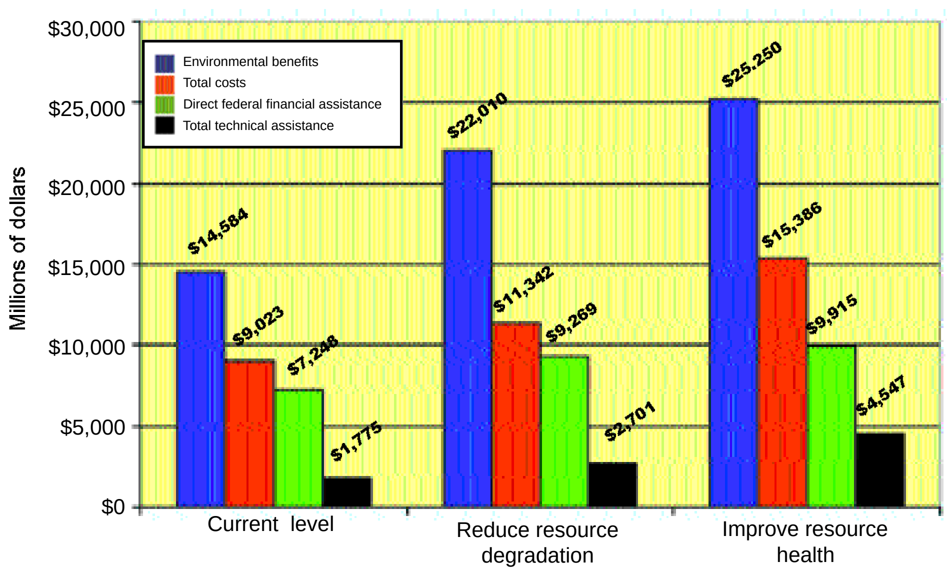
Discussion

To implement initiatives such as those presented above, USDA provides technical assistance, financial incentives, and research and educational services for conservation and environmental enhancement under a number of legislated authorities. The principal programs that deliver these services are described on pages 6 to 13.

Costs to accomplish the conservation and environmental enhancements presented in the analysis likely establish lower bound thresholds for several reasons. First, the principal means of simulating conservation accomplishments in the analysis is through imposition of successively higher levels of erosion control constraints or through requiring levels of the conservation practices (contouring, residue management, strip cropping and terraces) that are in the model system. Data on the costs and effects of intensive resource management systems, including costs for comprehensive nutrient and pesticide management systems, are not yet available at the regional levels of detail

FIGURE 17.

Benefits and costs to continue conservation investments at current levels, reduce resource degradation and improve resource health



Analysis of Conservation Alternatives

needed for incorporation into the modeling systems.

Second, modeled agricultural production costs did not include various non-modeled costs that are typically incurred as farmers change practices; for example, accelerated equipment replacement, losses associated with application of unfamiliar technology and incentives to cover the costs of changing to new and more intensive resource management systems.

Third, cost estimates for conservation practices are based on surveys of producers currently implementing the practices. Those estimates may not be representative of the conditions faced by producers who have not yet adopted the practice.

Fourth, the model used in this analysis (like any other model) does not include all options available to producers. As incentives change, both technology development and technology adoption occur, which lowers the cost of adoption and changes likely outcomes from the technologies that are currently available.

Alternatives

The remainder of this section provides additional details concerning each of the alternatives considered in this analysis.

BASE. Baseline conditions in the analysis match closely with current land use and economic and resource conditions as shown by the following:

- Just under 332 million acres of cropland planted.
- About 35 percent of cropland incorporating conservation tillage, strip cropping, contouring or terrace systems.
- About 32 million acres of land in the Conservation Reserve Program.
- About $7.2 billion in direct federal financial assistance to agricultural producers through CRP and AMTA payments.
- About $1.1 billion in federal technical assistance and support service costs for technology development, delivery and resource information such as inventories and soil and snow surveys.

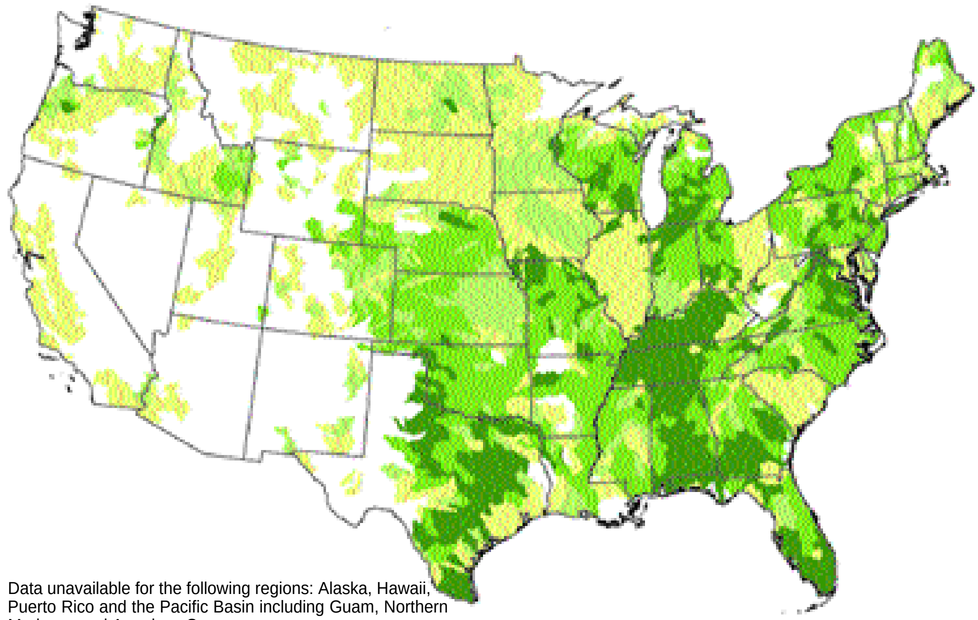
Extend the buffer program to achieve two million miles (BUF2; Figure 18, Table 5)

The annual cost to consumers/taxpayers to extend the buffer program to two million miles is $1.2 billion — $524 million as payments to producers and $673 million in higher farm gate commodity prices. However, producers receive both the government payments and the higher commodity prices, for a net gain of $529 million, so that the overall net financial cost to society is $668 million.

- Prices increase by 1.4 percent while production is down by 0.7 percent.
- Variable cost increases, but by less than do receipts, both in total and per acre.
- Net farm income is increased by 0.8 percent.
- The benefit/cost ratio is 4.1.
- With 4.5 million acres of additional cropped land placed into buffers, 0.4 million acres of previously idled cropland and 0.7 million acres of forest and

FIGURE 18.

Estimated percent reduction in total sediment yield (MAP 1), phosphorus yield (MAP 2) and nitrogen yield (MAP 3, next page) if buffers on cropland are increased to two million miles

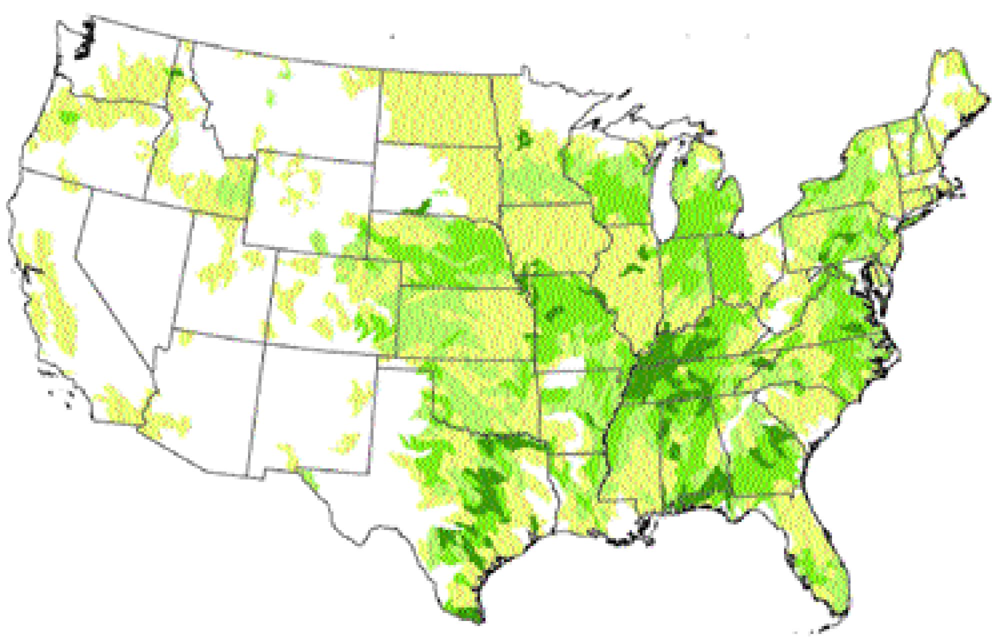


MAP 1

Percent reduction

- 25 or more
  12.7% of watersheds
  40.1% of total reduction
- 15 to 25
  19.6% of watersheds
  38.4% of total reduction
- 10 to 15
  11.8% of watersheds
  13.2% of total reduction
- 2 to 10
  25.1% of watersheds
  7.9% of total reduction
- Less than 2
  30.8% of watersheds
  0.4% of total reduction

Data unavailable for the following regions: Alaska, Hawaii, Puerto Rico and the Pacific Basin including Guam, Northern Marianas and American Samoa.

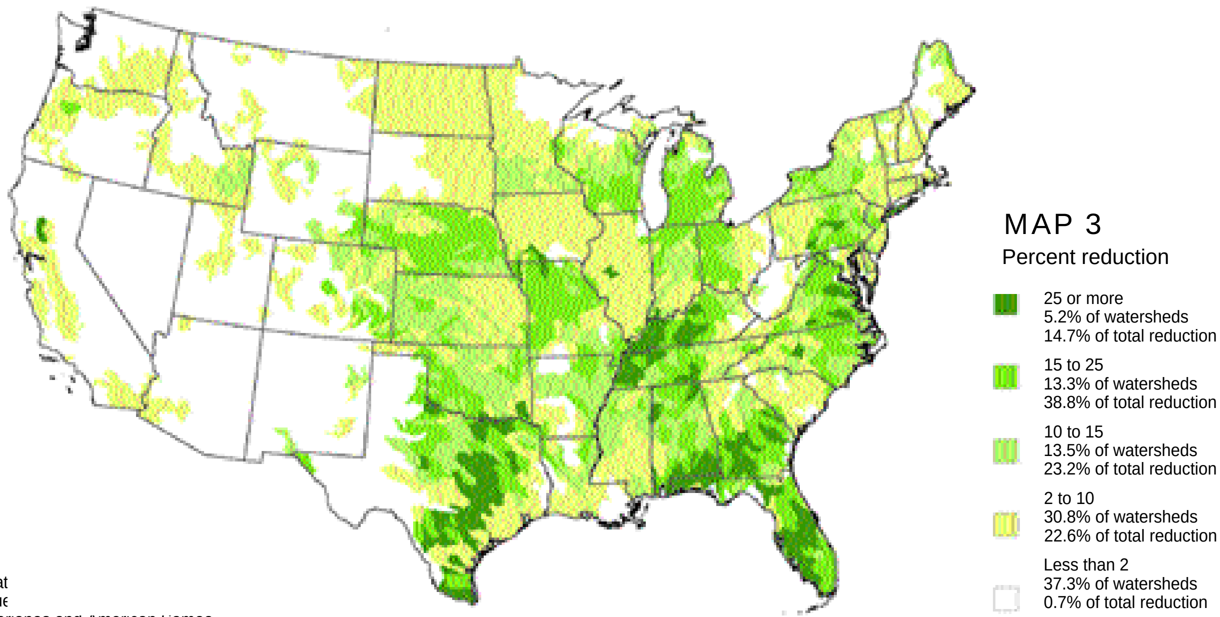


MAP 2

Percent reduction

- 25 or more
  3.7% of watersheds
  21.9% of total reduction
- 15 to 25
  13.3% of watersheds
  39.9% of total reduction
- 10 to 15
  12.4% of watersheds
  18.2% of total reduction
- 2 to 10
  31.4% of watersheds
  19.5% of total reduction
- Less than 2
  39.2% of watersheds
  0.5% of total reduction

Data unavailable for the following regions: Alaska, Hawaii, Puerto Rico and the Pacific Basin including Guam, Northern Marianas and American Samoa.



Dat
Pue
Marianas and American Samoa.

pasture land are converted to cropping in the model so that cropped land decreases by 3.5 million acres.

- Cropland rental value increases by $2.84 (3.9 percent) per acre.
- Effects of this program on the U.S. trade surplus are negligible (-/+0.01 percent).
- Regional impacts on producer income range from -2.4 percent ($238 million) in the Mountain states to 2.1 percent ($214 million) in the Pacific states.
- Impacts on levels of national resource use (cropland, irrigation water, grazing land and labor) are negligible (less than 1.5 percent).
- Reductions in potential pollutants to water bodies are 16 percent for sediment, 11 percent for nitrogen and 12 percent for phosphorus (see Figure 18).
- Technical assistance needs total

TABLE 5.

Impact of accomplishing two million miles of conservation buffers (buf2)

Estimated changes from baseline conditions (2000)

U.S. agricultural sector impact:	**Unit**	**Measure**
Producers	Million $	528.9
U.S. consumer	Million $	-673.1
U.S. taxpayers[2]	Million $	523.6
Total sector impact[2]	Million $	-667.7
Technical Assistance		
Federal	Million $	125.1
Partner	Million $	0.0
Total technical assistance	Million $	125.1
Total cost[2]	Million $	792.8
Estimated environmental benefits[3]	Million $	3288.1
Benefit cost ratio	Ratio	4.1
Producers' income	% change	0.81
Environmental impacts[6]		
Erosion	% change	n/a
Sediment	% change	-15.6
Total nitrogen	% change	-10.8
Total phosphorus	% change	-11.7

See Table C-2 in Appendix C (pages C-11-C-14) for more detail and footnotes.

$125 million.

Expand CRP to 45 million acres (CRP45; Table 6)

The annual cost to consumers/taxpayers to extend the CRP program to 45 million acres is $2.1 billion — $713 million as payments to producers and $1,434 million in higher farm gate commodity prices. However, producers receive both the government payments and the higher commodity prices, for a net gain of $1,890 million, so that the overall net financial cost to society is $256 million.

- Prices increase by 3.6 percent while production is down by 1.9 percent.
- Variable costs increase, but by less than do receipts, both in total and per acre.
- Net farm income is increased by 2.9 percent.
- The benefit/cost ratio is 2.8.
- With 14.6 million additional acres of cropland placed in CRP in this analysis, 1.7 million acres of previously idled cropland and 0.8 million acres of forest and pasture are converted to cropping in the model, so that cropped land decreases by 12.1 million acres.
- Cropland rental value increases by $6.51 (8.9%) per acre.
- The trade surplus declines by $229 million (1.1 percent).
- Regional distribution of impacts varies slightly; CRP reduces cropping more on highly erodible land relative to other cropland classes.
- Potential environmental impacts of extending the CRP to 45 million acres include reduction of total erosion and sediment by seven percent, nitrogen by three percent and phosphorus by about five percent.
- Technical assistance needs total $291 million.

TABLE 6.

Impact of expanding the Conservation Reserve Program to 45 million acres (crp45)

Estimated changes from baseline conditions (2000)

U.S. agricultural sector impact:	Unit	Measure
Producers	Million $	1890.2
U.S. consumer	Million $	-1433.7
U.S. taxpayers[2]	Million $	712.9
Total financial cost[2]	Million $	-256.4
Technical Assistance		
Federal	Million $	290.9
Partner	Million $	0.0
Total technical assistance	Million $	290.9
Total cost[2]	Million $	547.3
Estimated environmental benefits[3]	Million $	1532.8
Benefit cost ratio	Ratio	2.8
Producers income	% change	2.91
Environmental impacts[6]		
Erosion	% change	-6.9
Sediment	%. change	-6.7
Total nitrogen	% change	-2.8
Total phosphorus	% change	-4.5

See Table C-2 in Appendix C (pages C-11-C-14) for more detail and footnotes.

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Two options for a $50 million (annual) Grazing Land Reserve (Table 7)

The two Grazing Land Reserve options simulate enrollment of approximately two percent of the nation's pasture and private rangeland in a non-agricultural use reserve. Because the benefit/cost ratio relies heavily on erosion, which is not directly measured on rangeland, it does not accurately account for benefits on grazing lands. The national impacts on other land and water resources and on erosion are generally on the order of less than one percent.

In some regions, reducing the amount of grazing land means reduced livestock production and reduced feed production from cropland — hence, reduced erosion. In other regions, more feed is produced on cropland, and erosion increases slightly.

TABLE 7.

Impact of a $50 million (annual) Grazing Land Reserve Program

Estimated changes from baseline conditions (2000)

		GLRa	GLRv
U.S. agricultural sector impact:			
Producers	Million $	708.5	596.2
U.S. consumer	Million $	-641.0	-543.7
U.S taxpayers[2]	Million $	50.0	50.0
Total financial cost[2]	Million $	17.5	2.5
Technical Assistance			
Federal	Million $	12.6	12.6
Partner	Million $	8.5	8.5
Total technical assistance	Million $	21.1	21.1
Total cost[2]	Million $	38.6	23.7
Estimated environmental benefits[3]	Million $	-16.9	-31.3
Benefit cost ratio	Ratio	-0.4	-1.3
Producers Income	% change	1.1	0.9
Environmental impacts[6]			
Erosion	% change	0.1	0.1
Sediment	%. change	0.1	0.1
Total nitrogen	% change	0.0	0.1
Total phosphorus	% change	0.1	0.1

See Table C-2 in Appendix C (pages C-11-C-14) for more detail and footnotes.

Allocation to states proportionate to state grazing acreage (GLRa; Table 7)

This acreage alternative costs consumers/taxpayers $691 million — $50 million in payments to producers and $641 million from higher farm gate commodity prices. However, farmers receive the payments and benefit from higher prices for a net gain of $709 million.

- Economic welfare for the United States increases by $17.5 million, while overall welfare at the world level declines at the expense of trading partners.
- Prices increase by 0.2 percent, while production is down by less than 0.1 percent.
- In the livestock sector, variable costs decrease as receipts increase.
- Net farm income is increased by 1.1 percent.
- The trade surplus increases by $36 million (0.2 percent).
- When $50 million annually is spent to enroll land in a grazing reserve with distribution proportional to acreage (GLRa), 0.8 million acres of cropland are converted to pasture land. However, just over one-half of this conversion comes from

previously idled cropland, and cropped acreage decreases by 0.4 million acres.

- Cropland rental value increases by $0.80 per acre.
- Estimated environmental impacts are less than 0.1 percent, since only about two percent of the land is affected.
- Technical assistance needs total $21 million.

Allocation to states proportionate to state grazing land value (GLRv; Table 7)

This value alternative costs consumers/taxpayers $646 million — $50 million in payments to producers and $544 million from higher farm gate commodity prices. However, farmers receive the payments and benefit from higher prices, for a net gain of $596 million, implying that the overall cost to society is near zero.

- Economic welfare for the United States increases by $2.5 million, while overall welfare at the world level declines at the expense of trading partners.
- Prices increase by 0.1 percent while production is down by less than 0.1 percent.
- In the livestock sector variable cost decreases as receipts increase.
- Net farm income is increased by 0.9 percent.
- Livestock producers benefit the most.
- The trade surplus declines by $17 million (0.1 percent).
- When $50 million annually is spent to enroll land in a grazing reserve with distribution proportional to rental value (GLRv), 0.6 million acres of cropland are converted to pasture land. However, just over one-half of this conversion comes from previously idled cropland, and cropped acreage decreases by 0.2 million acres.
- Cropland rental value increases by $0.80 per acre.
- Estimated environmental impacts are less than 0.1 percent, since only two percent of the land is affected.
- Technical assistance needs total $21 million.

Doubling of conservation tillage (TILL2X; Table 8)

The effects of doubling conservation tillage were simulated without explicitly addressing the policy or program mechanisms required to bring about that result. Acreages of both reduced tillage and zero tillage were forced to double in the model, with greater relative increases forced in areas that have lower historical rates of adoption.

The annual cost to consumers/taxpayers from forcing a doubling of conservation tillage is $6.1 billion dollars — $383 million in higher farm gate commodity prices and a loss in net farm income of $5.7 billion dollars (mostly attributed to limitations in the model that forced cropping on marginal lands). Financial assistance needs were just over an additional $1.8 billion, with total costs estimated at $9.8 billion. Benefits totaled $4.9 billion for a benefit/cost ratio of 0.5.

Actual costs in a volunteer program would likely be higher than the

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model estimates as producers face costs of accelerated equipment replacement, education and risk associated with adopting new technology. Also, technical assistance costs and government-sponsored technology development costs would likely be higher per acre than that observed for previous adopters, especially if adoption were forced to the level simulated in the model.

- The model was forced to simulate a proportionate increase in use of conservation tillage within each state with the proportion varying by state. In many situations, technological considerations such as crops grown in rotation for which conservation tillage is not an option (for example, potatoes) resulted in overall increases in crop acreage and/or use of less than optimal crop mixes and/or production technologies. Consequently, production was nearly stable, but at an increased cost. With higher costs and stable production, prices (revenue) change little as costs increase; consequently both producers and consumers lose.
- Even though on a per-acre basis conservation tillage may "pay for itself," in some cases crop yields are lower, and changes in overall cropping patterns occur because of crop mix, rotation and land availability constraints. It is expected that many of these costs would be moderated or even offset over time through education and financial and technical assistance.

TABLE 8.

Impact of doubling acreage of conservation tillage (till2x)

Estimated changes from baseline conditions (2000)

U.S. agricultural sector impact:	Unit	Measure
Producers	Million $	-5723.6
U.S. consumer	Million $	-383.0
U.S. taxpayers[2]	Million $	1801.9
Total financial cost[2]	Million $	-7908.4
Technical Assistance		
Federal	Million $	1158.4
Partner	Million $	786.6
Total technical assistance	Million $	1945.0
Total cost	Million $	9853.4
Estimated environmental benefits[3]	Million $	4960.4
Benefit cost ratio	Ratio	0.5
Producers income	% change	-8.80
Environmental impacts[6]		
Erosion	% change	-22.3
Sediment	%. change	-27.3
Total nitrogen	% change	-7.2
Total phosphorus	% change	-14.4

See Table C-2 in Appendix C (pages C-11-C-14) for more detail and footnotes.

- Implementation of a single measure to address needs requires a technology in many parts of the country where it may not be practicable or feasible.
- Balanced systems of alternative management practices, rotations, cover crops, buffers and enduring practices would yield higher potential environmental and economic gains.
- In the modeled simulation in this analysis, variable costs increase by 7.9 percent, while production decreases by 0.9 percent.

- The benefit/cost ratio is 0.5.
- Prices increase by only 1.4 percent, and net farm income decreases by 8.8 percent.
- The trade surplus declines by $424 million (two percent).
- The $6,107-million cost to society divided by the 138 million acres adopting conservation tillage in this alternative implies a total adoption cost of $44.25 per acre.
- Meeting the conservation-tilled acreage constraint results in an artificial scarcity of cropland in some areas, resulting in an average rent increase of $35 per acre (48 percent).
- The net effect is conversion of 1.6 million acres of forest and pasture to cropping to meet the 0.8 million-acre increase in cropped and idled land.
- Cropland rental value increases by $35.11 per acre (48.0 percent).
- Impacts on levels of national resource use (cropland, irrigation water, grazing land and labor) are in the range of -4.3 percent (groundwater) to 1.5 percent (moderately erodible cropland).
- Regional impacts vary greatly. Erosion reduction ranges from 6.4 percent in the Appalachian region to 38.9 percent in the Pacific region.
- Producer income impact ranges from +2.4 percent in the Delta region to -22.6 percent in the Southern Plains region.
- Reductions in potential pollutants to water bodies are estimated at 15 percent for erosion, 19 percent for sediment, five percent for nitrogen and 10 percent for phosphorus.
- Direct financial assistance needs total $1.8 billion.
- Technical assistance needs total $2 billion.

Overall implications are that technical and financial assistance are needed to aid farmers in addressing all natural resource use management changes, including:

- tillage, supporting practices, rotations and resource management systems;
- change of cropping patterns across soils within a sub-region and across sub-regions;
- shifts in irrigation;
- establishing buffers; and
- protecting land idled in CRP by either developing reserve programs and/or developing alternative conservation management systems to continue use of land for production purposes.

Cropland stewardship proposal — Level 1 (CSP1)

Stewardship payments were interpreted in this analysis to provide rewards to producers who are already practicing sustainable resource management. Consequently, the payments were simulated as being added to farm income as a transfer in such a way as to not affect current resource management. No effects would result at national or regional levels, since the only effect is that $5.57 billion in direct payments to

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TABLE 9.
Average stewardship payment for acres of crop and pasture already adequately protected (csp1)

Farm production region	Crop and pasture adequately protected (%)	Current payments to producers (Billions $)	Estimated stewardship payment for crop and pasture already adequately protected ($ per acre)
Appalachian	75	0.20	7.22
Corn Belt	78	1.55	18.10
Delta States	83	0.54	21.65
Lake States	72	0.54	15.38
Mountain	69	0.37	11.67
Northeast	80	0.08	4.75
Northern Plains	79	1.19	15.83
Pacific	77	0.33	17.17
Southeast	78	0.15	7.65
Southern Plains	75	0.63	13.87
National Total	77	5.57	14.62

Note: Analysis precludes interregional redistribution of payments at this time but does allow redistribution within regions from all crop & pasture to land already adequately protected (i.e., eroding <T).

producers within states are reallocated to crop and pasture land already adequately protected.

Table 9 shows estimates of average payment levels for already existing stewardship by region, assuming no interregional redistribution of the current $5.57 billion in direct payments to producers.

Further comprehensive analysis is needed to estimate benefits and effects for incentive systems, resource management systems (including nutrient management, pesticide management, and wildlife habitat management) associated with stewardship provisions currently being discussed. Availability of data, modeling constraints and the time frame limited what could be included in this analysis.

Cropland stewardship proposal — Level 2; controlling all erosion to compliance levels (CPS2; Table 10)

The annual cost to consumers/taxpayers to extend erosion control at conservation compliance levels to all cropland is $981 million — $751 million of which stems from higher farm gate commodity prices and a net of $231 million of income losses to producers despite the higher prices.

- The cost is $1.78 per ton of erosion reduction for about 12 million additional acres treated with conservation techniques.
- Prices increase 1.2 percent as production declines by 0.4 percent.
- Total financial cost for the agricultural sector is just under $1.2 billion.

- The benefit/cost ratio is 4.1.
- The trade surplus declines by $28 million (0.1 percent).
- Regional impacts on farm income range from -7.1 percent ($-711 million) in the Southern Plains region to 3.0 percent ($299 million) in the Pacific region.
- The erosion control constraint resulted in a decrease in acres cropped of 1.7 million acres; 0.4 million acres of this land is converted to forest and pasture use and the per-acre rent declines by $0.82.
- Idled land increases by 1.3 million acres, resulting in a decline in total rental revenue of $98.7 million (at base rent rate).
- Erosion is reduced by 31 percent (550 million tons):
  - where the erosion index is less than 8, by 10 percent (42 million tons)
  - where erosion index is between 8 and 20, by 46 percent (138 million tons)
  - where the erosion index is greater than 20, by 65 percent (115 million tons)
  - where in Classes IIIw-VIIIw (some is highly erodible land), by 57 percent (82 million tons)
- Regional reductions range from nine percent in the Delta region to 64 percent in the Southern Plains region.
- Cropped acreage drops by 11 percent for land with an erosion index greater than 20.
- National use of other resources changes by less than one percent, except for a three-percent increase in use of groundwater.
- Cropland with conservation tillage, strip cropping, contouring or terraces increases by 11.8 million acres per year.
- Potential environmental benefits reduce erosion by 31 percent, sediment by 33 percent, nitrogen by 13 percent and phosphorus by 20 percent.
- Total financial cost to the agricultural sector is $1.2 billion.
- Technical assistance needs total $467 million — $278 million for the federal share and $189 million for partners.

TABLE 10.

Impact of second-level cropland stewardship proposal: control all cropland to conservation compliance levels (csp2)

Estimated changes from baseline conditions (2000)

U.S. agricultural sector impact:	Unit	Measure
Producers	Million $	-230.7
U.S. consumer	Million $	-750.5
U.S. taxpayers[2]	Million $	218.4
Total financial cost[2]	Million $	-1199.5
Technical Assistance		
Federal	Million $	278.1
Partner	Million $	188.9
Total technical assistance	Million $	467.0
Total cost[2]	Million $	1666.5
Estimated environmental benefits[3]	Million $	6827.9
Benefit cost ratio	Ratio	4.1
Producers'income	% change	-0.35
Environmental impacts[6]		
Erosion	% change	-30.7
Sediment	%. change	-33.2
Total nitrogen	% change	-12.5
Total phosphorus	% change	-19.7

See Table C-2 in Appendix C (pages C-11-C-14) for more detail and footnotes.

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Cropland stewardship proposal — Level 3; sustainable resource management on all cropland (CSP3; Table 11)

The annual cost to consumers/taxpayers to implement resource management systems is $2.9 billion. Under this scenario, consumers/taxpayers lose $5.1 billion because of higher commodity prices, while producers realize a net gain of $2.2 billion because the higher prices offset their variable cost increase.

- The cost is $3.45 per ton of erosion reduction for about 40 million additional acres treated with conservation techniques.
- Prices increase by 8.2 percent as production declines by 2.6 percent.
- Total costs are estimated at $6.3 billion.
- The benefit/cost ratio is 1.7.
- Crop variable cost is up nationally by 2.5 percent ($4.12) per acre and 1.5 percent overall, while sustainable level results in a decrease in cropland by 7.1 million acres, of which crop revenue is up 7.4 percent ($15.25 per acre).
- If all the crop variable cost increase were confined to the acres treated with new conservation techniques, then on those acres the per-acre increase would be 21 percent ($35).
- Controlling erosion to the one million acres are converted to forest and pasture use.
- Cropland rent value increases by $5.05 per acre (6.9 percent), but total rental revenues would decrease $442 million because of an additional six million acres of land that would be idled.
- Commodity prices increase by enough for producer revenue increases to exceed cost increases.
- Regional impacts on farm income range from -3.5 percent ($351 million) in the Southern Plains region to 9.9 percent ($995 million) in the Pacific region.
- Erosion is reduced by 47 percent (840 million tons):

TABLE 11.

Impact of third-level cropland stewardship proposal: sustainable resource management systems on all cropland (csp3)

Estimated changes from baseline conditions (2000)

U.S. agricultural sector impact:	Unit	Measure
Producers	Million $	2182.6
U.S. consumer	Million $	-5084.9
U.S. taxpayers[2]	Million $	954.7
Total financial cost[2]	Million $	-3857.0
Technical Assistance		
Federal	Million $	1451.5
Partner	Million $	985.6
Total technical assistance	Million $	2437.0
Total cost[2]	Million $	6294.0
Estimated environmental benefits[3]	Million $	10428.0
Benefit cost ratio	Ratio	1.7
Producers income	% change	3.36
Environmental impacts[6]		
Erosion	% change	-46.9
Sediment	%. change	-55.5
Total nitrogen	% change	-15.8
Total phosphorus	% change	-26.3

See Table C-2 in Appendix C (pages C-11-C-14) for more detail and footnotes.

- where the erosion index is less than 8, by 22 percent (91 million tons)
- where the erosion index is between 8 and 20, by 70 percent (212 million tons)
- where the erosion index is greater than 20, by 90 percent (158 million tons)
- where in Class IIIw-VIIIw (some is highly erodible land), by 62 percent (88 million tons)

- Regional reductions range from 20 percent in the Delta region to 73 percent in the Southern Plains region.
- Cropped acreage drops by 29 percent for land with an erosion index greater than 20.
- National use of other resources changes by less than two percent, except for a seven-percent increase in use of groundwater.
- As much as 21 percent of the total acreage of a crop (potatoes is the extreme) is shifted from the most highly erodible land to less erodible land.
- Cropland with conservation tillage, strip cropping contouring or terraces increases by about 40 million acres per year.
- Potential environmental benefits reduce erosion by 47 percent, sediment by 56 percent, nitrogen by 16 percent and phosphorus by 26 percent.
- Total financial cost to the agricultural sector is $3.8 billion.
- Technical assistance needs total $2.4 billion — $1.5 billion federal and $0.9 billion partners.

Simultaneous BUF2, CRP45 and CSP2 (Table 12)

All of the previous alternatives were analyzed independently of one another to assess their individual effects. Additional model simulations were conducted to simultaneously analyze potential effects of concurrently achieving existing conservation buffer goals, expanding the CRP and accomplishing different levels of conservation enhancements on cropland.

The annual cost to the U.S. economy from simultaneously extending the buffer program to two million miles, expanding the CRP to 45 million acres and requiring erosion control on all cropland at the conservation compliance levels is estimated to be $1.85 billion. Total financial costs to society decrease by $200 million from the CSP2 level because of economies and efficiencies from simultaneous implementation of these programs. The benefits that accrue from reduced erosion and sediment are $7.43 billion, for a benefit/cost ratio of 4.0.

- Producers have a net benefit of $3.7 billion because of higher market prices and $1.6 billion in direct financial assistance.
- Consumers lose $3.0 billion because of higher market prices.
- Taxpayers spend, in addition to the $1.6 billion in direct financial assistance, $0.9 billion in technical assistance to producers.
- Crop prices increase by 5.7 percent, while production is down by 2.5 percent.
- Variable cost increases, but by less than do receipts, both in total and per acre.

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- Net farm income is increased by 5.6 percent.
- The U.S. trade surplus declines by 1.6 percent ($332 million).
- The CRP and buffers increase by a total of 19.6 million acres, but cropping is reduced by only 16.5 million acres because 1.9 million acres of previously idled cropland and 0.7 million acres of forest and pasture would become cropped.
- Cropland rent value increases by $7.82 (10.7 percent) per acre.
- Cropland erosion is reduced by 33.4 percent (598 million tons), with the largest reduction occurring on land with higher erosive potential or hazard. Other pollutant reductions include:
  - Sediment movement off farm fields is reduced 36.0 percent.
  - Total nitrogen and total phosphorus movement off farm fields (and/or through the root zone) is reduced 17.9 percent and 25.7 percent, respectively.
- The percent of cropland with applied conservation measures increases by six percent.
- Cropped acreage decreases by 4.7 percent and the lost rent on this land, valued at baseline rental rates, is $1.2 billion or 4.7 percent of base rent. However, this loss is partially offset by the rental payments received for the buffer and CRP enrollments.
- Use of groundwater for irrigation increases by 5.8 percent while use of surface water decreases by 1.1 percent.

TABLE 12.

Impact of second-level cropland stewardship proposal plus conservation buffers to two million miles and CRP at 45 million acres

Estimated changes from baseline conditions (2000)

U.S. agricultural sector impact:	**Unit**	**Measure**
Producers	Million $	3668.6
U.S. consumer	Million $	-3040.9
U.S. taxpayers[2]	Million $	1611.1
Total financial cost[2]	Million $	-983.4
Technical Assistance		
Federal	Million $	681.5
Partner	Million $	180.3
Total technical assistance	Million $	861.8
Total cost	Million $	1845.2
Estimated environmental benefits[3]	Million $	7426.1
Benefit cost ratio	Ratio	4.0
Producers' income	% change	5.64
Environmental impacts[6]		
Erosion	% change	-33.4
Sediment	%. change	-35.9
Total nitrogen	% change	-17.9
Total phosphorus	% change	-25.7

See Table C-2 in Appendix C (pages C-11-C-14) for more detail and footnotes.

- Use of hired labor decreases by 0.6 percent, pasture use increases by 0.2 percent and changes in grazing land and family labor use are less than 0.1 percent.
- Direct financial assistance needs are estimated to total an additional $1.6 billion.
- Technical assistance costs total $862 million — $682 federal and $180 million from partner contributions.

Simultaneous BUF2, CRP45 and CSP3 (Table 13)

The annual cost to the U.S. economy from simultaneously extending the buffer program to two million miles, expanding the CRP to 45 million acres and requiring erosion control on all cropland at resource management system levels is estimated to be $5.89 billion. Total financial costs to society decrease by $676 million from the CSP3 level because of economies and efficiencies from simultaneous implementation of these programs. The benefits that accrue from reduced erosion and sediment are $10.67 billion, for a benefit/cost ratio of 1.8.

- Producers have a net benefit of $6.3 billion because of higher market prices and the $2.3 billion in direct financial assistance.
- Consumers lose $7.2 billion because of higher market prices.
- Taxpayers spend, in addition to the $2.3 billion direct financial assistance, $2.7 billion in technical assistance to producers.
- Crop prices increase by 12.9 percent while production is down by 4.6 percent.
- Variable cost increases, but by less than do receipts, both in total and per acre.
- Net farm income is increased by 9.7 percent.
- The U.S. trade surplus declines by 3.3 percent ($702 million).
- The CRP and buffers increase by a total of 19.6 million acres, but cropping would be reduced by 20.9 million acres because erosion control measures on some previously cropped acreage would be costly.
- About 0.2 million acres of cropland would be expected to convert to pasture and forestland.
- Idled land would increase by 1.7 million acres, resulting in decreased cropland rental revenue of $121.2 million, although cropland rent value would increase by $13.92 (19 percent) per acre.

TABLE 13.

Impact of third-level cropland stewardship proposal plus conservation buffers to two million miles and CRP at 45 million acres

Estimated changes from baseline conditions (2000)

U.S. agricultural sector impact:	Unit	Measure
Producers	Million $	6285.4
U.S. consumer	Million $	-7209.6
U.S. taxpayers[2]	Million $	2257.3
Total financial cost[2]	Million $	-3181.5
Technical Assistance		
Federal	Million $	1780.7
Partner	Million $	926.7
Total technical assistance	Million $	2707.4
Total cost	Million $	5888.9
Estimated environmental benefits[3]	Million $	10666.5
Benefit cost ratio	Ratio	1.8
Producers' income	% change	9.67
Environmental impacts[6]		
Erosion	% change	-47.9
Sediment	%. change	-55.5
Total nitrogen	% change	-19.6
Total phosphorus	% change	-31.0

See Table C-2 in Appendix C (pages C-11-C-14) for more detail and footnotes.

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- Cropland erosion is reduced by 47.9 percent (859 million tons), with the largest share of this occurring on land with higher erosive potential or hazard. Other pollutant reductions include:
  - Sediment movement off farm fields is reduced 55.5 percent.
  - Total nitrogen and total phosphorus movement off farm fields (and/or through the root zone) is reduced 19.6 percent and 31.0 percent, respectively.
- The percent of cropland with applied conservation measures increases by 14.7 percent.
- Cropped acreage decreases by 6.0 percent, and the lost rent on this land, valued at baseline rental rates, is $1.5 billion or 6.0 percent of base rent. However, this loss is partially offset by the rental payments received for the buffer and CRP enrollments.
- Use of groundwater for irrigation increases by 10.1 percent, while use of surface water decreases by 1.4 percent.
- Use of hired labor decreases by 0.8 percent, pasture and range land labor use decreases by 0.1 percent and 0.3 percent, while changes in grazing land and family labor use are less than 0.1 percent.
- Direct financial assistance needs are estimated at $2.3 billion.
- Technical assistance costs total $2.7 billion — $1.8 billion for the federal share and $.9 billion for partners.
- Technical assistance costs rise more than financial assistance relative to results at the CSP2 level because of significantly expanded requirements for intensive resource management systems.

Reduce resource degradation (Table 14)

Analysts combined the results for several alternatives to estimate the economic, environmental and program impacts that would accrue to reduce the rate of resource degradation. This alternative included program elements discussed in most of the public forums held during 2000 and in reports that were issued up through September 2000. The alternative includes achieving conservation compliance levels on all cropland at the CSP2 level, completion of two million miles of conservation buffers, enrolling 250,000 additional acres in WRP, slightly expanding FPP to $65 million, establishing WHIP at $50 million, increasing funding for FIP by $38 million, initiating a modest grazing land reserve and enrolling 45 million acres in CRP. These initiatives respond to the need to improve water and soil quality, reduce soil erosion, conserve marginal lands and wetlands, improve the condition of private grazing lands and provide economic incentives for land stewardship.

It was not possible to directly incorporate consequences from implementation of conditions for FPP, WHIP, FIP and WRP provisions in the modeling system, although cost information was available. This alternative (and the one below to improve resource health) incorporate cost information with results from the analysis for extending buffers to two million miles, increasing CRP to 45 million acres and adopting CSP at levels 2 and 3.

An additional 1.3 million acres of wildlife habitat would be enhanced annually at $50 million for WHIP and 115,000 additional acres of farmland would be protected annually through $65 million in funding for FPP. WRP would enroll 250,000 acres annually for an additional $286 million per year.

TABLE 14.
Impact of implementation of second- and third-levels of cropland stewardship proposal plus conservation buffers to two million miles and CRP at 45 million acres, WRP at 250,000 acres, FPP at $65 million, WHIP at $50 million and FIP

Estimated changes from baseline conditions (2000)

		Reduce resource degradation glr, wrp, fpp whip and fip[1]	**Improve resource health** glr, wrp, fpp whip and fip[1]
U.S. agricultural sector impact:	**Unit**	**Measurement**	
Producers	Million $	3668.6	6285.4
U.S. consumer	Million $	-3040.9	-7209.6
Direct federal financial assistance	Million $	2020.7	2666.8
Total financial cost[2]	Million $	-1392.9	-3591.1
Technical Assistance			
Federal	Million $	737.4	1836.6
Partner	Million $	188.9	935.2
Total technical assistance	Million $	926.3	2771.9
Total cost	Million $	2319.3	6362.9
Estimated environmental benefits[3]	Million $	7426.1	10666.5
Benefit cost ratio	Ratio	3.2	1.7
Producers Income	% change	5.64	9.67
Environmental impacts[6]			
Erosion	% change	-33.4	-47.9
Sediment	%. change	-35.9	-55.5
Total nitrogen	% change	-17.9	-19.6
Total phosphorus	% change	-25.7	-31.0

See Table C-2 in Appendix C (pages C-11-C-14) for more detail and footnotes.

The annual cost to the U.S. economy from simultaneously extending the buffer program to two million miles, expanding the CRP to 45 million acres and requiring erosion control on all cropland at conservation compliance levels is estimated to be $2.3 billion. The environmental benefits were not re-estimated from those in the simultaneous BUF2CRP45CSP2 scenario because of a lack of information, but they would be expected to increase proportionate to enhanced wildlife habitat and wetlands. The benefit/cost ratio is 3.2 without adjustments to the earlier benefit estimates.

All other agriculture sector impacts remain unchanged from that presented for simultaneous BUF2CRP45CSP2 with the exception of financial and technical assistance needs.

- Direct financial assistance needs are estimated to total an additional $2 billion.
- Technical assistance costs total $926 million — $737 for the federal share and $189 million in partner contributions.

Improve resource health (Table 14)

To achieve a higher level of resource protection and improve resource health, analysts added sustainable resource management systems on all cropland at the CPS3 level to the initiatives needed to slow resource degradation. This scenario addressed the highest level of conservation considered in the analysis.

The annual cost to the U.S. economy from simultaneously extending the buffer program to two million miles, expanding the CRP to 45 million acres and requiring erosion control on all cropland at sustainable resource management system levels is estimated to be $6.4 billion. Environmental benefits were not re-estimated from those in the simultaneous BUF2CRP45CSP3 scenario because of a lack of information, but they would be expected to increase proportionate to enhanced wildlife habitat and wetlands. The benefit/cost ratio is 1.7 without adjustments to the earlier benefit estimates.

All other agriculture sector impacts remain unchanged from those presented for simultaneous BUF2CRP45CSP3 with the exception of financial and technical assistance needs.

- Direct financial assistance needs are estimated at $2.7 billion.
- Technical assistance costs total $2.8 billion — $1.8 billion for the federal share and $.9 billion for partners.
- Technical assistance costs rise more than financial assistance relative to results at CSP3 because of significantly expanded requirements for intensive resource management systems.

Analysis of Conservation Alternatives

Conclusion

Adoption of conservation practices by many of this nation's private landowners has helped to reduce the impacts of food and fiber production on soil, water and air quality. Conservation of the land's resources is an ongoing process, however. Much remains to be done to ensure healthy soils and clean water and air to support viable communities (both urban and rural), contribute to a strong economy and our national security and protect important environmental attributes such as wildlife habitat.

The increasing human population and prevailing public views challenge landowners and agribusinesses to produce food and fiber without harming the nation's natural resources. The public looks to the government to ensure that farmers and ranchers produce an abundance of safe food and fiber at affordable prices while protecting and sustaining the nation's natural resource base. Farmers and ranchers look to the government for technical and financial assistance, research and technology and an income safety net needed to meet the challenge.

An effective program to achieve natural resource conservation goals will consider these needs. Each program element should recognize the important connection among technical assistance, education, research and technology and economic incentives for landowners who practice high-level stewardship.

As an example, to reduce erosion rates on all cropland to acceptable levels will require conservation techniques across a variety of soils, terrains, crops and climates. It will be more challenging in some parts of the country than in others. Likely, many farmers and ranchers will request technical assistance to apply the conservation measures, and because "one size will not fit all," new or improved technology springing from research will be necessary. In some areas, financial incentives and assistance will help ease any economic burden of achieving the goal.

To meet the needs identified by the public and achieve resource conservation goals, this country must recommit to a conservation program — a program to ensure that private landowners, who are the stewards of 70 percent of this nation's land, have the technical assistance, research and financial incentives to sustain our soil, water, air and wildlife habitat in perpetuity.

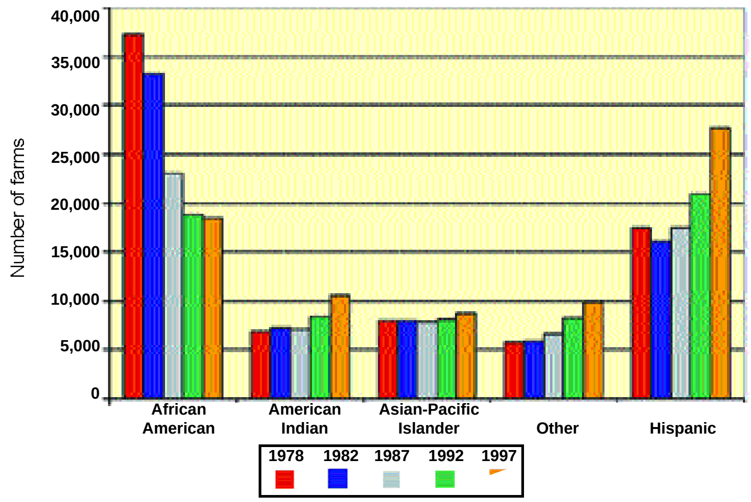
Appendix A

Facts

Agriculture

- There are less than two million farms in the United States today, far less than the peak of 6.5 million farms in the 1920s (ranches are included in all uses of the word "farm").
- The amount of land on U.S. farms peaked at about 1.2 billion acres in the 1950s and declined to a little more than 0.9 billion acres in 1997. The amount used for crops plus idled cropland has remained about 0.4 billion acres since the 1920s.
- The current market value of U.S. farmland is more than one trillion dollars, or $1,030 per acre on average. Cropland values were highest ($3,460 per acre) in the Pacific region and lowest ($668 per acre) in the Northern Plains region.
- The total value of U.S. agricultural commodities sold in 2000 was $191 billion.
- With less than one percent of the world's farmers, 4.5 percent of the world's population and 7 percent of the world's land, the U.S. produces more than 20 percent of the world's cotton, 46 percent of the world's soybeans, 13 percent of the world's wheat and 41 percent of the world's corn.
- Most (99 percent) of U.S. farms are family owned, family-held corporations or partnerships.
- Only 0.05 percent of U.S. farms (0.3 percent of all farmland) are non-family corporations with more than 10 stockholders.
- More than half of U.S. farms (14 percent of all farmland) average less than $10,000 in sales a year (1.5 percent of all U.S. agricultural sales). Average net farm income for these small farms is negative, but non-farm income brings the total family income to near the community average.
- Fifty percent of farm acreage is on the 435,000 farms (22.8 percent of all farms) with sales between $50,000 and $500,000 a year. These middle-sized farms, whose numbers are rapidly dwindling, account for 36.6 percent of total sales.
- Fifty-six percent of total sales stem from the 70,000 farms (3.6 percent of all farms) with sales over $500,000 a year.
- U.S. agricultural exports account for about 25 percent of gross cash farm receipts. These exports are pivotal in farm profitability.
- In 1999, average farm household income was $64,347 compared to $54,842 for average U.S. household income. But only $6,359 of the farm income average came from farming activities.
- In 1997, 26 percent of all farmers were 65 years of age or older, and the average age was 54.3 years. In 1978, only a little more than 15 percent of all farmers were above retirement age. Ninety-seven percent of farmers are White/non-Hispanic.

FIGURE A-1.
Number of farms operated by minorities, 1978 to 1997



- Most of the traditional USDA payments go to the "grain and oilseed" farmers, 98.7 percent of whom are White/non-Hispanic and whose lands comprise 22 percent of total farm acreage.
- The number of farms operated by Hispanics increased 58.6 percent during the 10 years from 1987 to 1997. The number of farms operated by Asians, American Indians and women is also rising steadily.
- The number of farms operated by African Americans has steadily declined, from a peak of 925,710 farms in 1920 to 18,451 farms in 1997.

Forestland

- Four-fifths, or nearly 393 million acres, of this nation's timber land (capable of 20 cubic feet of wood per year) is non-federal.
- The forest products industry accounts for more than seven percent of the total U.S. manufacturing output, employs 1.7 million people and ranks among the top 10 manufacturing employers in 46 states.
- Nationwide harvest of timber is expected to increase from slightly more than 16 billion cubic feet in 1991 to nearly 22 billion cubic feet in 2040. More than 80 percent of the increase in harvest is expected to be on non-federal forests.
- Eighty-five percent of the wood products consumed in this country come from U.S. forests.
- It is estimated that urban and community forests provide a variety of environmental and social benefits, estimated to be worth $3 billion per year nationwide.
- In the continental United States, non-federal forests store an estimated 38.6 billion metric tons of carbon (90 percent of the national total), and Alaskan forests store an additional 16 billion metric tons.
- Forests are the source of approximately 60 percent of the nation's total stream flow.

Appendix A

Urban

- Sixty-seven percent of the American public support measures to preserve farmland and open space.
- Fifty-eight percent of this country's counties are seriously concerned over loss of farmland because of expected growth in coming years, and 61 percent are seriously concerned over the loss of wildlife.
- More than 50 percent of the counties surveyed by General Accounting Office report a moderate to high concern for unsightly commercial development, traffic congestion, air and water pollution and the need for new infrastructure.
- About 45 percent of new construction from 1994 to 1997 occurred in rural areas.
- New housing construction averaged about 1.5 million units per year, with single-family home construction at more than 1 million per year. Forty-five percent of new housing construction from 1994 to 1997 occurred in rural areas.

Grazing lands

- Approximately 1.1 billion acres of public and private land in the United States are classified by the government as grazing land.
- The nation's grazing lands total 588 million acres of non-federal land and include pasture land, rangeland and grazed forestland. Combined, pasture land and rangeland amount to nearly 526 million acres, or 35 percent of non-federal land.
- Private and public grazing lands usually are stocked with more than 60 million cattle and eight million sheep, supporting a livestock industry that annually contributes $78 billion in farms sales to the U.S. economy.
- There are 785,672 cattle farm and ranches in the United States, totaling 474,966,508 acres, and 29,938 sheep and goat operations, totaling 20,359,376 acres.

Wildlife habitat

- Wildlife species have important ecologic, economic and aesthetic benefits for society. Their abundance is to a large extent a result of how the land is treated.
- All land is wildlife habitat, but the quality varies greatly and is often determined by how the land is used.
- Seventy-nine percent of the United States is in non-federal ownership, and therefore most habitat is managed by private landowners.
- White-tailed deer populations may be too abundant in some portions of their range, the result of favorable habitat, harvest management strategies and decreases in populations of natural predators.
- Small-game populations and populations of species associated with grassland, early successional regimes (for example, scrub-shrub) and

farmland habitats have declined in recent decades. The northern bobwhite is an example of one such species whose populations have exhibited significant declines for more than three decades.

- Studies revealed that fields enrolled in the Conservation Reserve Program had from 1.4 to 10.5 times greater bird abundances than did cropped fields. Nest abundance in CRP fields was reported to be from 8.8 to 27 times greater than nest abundance in cropped fields.
- The combined effect of CRP and the amelioration of drought conditions since 1993 in the Northern Plains region resulted in a dramatic recovery of waterfowl populations (and populations of Le Conte's sparrow) that was substantially greater than if either CRP or the favorable weather had been absent.
- By establishing needed vegetation, CRP has improved habitat; prevented loss of topsoil; improved water quality by reducing sediment, pesticide and fertilizer runoff; and provided billions of dollars in environmental benefits over the life of the program.
- CRP and the Wetlands Reserve Program combined represent less than 2.4 percent of non-federal wetlands in this country. Excellent opportunities for habitat management also exist on working lands through judicious selection of management practices that yield multiple resource benefits.

Sources

American Farm Bureau Federation 2000; Best et al. 1998; Brady 1985; Bureau of Labor Statistics undated; Economic Research Service undated; Flather et al. 1999; Follett et al, 2001; General Accounting Office 2000; NASS 1998, 2000a, b; NRCS 2000a; National Research Council 1998; Ryan et al. 1998; Sampson and DeCoster 1997; Samson et al. 1998; The Statistical Abstract of the United States undated; Warner and Brady 1994.

Appendix B

Public perceptions of conservation policies

Farmers, ranchers, suburban homeowners, urban residents, communities and other private landowners are the stewards of the nation's basic natural resources: soil, water and air. It is they who determine, through their actions, whether we will have healthy soil, pure water and breathable air. Their attitudes and opinions regarding the success of existing programs and the changes and modifications that need to be made in the future are important inputs in the development of conservation policy. These opinions are expressed through individual actions and the collective actions of agricultural, environmental and commodity groups. They provide a significant source of information for the development of the 2002 Farm Bill.

This appendix provides an overview of those attitudes, gleaned from surveys, Congressional testimony, listening sessions and publications. A review of this information indicates a number of common themes running through many of the reports and publications. The appendix describes these common themes and provides more detailed information on recommended actions and policy decisions that they suggest.

◆ Extension and modification of existing programs with increased funding and expanded eligibility.

Among all of the opinions sampled, there was nearly unanimous agreement that none of the existing conservation programs should be eliminated, but all of them should be expanded and funded to include more land and more landowners. In a number of listening sessions sponsored by the Soil and Water Conservation Society, there was nearly unanimous agreement that "expanding the reach of existing USDA conservation programs should be the most important conservation objective of the next farm bill." Participants recommended a combination of increased funding and programmatic reform, but agreed that more funding is by far the most important factor (Soil and Water Conservation Society 2001). The American Farm Bureau testified before the House Agricultural Committee in the spring of 2001 that the Environmental Quality Incentives Program should be increased nearly tenfold from previous fiscal year levels (U.S. House of Representatives 2001).

The report of the Commission on 21st Century Production Agriculture also recommends the continuation of both the Conservation Reserve Program (CRP) and the Environmental Quality Incentives Program (EQIP), with modifications in CRP to target buffer strips, filter strips, wetlands, grass waterways and partial field enrollments. The report also recommends sufficient modifications in these programs so that underfunded groups such as minority and limited resource farmers are not excluded (Commission on 21st Century Production Agriculture 2001).

Several organizations, including the Soil and Water Conservation Society, noted the current bias toward land retirement as a means to conserve resources. They cited the need for a better balance between financial assistance for land treatment and land retirement so that farmers can keep on farming in a manner that enhances the environment, rather than having to leave farming to conserve resources (American Farmland Trust 2001a, Cox 2001, Defenders of Wildlife 2000, Commission on 21st Century Production Agriculture 2001). Some comments noted a variety of constraints to program participation that should be addressed in the upcoming Farm Bill. These include the complexity of applications, inconsistency of programs and the "one size fits all" approach. Several groups called for the provision of more flexibility for small and limited resource farmers, as well as a greater variety of management practices and economic incentives for the landowner to choose from.

There is some sentiment for NRCS to expand its programs and activities in urban and rapidly growing areas, particularly with farmers on the urban fringe. The USDA Policy Advisory Committee on Farmland Protection and Land Use has recommended that USDA "ensure that its programs and policies are flexible enough to meet the needs of each community's unique set of resources and problems" (U.S. Department of Agriculture 2000a).

- Establishment of new programs, and modification of existing programs to enable farmers and ranchers to increase farm income while conserving natural resources (for example, "green payments").

The concept of "green payments" has been a topic of interest for several years. Green payments are a "subset of agri-environmental payment programs that have both environmental and farm income objectives" (Claassen et al. 2001). According to the Economic Research Service (ERS), "Green payments are frequently discussed as an alternative for, or supplement to, current farm income and environmental programs." Such a program must be designed carefully, according to ERS, to avoid unintended consequences and to assure the greatest environmental benefit. The American Farm Bureau, National Corn Growers Association, National Farmer's Union, National Grain Sorghum Producers, American Soybean Association and U.S. Rice Producers Association have all supported a voluntary environmental incentives program that pays producers for conservation practices already in place or to be applied (U.S. House of Representatives 2001).

Defenders of Wildlife support the concept of green payments in their recent policy paper. They refer to the objectives of the proposed Conservation Security Act (CSA), which allow for green payments to producers in exchange for providing environmental and ecological benefits on their land. Not surprisingly, they are interested in green payments because they would allow agricultural producers to be compensated for the "environment amenities they provide on private lands, including the restoration and conservation of native wildlife habitat" (Defenders of Wildlife 2000).

The Agricultural Conservation Innovation Center (ACIC) of the American Farmland Trust has proposed "creating an agricultural wetlands trust that increases farm income and environmental values" (American Farmland Trust 2001a). Because the high cost of existing mitigation systems precludes most farmers and ranchers from participating, the ACIC proposes a wetland mitigation trust that is environmentally sound, and affordable for the farmer by using a "trust" model rather than a "bank" model.

In its report "How Much is Enough for 2002?" (Wildlife Management Institute 2001), the Wildlife Management Institute recommends the establishment of a conservation security program that would reimburse landowners for providing key conservation practices on their land. A system of "conservation credits" would assure that the landowner would receive higher payments for more conservation. Support for an easement program to retain native grassland has also gathered widespread support (U.S. House of Representatives 2001).

◆ Stewardship-based agricultural conservation policy that rewards landowners for resource conservation practices.

The Soil and Water Conservation Society has challenged policymakers to make natural resource stewardship one of the most important components of the new farm policy. They recommend rewarding good actors "who have been investing in and implementing conservation systems, often without any governmental assistance or financial compensation" (Cox 2001).

Participants in the SWCS listening sessions felt strongly that current conservation programs often penalize farmers and ranchers who are already good conservationists, as well as penalizing early adopters of new conservation systems and practices (Soil and Water Conservation Society 2001). They want to see a conservation policy that rewards good actors and helps to keep farmers on the lands through conservation.

The Commission on 21st Century Production Agriculture also supports this approach by recommending the establishment of "an incentive-based conservation program (that provides) conservation payments and technical assistance to further encourage the application of locally appropriate conservation practices and technologies that are consistent with crop and livestock activities..." (Commission on 21st Century Production Agriculture 2001). Environmental Defense recommended incentive payments as a means of augmenting farm and ranch income (National Association of Conservation Districts 2001b).

As a panelist at the Leopold Center commented, "Achieving sustainability in agriculture requires more than just changing farm practices. It also includes sustaining those who care for the land" (Leopold Center for Sustainable Agriculture 1999).

◆ Greater awareness of the relationships, and possible contradictory interactions, between production programs and conservation programs.

A commonly held attitude is the belief that unintended conflicts and contradictions among various agricultural and conservation policies has resulted in negative impacts on the ability of landowners to practice conservation. Defenders of Wildlife's report, for example, notes that "the issue of consistency between the Title III conservation objectives of the Farm Bill and the objectives of other Titles (for example, commodity and risk management programs) is important in determining how effective resource conservation incentives can be. In some circumstances, other farm legislation may provide disincentives for producers to practice resource conservation" (Defenders of Wildlife 2000).

As a result of a nationwide survey in 1997, the American Farmland Trust recommends a policy audit to identify and eliminate policies and programs that work at cross purposes to good land stewardship (American Farmland Trust Undated). Participants in Soil and Water Conservation workshops also agreed that "agricultural commodity and risk management programs should not exacerbate conservation and environmental problems by encouraging production on environmentally sensitive or fragile land or intensifying agricultural production systems (Soil and Water Conservation Society 2001).

Finally, the Wildlife Management Institute, in its recommendations for the 2002 Farm Bill, proposes linking agricultural support payments to conservation compliance. The Institute maintains that "public monies spent via farm bill programs should be based on comprehensive land stewardship, including wildlife, rather than on commodity production" (Wildlife Management Institute 2001).

- Increased capacity for Natural Resources Conservation Service conservation technical assistance in the field.

All of the policy proposals and program comments reviewed emphasized the need for additional technical support from NRCS, including training and additional staff. To fill this need, they unanimously recommended increased funding for NRCS conservation technical assistance.

The National Drought Policy Commission strongly recommended, "Congress should fund existing drought preparedness programs such as the U.S. Department of Agriculture's Conservation Technical Assistance Program (Public Law 46) and Environmental Quality Incentives Program (16 U.S.C. 3839)...." They also recommended modernization, expansion and coordination of observation technologies such as the Soil Climate Analysis (SCAN) and Snowpack Telemetry (SNOTEL; National Drought Policy Commission 2000).

One of seven recommendations Defenders of Wildlife has proposed for the USDA Conservation Program states that "Federal funding for conservation technical and administrative assistance, agricultural research, and extension should be substantially increased to assist private landowners to meet mandated environmental and ecological standards (Defenders of Wildlife 2000). A similar recommendation can be found in the report of the Wildlife Management Institute (Wildlife Management Institute 2001).

Farmers and ranchers engaged in operations where animal waste is produced are concerned about the availability of NRCS technical specialists to assist in the preparation of Comprehensive Nutrient Management Plans and the availability of funding support for animal waste structures (National Milk Producers Federation 2000).

- ◆ Program elements that provide a "safe harbor" to producers, with a balance of regulatory and voluntary approaches.

Defenders of Wildlife addresses the concept of "safe harbor" in their recent policy paper. The group suggests that agricultural producers could be afforded a certain level of regulatory security if they integrate a safe harbor program into a resource conservation agreement (Defenders of Wildlife 2000).

Several groups commented on the balance between voluntary and regulatory programs and policies. Based on a survey of farm, ranch and forestland owners, the American Farmland Trust recommends that environmental and land use policies should offer a "fair, effective combination of regulations and incentives, including a dramatic increase in conservation funding and elimination of counterproductive subsidies" (American Farmland Trust Undated).

- ◆ Recognition of the secondary benefits or public goods of agricultural resource conservation.

A final theme in the reports, meetings and papers was the concept of agriculture as a source of societal benefits other than food and fiber as well as the fact that conservation policy often fails to recognize these benefits. Several authors and speakers have pointed out the "multifunctionality" of farming; that is, "farmland that provides environmental, landscape and rural viability benefits in addition to producing food and fiber" (Center for the Study of Rural America 2000). As one author writes, "the farm is still the one link in the agrifood chain accounting for the largest share of agriculture's public goods, including half the world's jobs, many of its most vital communities, and many of its most diverse landscapes" (Kirschenmann 2000). Another notes that "other public goods from agriculture might be clean air, reduced global warning, and biodiversity as well as food and feedstuffs (Leopold Center for Sustainable Agriculture 1999).

The Commission on 21st Century Production Agriculture has acknowledged the importance of agriculture in carbon sequestration by recommending the provision of "appropriate incentives and technical assistance to establish and compensate producers for on-farm carbon sequestration..." (Commission on 21st Century Production Agriculture 2001). Their question is: If agriculture contributes so much to society in general, shouldn't farmers and ranchers benefit

Appendix C

Analysis of Alternatives

Models Used in the Analysis

Although a variety of models and other analytical tools were used in the analysis, the three main simulation models were: Environmental Policy Integrated Climate (EPIC), also known as the Erosion Productivity Impact Calculator (Putman et al. 1988, Rosenberg et al. 1992, Edwards et al. 1994, Williams 1995, Wu et al. 1996, Campbell 2000); Agriculture Sector Model (ASM; Chang et al. 1992, McCarl 1993, McCarl and Callaway 1993, McCarl et al. 1993, Chang et al. 1994, Chen 1998, Atwood et al. 2000, Schneider 2000); and the Hydrologic Unit Modeling of the United States (HUMUS; Srinivasan and Arnold 1994, Arnold et al. 1998, Srinivasan et al. 1998). For this analysis, design, development and production of analysis products from these systems were in partnership with Texas A&M University and the Agricultural Research Service.

EPIC is a field-scale model providing a detailed simulation of hydrologic, nutrient, carbon, soil and vegetative growth processes, with environmental consequences simulated to the edge of the field and to the bottom of the root zone. Environmental consequences include estimates of erosion, nutrient and pesticide leaching and runoff and changes in the quantity and quality of the soil resource. Besides producing environmental consequence estimates directly, EPIC is used to calculate per-acre model coefficients for the ASM for alternative crop management technologies and soil types. Some of the data developed for EPIC is also used in the HUMUS modeling system.

The ASM simulates the simultaneous market equilibrium determination process for primary and processed commodities and for land, labor and water resources in the United States, accounting for export and import markets and supply of production inputs. Cropland is divided into classes based on erodibility and other environmental characteristics. Alternative crop production technologies are included, with the model solution process for a given scenario choosing the set of technologies most likely to be used by producers in the situation simulated by the scenario. Model output includes estimates of commodity prices, production, exports, imports; resource use and prices; a description of agricultural technology used and estimates of sheet and rill and wind erosion.

HUMUS consists of three major components: (1) A set of basin-scale Soil and Water Assessment Tool (SWAT) runs that model surface and subsurface water quality and quantity at the 8-digit hydrologic accounting unit scale (2,150 watershed areas); (2) a geographic information system (GIS) to collect, manage, analyze and display the spatial and temporal inputs and outputs; and (3) relational databases needed to manage non-spatial data and drive the models. The acres of crops by watershed can be determined by the ASM model for each alternative scenario and passed to the HUMUS system. Modeling routines for simulating some scenario characteristics such as different types of buffer strips were developed for the SWAT model at a regional scale and were incorporated into the national HUMUS system as part of the analysis.

Appendix C

Modeling changes in agricultural market relationships and policy or program changes

The ASM model is initially set up and calibrated for a specific baseline, usually for the most recent year for which published information is available on commodity prices, yields and disposition and on resources used in production. The parameters of the market relationships in the model for domestic demand and exports and imports of each primary and secondary (processed) commodity can then be changed to reflect the nature of a future scenario. The market relationships are specified with three parameters — baseline quantity, baseline price and the elasticity coefficient for the ratio of percent change in quantity to percent change in price. Supply functions for cropland, groundwater, hired labor and private pasture and range resources have the same three parameters. For example, a scenario to reflect higher export demand for wheat increases the quantity associated with the baseline price and/or changes the responsiveness of the quantity to price. Similarly, an increase in Conservation Reserve Program land can be simulated by reducing the amount of land supplied at a given price. Simulating an increase in the use of conservation tillage is accomplished by imposing a constraint requiring the use of that type of technology in cases where it was not previously employed.

For this analysis, the baseline model solution was calibrated with commodity market conditions for 2000 as reported in the USDA Agricultural Outlook baseline (USDA 2000c). Additional resource availability and management conditions were calibrated to data for year 1997 using the Census of Agriculture and National Resources Inventory data.

The ASM model output was linked with the results from other modeling systems to provide information such as the following:

- changes in levels of production, costs, income and social welfare measures
- changes in crop acres and land uses
- changes in the mixes of crops across soils, tillage types and conservation practices
- changes in levels of production and income by region that can be related to farm size and demographic producer groups using Census of Agriculture data
- changes in crop acres and land use to estimate water quality impacts for selected scenarios using the HUMUS model
- crop acreage distributions and management information combined with the per-acre results from bio-physical models to show a variety of economic and environmental impacts such as erosion, sediment, phosphorus and nitrogen losses to surface water and groundwater
- technical and financial assistance needs associated with each alternative (technical assistance costs based on results from the NRCS Workload Analysis System combined with land treatment needs from the ASM)

The following alternatives were directly analyzed:

BASE: Current program and current conditions as approximated by the USDA baseline for 2000, the 1997 Census of Agriculture, the 1997 National Resources Inventory and Conservation Reserve Program and buffer program data as of September 2000.

Increase buffers to two million miles (BUF2): Simulate imposed enrollment of sufficient buffer acres to reach the two-million-mile goal under the assumption of current rules for CRP, installation costs and rental rates.

Expand the Conservation Reserve Program to 45 million acres (CRP45): Simulate imposed enrollment of acreage to expand the Conservation Reserve Program to 45 million acres under the assumption of continuing with current rules.

Initiate a Grazing Lands Reserve Program (GLR)
GLRa: Fund Grazing Land Reserve at $50 million annually, distributed proportionate to acres.
GLRv: Fund Grazing Land Reserve at $50 million annually, distributed proportionate to value.

Simulate conservation compliance level of erosion control for all cropland (CCALL).

Double the national acreage in mulch and zero till (TILL2X).

Cropland Stewardship Proposal (CSP)
CSP1: Redistribute $5.57 billion in payments in each state to cropland and pasture land that already incorporate sustainable resource management systems.
CSP2: CSP1 plus simulate imposition of erosion control on remaining cropland to conservation compliance levels.
CSP3: CSP1 plus simulate imposition of erosion control on remaining cropland to sustainable resource management systems.

Simultaneous BUF2, CRP45 and CSP2.

Simultaneous BUF2, CRP45 and CSP3.

Increase funding for the Farmland Protection Program to $65 million annually (FPP65).*

Double the Wetlands Reserve Program acreage by enrolling 250,000 acres annually for five years (WRP250).*

Increase funding for the Forestry Incentives Program by $38 million a year (FIP38).*

Increase funding for the Wildlife Habitat Incentives Program to $50 million annually (WHIP50).*

(*Not explicitly modeled, but estimated impacts were developed based on program specification and results of other scenarios.)

BASE — The baseline was calibrated to 1997 conditions for U.S. agriculture

Resource availability and technical data components of ASM were first updated with available 1997 data from the Census of Agriculture (CEN), the National Resources Inventory (NRI) and other sources. The model solution was calibrated to simulate agricultural commodity and resource market outcomes consistent with 1997 conditions. Conservation compliance (CC) participation was assumed to continue at the 1997 level. Miles of conservation buffers were translated to acres in buffers at the rate of 3.6 acres per mile, which is used for program planning purposes.

Only the crop production component of ASM was updated with 1997 NRI data because the full NRI was not available at the start of the analysis. Acreages for pasture, range and irrigation water land components were based on the 1992 NRI and will be updated later. Three crop simulation updates were applied:

- split of cropland into four cropland classes (based on wetness and erosion hazard) by sub-region
- adjustment of per-acre cost, erosion (USLE and Wind) and yields of cropping technologies to 1997 conditions
- calibration so that in the model solution, use of various tillage types and supporting practices were consistent with the NRI and the Crop Residue Management Survey

BUF2 — Increase national miles of conservation buffers to two million miles

In 1997, USDA launched a national initiative to develop two million miles of conservation buffer strips. As of September 2000, 750,000 miles of buffers had been installed (based on 3.6 acres of cropland per mile of buffer). Of that acreage, 1.2 million acres were formally enrolled as part of the nation's 36.4 million-acre Conservation Reserve Program (CRP) through Continuous Signup (CONCRP) provisions. The remaining 1.5 million acres associated with the current buffers were assumed to be distributed in the same proportionate manner across sub-regions and soils as the CONCRP acres.

The BUF2 scenario simulated achievement of the two million-mile buffer initiative by requiring an additional 1.25 million miles of buffers, bringing the total to two million miles (4.5 million additional acres of cropland). Regular CRP and CONCRP signup were simulated separately. The additional buffer strip acreage was treated as CONCRP signup with the same per-acre costs (private and government) and benefits as land previously enrolled in the CONCRP. BUF2 was simulated by putting cropland-using buffer activities into the model by sub-region and cropland class (for example, adding an additional crop with sub-regional and soil class level constraints on the level of the crop).

The distribution of the additional buffer acres was based on an NRCS comprehensive study of ideal buffer strip distribution for the Buffer Initiative and for program planning for the CONCRP. For this analysis, the sum of current CONCRP enrollment and the additional buffer acres was distributed proportionally to sub-regions based on that ideal distribution as follows: within each sub-region, the new buffer acres were allocated across cropland classes in the same proportions as the classes were allocated to total cropland.

For BUF2:

- expand the CONCRP enrollment by a factor of 2.25 in each sub-region to increase the national total to 2.7 million acres for the buffer "base" (as of September 2000, no explicit distribution data for the buffer acres not enrolled in CONCRP were available)
- redistribute 160,000 acres from the 12 sub-regions where the expansion exceeds the ideal value to the 35 sub-regions with the greatest divergence from ideal
- increase buffer acreage by 20 percent in every sub-region
- calculate the difference (if positive) by sub-region between the ideal distribution and 120 percent of the baseline buffer acreage
- after deducting the 20-percent increase from the total needed 4.5 million-acre increase, distribute the remaining required increase across sub-regions proportionate to each sub-region's share of the national difference between the 120 percent baseline buffer level and the ideal

The costs and benefits of buffer strips were calculated separately for currently enrolled CONCRP acres and for the expanded buffer acres to reflect additional incentives now being offered for enrollments. The following assumptions were used for current CONCRP (rent, cost share and maintenance values were all taken from the current enrollment database):

- the average enrollment contract covers a 12.5-year period
- a discount rate of six percent is used for annualization
- the government cost share is 50 percent of the cost of establishing cover
- the annual maintenance cost paid by the government is included in the rent

With these assumptions:

government cost = (rent + (cost share)*0.116))

producer benefit = (rent - (cost share*0.116) - maintenance)

For the new buffer acres the following assumptions were made:

- average enrollment contract covers a 12.5-year period
- a discount rate of six percent is used for annualization
- cost share is 50 percent of the cost of establishing cover

- government pays an additional incentive equal to 40 percent of private costs of establishing cover
- government pays a signup bonus of $10 per acre per year of enrollment period
- government pays an additional $3.50 per acre maintenance incentive annually
- cost share, maintenance and rent values for previous CONCRP enrollments are used

With these assumptions:

government cost = (rent + 3.5 + (1.8*cost share*0.116) + (125*0.116))

producer benefit = (rent + 3.5 - (0.2*cost share*0.116) - maintenance + (125*0.116))

Per-acre estimates of sheet and rill and wind erosion for CRP land were calculated from the NRI data and used for both current CONCRP and new buffer acres.

CRP45 — Expand Conservation Reserve Program (CRP) to 45 million acres

Baseline CRP enrollment was set at the statutory limit of 36.4 million acres, which is actually a few million acres above current enrollment because of the holdouts for CONCRP and the state-partnered CRP Enhancement Programs (CREEP). The additional 8.6 million acres for the CRP45 scenario were distributed based on the "likely to enroll" database that the Farm Services Agency (FSA) constructed using NRI and economic data provided by the Economic Research Service for the "likely to enroll" estimates. That database considered the environmental benefits scoring used to rank enrollment bids, probable CRP rent level, and estimated profit from continued cropping. However, sample size and other considerations dictated that those estimates be made at the aggregate USDA Farm Production Region 10-region level. Also, the estimates were for the three land classes of ASM that are based on the erosion index (ei) because the "likely to enroll" database does not include Land Capability Class and sub-class information. Government costs, producer benefits and erosion coefficients for CRP land were calculated in the same manner as for the BUF2 scenarios.

To allocate the 10-region acreage estimates to ASM sub-region and soil class, we took the following steps:

- calculate the proportional increase by USDA 10-region need to move from the estimated base to the 45 million-acre CRP
- allocate enrollment to the four ASM land classes assuming the same proportionate split of the new CRP across the four land classes as for previous enrollments
- allocate from the 10 regions to the ASM sub-regions based on the distribution of current CRP

GLRa and GLRv — Grazing Land Reserve Program

Few specifics accompany the proposal that $50 million be spent annually on a grazing land reserve program. Some discussion has focused on protecting land with unique ecological functions, while other discussion centers on

TABLE C-1.

Changes in cropland use (1000 acres)

	Cropped	CRP regular	CRP continuous	Buffer (non-CRP)	Cover or idle	*Total Crop potential	Marginal rent value ($/acre)	Change in rent
BASE	348278.2	30427.6	1500.8	1198.5	17544.1	398949.2	73.16	
Change:								
buf2	-3458.8	0.0	0.0	4499.9	-355.7	685.4	76.00	2.84
crp45	-12059.9	14566.5	0.0	0.0	-1736.6	770.1	79.67	6.51
Till2x	796.4	0.0	0.0	0.0	836.4	1632.8	108.27	35.11
GlrA	-352.0	0.0	0.0	0.0	-406.8	-758.8	74.04	0.80
GlrV	-228.0	0.0	0.0	0.0	-348.8	-576.8	73.98	0.80
csp2	-1735.1	0.0	0.0	0.0	1348.8	-386.3	72.66	-0.82
csp3	-7063.3	0.0	0.0	0.0	6044.0	-1019.2	78.21	5.05
bc2452	-16481.5	14566.5	0.0	4499.9	-1933.4	651.5	80.98	7.82
bc2453	-20891.7	14566.5	0.0	4499.9	1656.0	-169.3	87.08	13.92

*Total crop potential is sum of cropped, CRP, buffers, and cover or idle. Increases in total represent conversions from forest and pasture; decreases are conversion of cropland to forest and pasture.

increasing grazing productivity and/or production of various environmental benefits. For purposes of this simulation, it was assumed that grazing land would be removed from production with compensation paid to the landowners in a program similar to the CRP. Two alternative methods of distributing the funds across the nation were simulated:

- GLRa distributes the funds proportionately across sub-regions based on sub-region proportion of national grazing acres.
- GLRv distributes the funds proportionately across sub-regions based on sub-region proportion of national grazing rent value.

ASM represents grazing land in three categories:

- privately owned pasture land where transactions are in terms of acres
- public grazing land (range) where transactions are in terms of Animal Unit Months (AUMs)
- privately owned grazing land (range) where transactions are in terms of AUMs

Acreage values in ASM for pasture and AUMs for rangeland are taken from Agricultural Statistic and Census related "use" surveys and are generally less than the NRI estimates of pasture and rangeland, particularly in the Appalachian and Southeast regions. Note also that in the ASM, the supply of public grazing by sub-region is represented by fixed quantity and price, while supply of pasture and private grazing are represented by price-responsive supply functions.

The GLRa distribution of grazing land was developed using the following steps:

- determine national acreage shares of pasture and private range in ASM after converting the private AUMs to an acreage basis

- divide the $50 million between national pasture and range proportionate to their total acreages
- divide each of pasture's and range's national fund allocation among sub-regions based on sub-region shares of total acreage

GLRa calculations showed 391.3 million acres of pasture and 152.6 million acres of range, resulting in 72 percent of the funds going to pasture and 28 percent to range.

GLRv distribution of grazing land was developed as follows:

- determine national value shares of pasture and private range in ASM by summing up across states the product of base use and base rent
- divide the $50 million to pasture and range proportionate to their shares of national rent value
- divide each of pasture's and range's national fund allocation among sub-regions based on sub-region shares of total value

The GLRv calculations show national rent values of $6,451 and $642 million for pasture and range, resulting in national GLR shares of 91 percent for pasture and nine percent for range.

The GLR scenarios are modeled in ASM by adding GLR pasture and range activities in each sub-region that "pay" the BASE scenario rent rates and "use" sufficient grazing land resources to expend the allocated GLR funds. The solution showed both the use level and the per-acre cost of enrolling the land by sub-region. Technically, removing that land from production would cause a small increase in the rental rate, implying that actual program implementation would require paying slightly more than the BASE rates. However, in most sub-regions, less than two percent of the grazing land was taken out of production, though as much as 10 percent was removed in a couple of sub-regions. And the ASM solution contains an estimate of how much the rents increase.

CCALL — All cropped acreage will have erosion limited to the CC levels

The conservation compliance (CC) rules have applied to farmers who had traditionally participated in federal farm programs and who farm any highly erodible land (HEL). Those farmers have had qualifying production plans fully implemented since 1995. However, excess erosion continues to be a problem, both from land not covered by the CC provisions and from some CC land. The intent of this scenario is to estimate the costs and benefits to the agricultural sector of requiring that all land be treated in a CC type manner. This simulation requires setting allowable erosion limits as a proxy for the erosion levels associated with approved conservation plans. The implied CC limits assumed for this study are:

- for non-HEL both USLE and wind erosion must be less than six tons
- for HEL both USLE and wind erosion must be less than 10 tons.

Since the erosion levels associated with some of the baseline solution production technologies exceed the CC limits, in the CCALL scenario the ASM will choose the next best (based on economics) cropping activities that meet the CC erosion levels. These next-best technologies may have higher production costs and/or lower yields. The ASM estimates welfare impacts for the sector and describes a new mix of tillage, practices, rotations and, in some cases, different crop mixes by region and cropland class.

TILL2X — Double acreage in reduced tillage at the national level relative to the baseline

Adoption of reduced tillage has slowed at the national level since 1995. This scenario explores the impacts of doubling the current 37 percent of cropland that uses some form of reduced tillage. TILL2X is simulated in ASM by imposing a minimum acreage constraint for each of conservation and zero tillage use in each sub-region. The ASM solution will show both the sector impacts and the sub-regional marginal per-acre costs of adopting those levels of reduced tillage (shadow price of the constraints).

The procedure for developing the distribution of increased reduced tillage across sub-regions has the following steps:

- using Conservation Technology Information Center (CTIC) 1997 data, calculate the proportion of cropped acreage in conservation and zero till for each sub-region
- apply a formula that increases the proportions in these tillage types by sub-region more for areas with lower 1997 proportions and less for areas with higher 1997 proportions, with the cumulative effect of the proportionate increases resulting in national doubling of each type of tillage
- after review by CTIC and NRCS staff, reduce the increase to a doubling in Montana, Oregon, Texas, Washington and Wyoming and to 20 percent in Arizona, California, Connecticut, Florida, Idaho, Maine, Massachusetts, Nevada, New Hampshire, New Mexico, Rhode Island, Utah and Vermont
- spread the remaining acreage needed to meet the national doubling of conservation tillage across sub-regions with large cropland acreages

CSP1, CSP2, CSP3 — Cropland Stewardship Proposal

The Cropland Stewardship Proposal (CSP) simulated in these scenarios was to reflect current policy debates concerning the principal that farmers and landowners should be rewarded for good stewardship already accomplished and that society should be able to expect some stewardship behavior from the landowners in exchange for further government assistance to agriculture. Three model runs were made to simulate CSP, but it should be noted that the analysis was in actuality conducted on the basis of attempting to evaluate implementation of successively higher levels of erosion control rather than assessing progressive levels of incentive payments. Availability of data, time constraints, and modeling constraints limited the scope of what could be incorporated in this analysis. A more comprehensive analysis is needed to estimate benefits and effects for resource management systems, new comprehensive nutrient management, pesticide management, and wildlife habitat management systems to adequately address proposed stewardship incentive provisions currently being considered.

Appendix C

CSP1 involves a lump sum redistribution (within each sub-region) of $5.57 billion in direct payments to acres of cropland and pasture currently managed at erosion levels below the soil loss tolerance rate (T). These payments were added to the objective function as income to the farming sector by sub-region and are also included in government cost accounting at the sub-region level. The procedures for allocating these payments are:

- determine by sub-region the 1997 NRI acreages of crop and pasture with erosion less than T
- apply the following formula in each sub-region to solve for a pasture payment rate (y), and the calculate rates for the cropland classes as multiples of the pasture rate as shown

$AMTA = yP + 3.5yW + 3.5yL + 4.5yM + 6.5yS
where
$AMTA is the AMTA payment total;
P is acreage of qualifying pasture;
W is acreage of qualifying cropland with Class III-VIII, subclass w;
L is the non-W qualifying cropland with erosion index less than 8.;
M is the non-W qualifying cropland with erosion index between 8 and 20; and
S is the non-W qualifying cropland with erosion index greater than 20.

The average per-acre payments and the national allocations by ASM cropland class were:

	ASM class	per acre	acres (millions)	allocation (millions)
P	Pasture	$4.48	112.9	$505.8
W	III-VIII with w	$19.55	33.7	$658.8
L	ei < 8	$18.24	189.1	$3449.2
M	8<=ei<20	$19.79	36.2	$716.4
S	ei >=20	$26.19	9.1	$238.3

The CSP1 payments were also included in the CSP2 and CSP3 scenarios. The intent of CSP2 was to determine the additional economic impact of requiring that erosion is reduced to six tons per-acre on non-HEL and 10 tons per-acre on HEL. This solution should be the same (for resource allocation and management) as CCALL because the CSP1 payments are included only as lump sum transfers. The erosion control aspects of this scenario are set up as in CCALL (that is, by eliminating cropping activities where either wind or water erosion exceeds the specified limits). However, farm income and government payment estimates will be different from CCALL because of the CSP1 payments.

CSP3 is similar to CSP2, except that both water and wind erosion (individually) will be reduced to the soil loss tolerance level for all cropland as a means of simulating implementation of resource management systems.

BC2452 Simultaneous BUF2, CRP45, and CSP2

BC2453 Simultaneous BUF2, CRP45, and CSP3

TABLE C-2.

Farm income implications from National Conservation Program Analysis, average annual changes from current levels

U.S. agricultural sector impact:		buf2	crp45	Till2X	GlrA	GlrV	csp1*	ccall	csp2
Producers	Million $	528.9	1890.20	-5723.60	708.5	596.2	0	-230.7	-230.7
U.S. consumer	Million $	-673.1	-1433.70	383	-641	-543.7	0	-750.5	-750.5
U.S. taxpayers[2]	Million $	523.6	712.9	1801.90	50	50	0	218.4	218.4
Total financial cost[2]	Million $	-667.7	-256.4	-7908.40	17.5	2.5	0	-1199.50	-1199.5
Technical Assistance									
Federal	Million $	125.1	290.9	1158.40	12.6	12.6	0	247.1	278.1
Partner	Million $	0.0	0	786.6	8.5	8.5	0	167.8	188.9
Total technical assistance	Million $	125.1	290.9	1945.00	21.1	21.1	0	414.9	467
Total cost[2]	Million $	792.8	547.3	9853.40	38.6	23.7	0	1614.40	1666.50
Estimated environmental benefits3	Million $	3288.10	1532.80	4960.40	-16.9	-31.3	0	6827.90	6827.90
Benefit cost ratio	Ratio	4.1	2.8	0.5	-0.4	-1.3	0	4.20	4.10
Producers' income	% change	0.81	2.91	-8.8	1.09	0.92	0	-0.35	-0.35
Crop commodity indices:									
Production	Index	99.32	98.12	99.14	99.94	99.95	100	99.57	99.57
Price	Index	101.36	103.62	101.41	100.17	100.12	100	101.19	101.19
Total Cropped Acres	% change	-1.00	-3.50	0.20	-0.10	-0.10	0	-0.50	-0.50
Cropland with new conservation[4]	% change	2.40	2.90	-0.20	-0.20	34.20	0	4.00	4.00
Crops per-acre change (%):									
Variable costs	% change	1.09	3.02	4.74	-0.01	-0.01	0	0.66	0.66
Receipts	% change	1.64	4.88	0.92	0.16	0.06	0	1.34	1.34
Profit	% change	4.04	12.95	-15.61	0.87	0.34	0	4.28	4.28
Crops per-acre change ($):									
Variable costs	$ change	1.82	5.03	7.91	-0.02	-0.01	0	1.10	1.10
Receipts	$ change	3.38	10.02	1.9	0.32	0.12	0	2.75	2.75
Profit	$ change	1.56	4.99	-6.01	0.34	0.13	0	1.65	1.65
Sector change (%):									
Crop	Receipts	0.67	1.68	0.54	0.11	0.07	0	0.75	0.75
Crop	Var. costs	0.19	-0.98	7.32	-0.13	-0.08	0	0.04	0.04
Crop	Profit	3.13	15.38	-34.45	1.35	0.87	0	4.43	4.43
Livestock	Receipts	0.23	-0.12	-0.32	1.41	1.34	0	0.09	0.09
Livestock	Var. costs	-0.02	-0.09	0.10	-0.05	-0.03	0	-0.05	-0.05
Livestock	Profit	0.44	-0.14	-0.71	2.81	2.65	0	0.23	0.23

Appendix C

csp3	bc2452	bc2453	wrp	fpp	whip	fip	reduce resource degradation: glr, wrp, fpp, whip & fip[1]	improve resource health: glr,wrp, fpp, whip & fip
2182.60	3668.6	6285.4	n/a	n/a	n/a	n/a	3668.6	6285.4
-5,084.90	-3040.9	-7209.6	n/a	n/a	n/a	n/a	-3040.9	-7209.6
954.7	1611.10	2257.30	263.5	23.5	41.3	31.3	2020.70	2666.80
-3857.00	-983.4	-3181.50	263.5	23.5	41.3	31.3	-1392.90	-3591.10
1451.50	681.5	1780.70	22.5	5.1	9	6.8	737.4	1836.60
985.6	180.3	926.7	0	0	0	0	188.9	935.2
2437.00	861.8	2707.40	22.5	5.1	9	6.8	926.3	2771.90
6294.00	1845.20	5888.90	286	28.6	50.2	38.1	2319.30	6362.90
10,428.00	7426.10	10,666.50	n/a	n/a	n/a	n/a	7426.10	10,666.50
1.7	4	1.8	n/a	n/a	n/a	n/a	3.2	1.7
3.36	5.64	9.67	n/a	n/a	n/a	n/a	5.64	9.67
97.35	97.45	95.41	n/a	n/a	n/a	n/a	97.45	95.41
108.24	105.69	112.91	n/a	n/a	n/a	n/a	105.69	112.91
-2.00	-4.70	-6.00	n/a	n/a	n/a	n/a	-4.70	-6.00
13.70	6.00	14.70	n/a	n/a	n/a	n/a	6.00	14.70
2.47	4.05	5.93	n/a	n/a	n/a	n/a	4.05	5.93
7.43	7.63	14.19	n/a	n/a	n/a	n/a	7.63	14.19
28.9	23.16	49.95	n/a	n/a	n/a	n/a	23.16	49.95
4.12	6.8	9.9	n/a	n/a	n/a	n/a	6.8	9.9
15.25	15.7	29.1	n/a	n/a	n/a	n/a	15.7	29.1
11.13	8.92	19.25	n/a	n/a	n/a	n/a	8.92	19.25
5.41	3.11	7.83	n/a	n/a	n/a	n/a	3.11	7.83
1.48	-2.11	-0.91	n/a	n/a	n/a	n/a	-2.11	-0.91
25.7	30.04	52.9	n/a	n/a	n/a	n/a	30.04	52.9
0.52	0.79	0.78	n/a	n/a	n/a	n/a	0.79	0.78
-0.19	-0.23	-0.33	n/a	n/a	n/a	n/a	-0.23	-0.33
1.2	1.77	1.84	n/a	n/a	n/a	n/a	1.77	1.84

table continues on next page

TABLE C-2. (continued from previous page)

U.S. agricultural sector impact:		buf2	crp45	Till2X	GlrA	GlrV	csp1*	ccall	csp2
Total	Receipts	0.36	0.46	-0.04	0.99	0.93	0	0.3	0.3
Total	Var. costs	0.07	-0.49	3.35	-0.09	-0.05	0	-0.01	-0.01
Total	Profit	0.8	1.9	-5.15	2.62	2.42	0	0.78	0.78
Sector change (Million $):									
Crop	Receipts	457.5	1145.00	367.2	74.9	49.7	0	514.7	514.7
Crop	Var. costs	110.2	-559.2	4185.80	-74.8	-47.1	0	23.8	23.8
Crop	Profit	347.2	1704.20	-3818.60	149.7	96.8	0	490.9	490.9
Livestock	Receipts	309.4	-166.3	-455.5	2023.10	1919.70	0	128.5	128.5
Livestock	Var. costs	-15.6	-61.1	67.9	-35.8	-21.7	0	-36.6	-36.6
Livestock	Profit	324.9	-105.2	-523.4	2058.90	1941.40	0	165.1	165.1
Total	Receipts	766.9	978.7	-88.3	2098.00	1969.40	0	643.2	643.2
Total	Var. costs	94.7	-620.3	4253.70	-110.7	-68.8	0	-12.8	-12.8
Total	Profit	672.2	1599.00	-4342.00	2208.60	2038.20	0	656	656
Change in cropped acreage	Mil. acres	-3.5	-12.1	0.8	-0.4	-0.2	0		-1.7
Change in cropland rent[5]	$ per acre	2.84	6.51	35.11	0.8	0.8	0		-0.82
Trade surplus	% change	0.01	-1.08	-1.99	0.17	0.08	0	-0.13	-0.13
Trade surplus	Million $	2	-228.8	-423.5	35.9	16.7	0	-28.4	-28.4
Environmental Impacts[6]									
Erosion	% change	n/a	-6.9	-22.3	0.1	0.1	0	-30.7	-30.7
Sediment	% change	-15.6	-6.7	-27.3	0.1	0.1	0	-33.2	-33.2
Total nitrogen	% change	-10.8	-2.8	-7.2	0	0.1	0	-12.5	-12.5
Total phosphorus	% change	-11.7	-4.5	-14.4	0.1	0.1	0	-19.7	-19.7

Footnotes for Tables 5-8, 10-14 and C-2:

* No change in impacts because payments were held constant for each region even though there could be income redistribution to producers in each region who already have fully implemented conservation systems.

n/a not available.

Technical Assistance costs based upon results from the NRCS workload analysis system combined with land treatment needs from Agricultural Sector model.

1 WRP, FPP, WHIP, and FIPcould not be included in the modeling analysis and are not included in benefit estimates for bc2452 and bc2453. ERS estimates a benefit cost ratio of 2.21 for treatments on highly erodible cropland (Economic Research Service 1997).

2 U.S. taxpayer cost represents direct payments to producers for rent and practice installations. Total sector impact equals impact on producers plus consumers less direct payments. Total cost is positive sum of sector impact plus technical assistance.

3 Estimated environmental benefits include soil, water, air quality and wildlife habitat benefits. The analysis presumes that additional acreage retired and conservation treatments are optimally located to maximize environmental benefits. Complete accounting and quantifiable estimates for all environmental benefits are not yet available in the literature. Of benefits currently estimated, wildlife habitat is just over 50 percent, water quality is 35 percent, soil productivity is 10 percent, and air quality is four percent of the total. Arecent analysis of national and regional benefits can be found in Claassen et al. 2001.

Appendix C

csp3	bc2452	bc2453	wrp	fpp	whip	fip	reduce resource degradation: glr, wrp, fpp, whip & fip[1]	improve resource health: glr,wrp, fpp, whip & fip
2.1	1.54	3.05	n/a	n/a	n/a	n/a	1.54	3.05
0.56	-1.07	-0.59	n/a	n/a	n/a	n/a	-1.07	-0.591
4.42	5.48	8.55	n/a	n/a	n/a	n/a	5.48	8.55
3691.60	2124.1	5340.2	n/a	n/a	n/a	n/a	2124.1	5340.2
843.1	-1204	-519.9	n/a	n/a	n/a	n/a	-1204	-519.9
2848.50	3328.1	5860.1	n/a	n/a	n/a	n/a	3328.1	5860.1
747	1135.3	1118	n/a	n/a	n/a	n/a	1135.3	1118
-130	-160.1	-230.2	n/a	n/a	n/a	n/a	-160.1	-230.2
877	1295.4	1348.2	n/a	n/a	n/a	n/a	1295.4	1348.2
4438.60	3259.4	6458.2	n/a	n/a	n/a	n/a	3259.4	6458.2
713.0	-1364.1	-750.1	n/a	n/a	n/a	n/a	-1364.1	-750.1
3725.50	4623.6	7208.3	n/a	n/a	n/a	n/a	4623.6	7208.3
-7.1	-16.5	-20.9	n/a	n/a	n/a	n/a	-16.5	-20.9
5.05	7.82	13.92	n/a	n/a	n/a	n/a	7.82	13.92
-1.07	-1.56	-3.29	n/a	n/a	n/a	n/a	-1.56	-3.29
-227.6	-332.1	-701.9	n/a	n/a	n/a	n/a	-332.1	-701.9
-46.9	-33.4	-47.9	n/a	n/a	n/a	n/a	-33.4	-47.9
-55.5	-35.9	-55.5	n/a	n/a	n/a	n/a	-35.9	-55.5
-15.8	-17.9	-19.6	n/a	n/a	n/a	n/a	-17.9	-19.6
-26.3	-25.7	-31	n/a	n/a	n/a	n/a	-25.7	-31.0

4 Acres with new conservation accounts for conservation tillage, terraces, contouring, strip cropping, or cropland idled to grass (but not in CRP). Does not include soil quality enhancing management practices, nutrient management, rotations, etc.

5 Offset in buffer and CRP scenarios by government rent payments.

6 Buffers to two million miles based upon HUMUS model outcome for estimated delivery to water bodies, all other estimates based upon ASM/EPIC model results for edge of field. WRP and FPP based upon 2001 budget, WHIP and FIP estimated. Partner technical assistance estimated at .679 of federal; CRP, buffers, and WRP are federal only. Total partner technical assistance and financial assistance was $734 million in 2000. Financial assistance needs for till2x, csp2, csp3, bc2452, and bc2453 based on model output for cropland idled to grass, acres of dry, and irrigated land with new conservation tillage, terraces, contouring, or strip cropping practices using the following dollar amounts: $10 per acre for crop idled to grass; $15 per acre for conservation till and other practices. Based upon inflation adjusted ACPaverage.

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