

URBAN AFFAIRS

MAJORS & CAREERS

Section III

ENVIRONMENTAL STUDIES

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ENVIRONMENTAL STUDIES: Environmental Scientists and Hydrologists

Environmental Studies: Environmental Scientists and Hydrologists

Environmental scientists and hydrologists often split their work between offices, laboratories, and field sites.

Federal, State, and local governments employ over half of all environmental scientists and hydrologists.

Although a bachelor's degree in an earth science is adequate for a few entry-level jobs, employers increasingly prefer a master's degree; a Ph.D. degree is required for most high-level research or college teaching positions.

The strongest job growth should be in private-sector consulting firms.

Environmental Studies: Environmental Scientists and Hydrologists: Nature of the Work

Environmental scientists and hydrologists use their knowledge of the physical makeup and history of the Earth to protect the environment, study the properties of underground and surface waters, locate water and energy resources, predict water-related geologic hazards, and offer environmental site assessments and advice on indoor air quality and hazardous-waste-site remediation.

Environmental scientists conduct research to identify and abate or eliminate sources of pollutants or hazards that affect people, wildlife, and their environments. These workers analyze and report measurements or observations of air, food, water, soil, and other sources and make recommendations on how best to clean and preserve the environment. Understanding the issues involved in protecting the environment—degradation, conservation, recycling, and replenishment—is central to the work of environmental scientists, who often use their skills and knowledge to design and monitor waste disposal sites, preserve water supplies, and reclaim contaminated land and water to comply with Federal environmental regulations.

Many environmental scientists do work and have training that is similar to other physical or life scientists, but is applied to environmental areas. Many specialize in some specific area, such as environmental ecology and conservation, environmental chemistry, environmental biology, or fisheries science. Most environmental scientists are further classified by the specific activity they perform, although recent advances in the understanding of basic life processes within the ecosystem have blurred some traditional classifications. For example, *environmental ecologists* study the relationships between organisms and their environments and the effects of influences such as population size, pollutants, rainfall, temperature, and altitude. Utilizing their knowledge of various scientific disciplines, they may collect, study, and report data on air, food, soil, and water. *Ecological modelers* study ecosystems, the control of environmental pollution, and the

management of resources. These environmental scientists may use mathematical modeling, systems analysis, thermodynamics, and computer techniques. *Environmental chemists* may study the toxicity of various chemicals—how those chemicals affect plants, animals, and people.

Hydrologists study the quantity, distribution, circulation, and physical properties of underground and surface waters. Often, they specialize in either underground water or surface water. They examine the form and intensity of precipitation, its rate of infiltration into the soil, its movement through the earth, and its return to the ocean and atmosphere. Hydrologists use sophisticated techniques and instruments. For example, they may use remote sensing technology, data assimilation, and numerical modeling to monitor the change in regional and global water cycles. Some surface-water hydrologists use sensitive stream-measuring devices to assess flow rates and the quality of water. The work hydrologists do is particularly important in flood control and environmental preservation, including ground-water decontamination.

Many environmental scientists and hydrologists work at consulting firms, advising and helping businesses and government agencies comply with environmental policy, particularly with regard to ground-water decontamination and flood control. Environmental scientists and hydrologists at consulting firms are generally hired to solve problems. Most firms fall into two categories: large multidisciplinary engineering companies, the largest of which may employ more than 15,000 workers, and small niche firms that may employ fewer than 50 workers. When entering the field, prospects should consider the type of firm and the scope of the projects it undertakes. In larger firms, environmental scientists are more likely to engage in large, long-term projects in which their role will mesh with those of workers in other scientific disciplines. In smaller specialty firms, however, they may be responsible for many skills beyond traditional environmental disciplines, such as working with environmental laws and regulations, making environmental risk assessments, writing technical proposals, giving presentations to managers and regulators, and working with other specialists on a variety of issues, including engineering remediation.

Environmental scientists who determine policy may help identify how human behavior can be modified in the future to avoid such problems as ground-water contamination and depletion of the ozone layer. Some environmental scientists work in managerial positions, usually after spending some time performing research or learning about environmental laws and regulations. (Information on [geoscientists](#), whose work is closely related to that of environmental scientists and hydrologists, is located elsewhere in the *Handbook*.)

Environmental Studies: Environmental Scientists and Hydrologists: Working Conditions

Most entry-level environmental scientists and hydrologists spend the majority of their time in the field, while more experienced workers generally devote more of their time to office or laboratory work. Many beginning hydrologists and some environmental

scientists, such as environmental ecologists and environmental chemists, often take field trips that involve physical activity. Environmental scientists and hydrologists in the field may work in warm or cold climates, in all kinds of weather. In their research, they may dig or chip with a hammer, scoop with a net, come in contact with water, and carry equipment in a backpack. Travel often is required to meet with prospective clients or investors. Those in laboratories may conduct tests, run experiments, record results, and compile data.

Environmental scientists and hydrologists in research positions with the Federal Government or in colleges and universities frequently are required to design programs and write grant proposals in order to continue their data collection and research. Environmental scientists and hydrologists in consulting jobs face similar pressures to market their skills and write proposals so that they will have steady work. Occasionally, those who write technical reports to business clients and regulators may be under pressure to meet deadlines.

Environmental Studies: Environmental Scientists and Hydrologists: Training, Other Qualifications, and Advancements

A bachelor's degree is adequate for a few entry-level positions, but environmental scientists are increasingly needing a master's degree in a natural science. A master's degree also is the minimum educational requirement for most entry-level applied research positions in private industry, in State and Federal agencies, and at State geological surveys. A doctoral degree is necessary for college teaching and most high-level research positions.

Many environmental scientists earn degrees in life science, chemistry, geology, geophysics, atmospheric science, or physics and then, either through further education or through their research interests and work experience, apply their education to environmental areas. Others earn a degree in environmental science. A bachelor's degree in environmental science offers an interdisciplinary approach to the natural sciences, with an emphasis on biology, chemistry, and geology. In addition, undergraduate environmental science majors should focus on data analysis and physical geography, particularly if they are interested in studying pollution abatement, water resources, or ecosystem protection, restoration, or management. Understanding the geochemistry of inorganic compounds is becoming increasingly important in developing remediation goals. Those students interested in working in the environmental or regulatory fields, either in environmental consulting firms or for Federal or State governments, should take courses in hydrology, hazardous-waste management, environmental legislation, chemistry, fluid mechanics, and geologic logging. An understanding of environmental regulations and government permit issues also is valuable for those planning to work in mining and oil and gas extraction.

Students interested in the field of hydrology should take courses in the physical sciences, geophysics, chemistry, engineering science, soil science, mathematics, aquatic biology, atmospheric science, geology, oceanography, hydrogeology, and the management or

conservation of water resources. In some cases, graduates with a bachelor's degree in a hydrologic science are qualified for positions in environmental consulting and planning regarding water quality or wastewater treatment. Curricula for advanced degrees often emphasize the natural sciences, but not all universities offer all curricula.

The American Institute of Hydrology offers certification programs in professional hydrology. Certification is recommended for those seeking advancement and for those seeking to upgrade their knowledge.

For environmental scientists and hydrologists who enter the field of consulting, courses in business, finance, marketing, or economics may be useful. In addition, combining environmental science training with other disciplines such as engineering, or a technical degree coupled with a master's degree in business administration, qualifies these scientists for the widest range of jobs. Environmental scientists and hydrologists also should have some knowledge of the potential liabilities associated with some environmental work.

Computer skills are essential for prospective environmental scientists and hydrologists. Students who have some experience with computer modeling, data analysis and integration, digital mapping, remote sensing, and geographic information systems will be the most prepared to enter the job market. A knowledge of the Geographic Information System (GIS) and Global Positioning System (GPS)—a locator system that uses satellites—is vital.

Environmental scientists and hydrologists must have excellent interpersonal skills, because they usually work as part of a team with other scientists, engineers, and technicians. Strong oral and written communication skills also are essential, because writing technical reports and research proposals and communicating technical and research results to company managers, regulators, and the public are important aspects of the work. Those involved in fieldwork must have physical stamina.

Environmental scientists and hydrologists often begin their careers in field exploration or, occasionally, as research assistants or technicians in laboratories or offices. They are given more difficult assignments as they gain experience. Eventually, they may be promoted to project leader, program manager, or some other management and research position.

Because international work is becoming increasingly pervasive, knowledge of a second language can be a valuable skill to employers.

Environmental Studies: Environmental Scientists and Hydrologists: Employment

Environmental scientists and hydrologists held about 81,000 jobs in 2004. Jobs for hydrologists accounted for only 10 percent of the total. Many more individuals held environmental science faculty positions in colleges and universities, but they are

classified as college and university faculty. (See the statement on [teachers—postsecondary](#) elsewhere in the *Handbook*.)

About 44 percent of environmental scientists were employed in State and local governments; 15 percent in management, scientific, and technical consulting services; 14 percent in architectural, engineering and related services; and 8 percent in the Federal Government. About 5 percent were self-employed.

Among hydrologists, 22 percent were employed in architectural, engineering, and related services, and 18 percent worked for management, scientific, and technical consulting services. In 2004, the Federal Government employed about 2,500 hydrologists, mostly within the U.S. Department of the Interior for the U.S. Geological Survey (USGS) and within the U.S. Department of Defense. Another 15 percent worked for State agencies, such as State geological surveys and State departments of conservation. About 5 percent of hydrologists were self-employed, most as consultants to industry or government.

Environmental Studies: Environmental Scientists and Hydrologists: Job Outlook

Employment of environmental scientists is expected to grow about as fast as the average for all occupations through 2014, while employment of hydrologists should [grow much faster than average](#). Job growth for environmental scientists and hydrologists should be strongest at private-sector consulting firms. Demand for environmental scientists and hydrologists will be spurred largely by public policy, which will oblige companies and organizations to comply with complex environmental laws and regulations, particularly those regarding ground-water decontamination, clean air, and flood control.

Job opportunities also will be spurred by a continued general awareness regarding the need to monitor the quality of the environment, to interpret the impact of human actions on terrestrial and aquatic ecosystems, and to develop strategies for restoring ecosystems.

Many environmental scientists and hydrologists work in consulting. Consulting firms have hired these scientists to advise and help businesses and government comply with new regulations on issues related to underground tanks, land disposal areas, and other hazardous-waste-management facilities. Currently, environmental consulting is maturing and evolving from investigations to remediation and engineering solutions. At the same time, the regulatory climate is evolving from a rigid structure to a more flexible risk-based approach. These factors, coupled with new Federal and State initiatives that integrate environmental activities into the business process itself, will result in a greater focus on waste minimization, resource recovery, pollution prevention, and the consideration of environmental effects during product development. This shift in focus from reactive solutions to preventive management will provide many new opportunities for environmental scientists and hydrologists in consulting roles.

Some opportunities are expected for environmental scientists at State geological surveys, stemming from the need to conduct environmental site assessments for local governments to help improve the flow of railroad and automobile traffic in urban areas. In addition,

environmental scientists will be needed to help planners and communities develop and construct buildings, transportation corridors, and utilities that protect water resources and reflect efficient and beneficial land use.

Opportunities will be better for hydrologists as the population increases and moves to more environmentally sensitive locations. For example, as people increasingly migrate toward coastal regions, hydrologists will be needed to assess building sites for potential geologic hazards and to mitigate the effects of natural hazards such as floods and landslides. Hydrologists also will be needed to conduct research on hazardous-waste sites in order to determine the impact of hazardous pollutants on soil and ground water so that engineers can design remediation systems. Demand is growing for hydrologists who understand both the scientific and engineering aspects of waste remediation. As States design initiatives to improve water resources by preventing pollution, there should be opportunities for hydrologists in State government. Increased government regulations, such as those regarding the management of storm water, and issues related to water conservation, deteriorating coastal environments, and rising sea levels also will stimulate employment growth for these workers.

Federal and State geological surveys depend to a large extent on the public climate and the current budget. Thus, job security for environmental scientists and hydrologists within a State survey may be cyclical. During periods of economic recession, layoffs of environmental scientists and hydrologists may occur in consulting firms; layoffs are much less likely in government.

Environmental Studies: Environmental Scientists and Hydrologists: Earnings

Median annual earnings of environmental scientists were \$51,080 in May 2004. The middle 50 percent earned between \$39,100 and \$67,360. The lowest 10 percent earned less than \$31,610, and the highest 10 percent earned more than \$85,940.

Median annual earnings of hydrologists were \$61,510 in May 2004, with the middle 50 percent earning between \$47,080 and \$77,910, the lowest 10 percent earning less than \$38,580, and the highest 10 percent earning more than \$94,460.

Median annual earnings in the industries employing the largest number of environmental scientists in May 2004 were as follows:

Federal Government	\$73,530
Management, scientific, and technical consulting services	51,190
Architectural, engineering, and related services	49,160
Local government	48,870
State government	46,850

According to the National Association of Colleges and Employers, beginning salary offers in July 2005 for graduates with bachelor's degrees in an environmental science averaged \$31,366 a year.

In 2005, the Federal Government's average salary for hydrologists in managerial, supervisory, and nonsupervisory positions was \$77,182.

ENVIRONMENTAL STUDIES: Conservation Scientists and Foresters

Environmental Studies: Conservation Scientists and Foresters

About two thirds of salaried conservation scientists and foresters work for Federal, State, or local governments.

A bachelor's degree in forestry, range management, or a related discipline is the minimum educational requirement.

Slower than average job growth is projected; most new jobs will be in State and local governments and in private sector forestry and conservation consulting.

Environmental Studies: Conservation Scientists and Foresters: Nature of the Work

Forests and rangelands supply wood products, livestock forage, minerals, and water; serve as sites for recreational activities; and provide habitats for wildlife.

Conservation scientists and foresters manage their use and development and help to protect these and other natural resources, and for this reason are becoming known as natural resource managers.

Foresters manage forested lands for a variety of purposes. Those working in private industry may manage company-owned forest land or procure timber from private landowners. Company forests usually are managed to produce a sustainable supply of wood for company mills. *Procurement foresters* contact local forest owners and gain permission to take inventory of the type, amount, and location of all standing timber on the property, a process known as timber cruising. These foresters then appraise the timber's worth, negotiate its purchase, and draw up a contract for procurement. Next, they subcontract with loggers or pulpwood cutters for tree removal and aid in laying out roads to access the timber. Throughout the process, foresters maintain close contact with the subcontractor's workers and the landowner to ensure that the work meets the landowner's requirements, as well as Federal, State, and local environmental specifications. Forestry consultants often act as agents for forest owners, monitoring the

growth of the timber on the owners' property and negotiating timber sales with industrial procurement foresters.

Foresters, referred to as *land management foresters*, work for both government and private industry and manage and protect the forests and supervise harvests. These foresters supervise the planting and growing of new trees, called regeneration. They choose and direct the preparation of the site using controlled burning, bulldozers, or herbicides to clear weeds, brush, and logging debris. They advise on the type, number, and placement of trees to be planted. Foresters then monitor the seedlings to ensure healthy growth and to determine the best time for harvesting. If they detect signs of disease or harmful insects, they consult with specialists in forest pest management to decide on the best course of treatment. They may also design campgrounds and recreation areas on public lands.

Throughout the forest management and procurement processes, foresters consider the economics as well as the environmental impact on natural resources. To do this, they determine how to conserve wildlife habitats, creek beds, water quality, and soil stability, and how best to comply with environmental regulations. Foresters must balance the desire to conserve forested ecosystems for future generations with the need to use forest resources for recreational or economic purposes.

Foresters use a number of tools to perform their jobs. Clinometers measure the height of trees; diameter tapes measure the diameter; and increment borers and bark gauges measure the growth of trees so that timber volumes can be computed and growth rates estimated. Remote sensing (aerial photographs and other imagery taken from airplanes and satellites) and Geographic Information Systems (GIS) data often are used for mapping large forest areas and for detecting widespread trends of forest and land use. Once the map is generated, the data are digitized to create a computerized inventory of information required to manage the forest land and its resources. Moreover, hand-held computers, Global Positioning Systems (GPS), and World Wide Web-based applications are used extensively.

Conservation scientists manage, improve, and protect the country's natural resources. They work with the landowners and Federal, State, and local governments to devise ways to use and improve the land without damaging the environment. Although conservation scientists mainly advise farmers, farm managers, and ranchers on ways they can improve their land for agricultural purposes and to control erosion, a growing number are advising landowners and governments on recreational uses for the land.

Two of the more common conservation scientists are range managers and soil conservationists. *Range managers*, also called *range conservationists*, *range ecologists*, or *range scientists*, study, manage, improve, and protect rangelands to maximize their use without damaging the environment. Rangelands cover hundreds of millions of acres of the United States, mostly in Western States and Alaska. They contain many natural resources, including grass and shrubs for animal grazing, wildlife habitats, water from vast watersheds, recreation facilities, and valuable mineral and energy resources. Range

managers may inventory soils, plants, and animals, develop resource management plans, help to restore degraded ecosystems, or assist in managing a ranch. For example, they may help ranchers attain optimum livestock production by determining the number and kind of animals to graze, the grazing system to use, and the best season for grazing. At the same time, however, range managers maintain soil stability and vegetation for other uses such as wildlife habitats and outdoor recreation. They also plan and implement revegetation of disturbed sites.

Soil and water conservationists provide technical assistance to farmers, ranchers, forest managers, State and local agencies, and others concerned with the conservation of soil, water, and related natural resources. They develop programs for private landowners designed to make the most productive use of land without damaging it. Soil conservationists also assist landowners by visiting areas with erosion problems, finding the source of the problem, and helping landowners and managers develop management practices to combat it. Water conservationists also assist private landowners and Federal, State, and local governments by advising on a broad range of natural resource topics—specifically, issues of water quality, preserving water supplies, groundwater contamination, and management and conservation of water resources.

Conservation scientists and foresters often specialize in one area, such as wildlife management, urban forestry, pest management, native species, or forest economics.

Environmental Studies: Conservation Scientists and Foresters: Working Conditions

Working conditions vary considerably. Although some of the work is solitary, foresters and conservation scientists also deal regularly with landowners, loggers, forestry technicians and aides, farmers, ranchers, government officials, special interest groups, and the public in general. Some foresters and conservation scientists work regular hours in offices or labs. Others may split their time between fieldwork and office work, while independent consultants and especially new, less experienced workers spend the majority of their time outdoors overseeing or participating in hands-on work.

The work can be physically demanding. Some conservation scientists and foresters work outdoors in all types of weather, sometimes in isolated areas, and consequently may need to walk long distances through densely wooded land to carry out their work. Foresters also may work long hours fighting fires. Conservation scientists often are called to prevent erosion after a forest fire, and they provide emergency help after floods, mudslides, and tropical storms.

Environmental Studies: Conservation Scientists and Foresters: Training, Other Qualifications, and Advancement

A bachelor's degree in forestry, biology, natural resource management, environmental sciences, or a related discipline is the minimum educational requirement for careers in forestry or conservation science. In the Federal Government, a combination of experience

and appropriate education occasionally may substitute for a 4-year forestry degree, but job competition makes this difficult. Foresters who wish to perform specialized research or teach should have an advanced degree, preferably a Ph.D.

Seventeen States have mandatory licensing and/or voluntary registration requirements that a forester must meet in order to acquire the title “professional forester” and practice forestry in the State. Of those 17 States, 9 have mandatory licensing; 8 have mandatory registration. Both licensing and registration requirements usually entail completing a 4-year degree in forestry and several years of forestry work experience. Candidates pursuing licensing also may be required to pass a comprehensive written exam.

Most land-grant colleges and universities offer a bachelor’s or higher degree in forestry. The Society of American Foresters accredits about 48 such programs throughout the country. Curriculums stress four components: Forest ecology and biology, measurement of forest resources, management of forest resources, and public policy. Students should balance general science courses such as ecology, biology, tree physiology, taxonomy, and soil formation with technical forestry courses, such as forest inventory or wildlife habitat assessment, remote sensing, land surveying, GPS technology, integrated forest resource management, silviculture, and forest protection. In addition mathematics, statistics, and computer science courses also are recommended. Many forestry curriculums include advanced computer applications such as GIS and resource assessment programs. Courses in resource policy and administration, specifically forest economics and business administration, supplement the student’s scientific and technical knowledge. Forestry curriculums increasingly include courses on best management practices, wetlands analysis, and sustainability and regulatory issues in response to the growing focus on protecting forested lands during timber harvesting operations. Prospective foresters should have a strong grasp of Federal, State, and local policy issues and of increasingly numerous and complex environmental regulations that affect many forestry-related activities. Many colleges require students to complete a field session either in a camp operated by the college or in a cooperative work-study program with a Federal or State agency or with private industry. All schools encourage students to take summer jobs that provide experience in forestry or conservation work.

Conservation scientists generally hold a minimum of a bachelor’s degree in fields such as: ecology, natural resource management, agriculture, biology, environmental science, or related field. A master’s or Ph.D. degree is usually required for teaching and research positions.

Range managers usually have a degree in range management or range science. Nine colleges and universities offer degrees in range management that are accredited by the Society of Range Management. More than forty other schools offer course work in range science or in a closely related discipline offering a range management or range science option. Specialized range management courses combine plant, animal, and soil sciences with principles of ecology and resource management. Desirable electives include economics, statistics, forestry, hydrology, agronomy, wildlife, animal husbandry, computer science, and recreation. Selection of a minor in range management, such as

wildlife ecology, watershed management, animal science, or agricultural economics, can often enhance qualifications for certain types of employment.

The Society for Range Management offers two types of certification: one as a certified professional in rangeland management (CPRM) and another as a certified range management Consultant. Candidates seeking certification must have at least a bachelor's degree in range science or a closely related field, have a minimum of 6 years of full-time work experience, and pass a comprehensive written exam.

The Society of American Foresters has a Certified Forester Program. To become certified through this program, a candidate must graduate with at least a bachelor's degree from a forestry program accredited by the Society, or from a forestry program that, though not accredited by the Society, is substantially equivalent. In addition, the candidate must have five years of qualifying professional experience and pass an examination.

Additionally, a graduate with the proper coursework in college can seek certification as a wetland scientist through the Society of Wetland Scientists, and certification as a professional wildlife biologist through the Wildlife Society.

Very few colleges and universities offer degrees in soil conservation. Most soil conservationists have degrees in environmental studies, agronomy, general agriculture, hydrology, or crop or soil science; a few have degrees in related fields such as wildlife biology, forestry, and range management. Programs of study usually include 30 semester hours in natural resources or agriculture, including at least 3 hours in soil science.

In addition to meeting the demands of forestry and conservation research and analysis, foresters and conservation scientists generally must enjoy working outdoors, be able to tolerate extensive walking and other types of physical exertion, and be willing to move to where the jobs are. They also must work well with people and have good communication skills.

Recent forestry and conservation scientist graduates usually work under the supervision of experienced foresters or scientists. After gaining experience, they may advance to more responsible positions. In the Federal Government, most entry-level foresters work in forest resource management. An experienced Federal forester may supervise a ranger district, and may advance to forest supervisor, to regional forester, or to a top administrative position in the national headquarters. In private industry, foresters start by learning the practical and administrative aspects of the business and acquiring comprehensive technical training. They are then introduced to contract writing, timber harvesting, and decisionmaking. Some foresters work their way up to top managerial positions within their companies. Foresters in management usually leave the fieldwork behind, spending more of their time in an office, working with teams to develop management plans and supervising others. After gaining several years of experience, some foresters may become consulting foresters, working alone or with one or several partners. They contract with State or local governments, private landowners, private industry, or other forestry consulting groups.

Soil conservationists usually begin working within one county or conservation district and, with experience, may advance to the area, State, regional, or national level. Also, soil conservationists can transfer to related occupations, such as farm or ranch management advisor or land appraiser.

Environmental Studies: Conservation Scientists and Foresters: Employment

Conservation scientists and foresters held about 32,000 jobs in 2004. More than 1 in 3 workers were employed by the Federal Government, mostly in the U.S. Departments of Agriculture (USDA) and Interior. Foresters were concentrated in the USDA's Forest Service; soil conservationists were employed primarily in the USDA's Natural Resource Conservation Service. Most range managers worked in the U.S. Department of the Interior's Bureau of Land Management, the Natural Resource Conservation Service, or the Forest Service. Another 21 percent of conservation scientists and foresters worked for State governments, and about 11 percent worked for local governments. The remainder worked in private industry, mainly in support activities for agriculture and forestry or in wood product manufacturing. Some were self-employed as consultants for private landowners, Federal and State governments, and forestry-related businesses.

Although Conservation scientists and foresters work in every State, employment of foresters is concentrated in the Western and Southeastern States, where many national and private forests and parks, and most of the lumber and pulpwood-producing forests, are located. Range managers work almost entirely in the Western States, where most of the rangeland is located. Soil conservationists, on the other hand, are employed in almost every county in the country. Besides the jobs described above, some foresters and conservation scientists held faculty positions in colleges and universities. (See the section on [teachers—postsecondary](#) elsewhere in the *Handbook*.)

Environmental Studies: Conservation Scientists and Foresters: Job Outlook

Employment of conservation scientists and foresters is expected to [increase more slowly than the average](#) for all occupations through 2014. Growth should be strongest in private sector consulting firms. Demand will be spurred by a continuing emphasis on environmental protection, responsible land management, and water-related issues. Growing interest in developing private lands and forests for recreational purposes will generate additional jobs for foresters and conservation scientists. Fire prevention is another area of growth for these two occupations.

Job opportunities for conservation scientists will arise because government regulations, such as those regarding the management of storm water and coastlines, have created demand for persons knowledgeable about runoff and erosion on farms and in cities and suburbs. Soil and water quality experts will be needed as States design initiatives to improve water resources by preventing pollution by agricultural producers and industrial plants.

Overall employment of conservation scientists and foresters is expected to decline slightly in Federal Government, mostly because of budgetary constraints and the trend among all levels of government toward contracting these functions out to private consulting firms. Also, Federal land management agencies, such as the USDA Forest Service, have de-emphasized their timber programs and increasingly focused on wildlife, recreation, and sustaining ecosystems, thereby spurring demand for other life and social scientists rather than for foresters. However, departures of foresters who retire or leave the Government for other reasons will result in many job openings. Additionally, State governments are expected to increase their hiring of conservation scientists and foresters as their budgetary situations improve. A small number of new jobs will result from the need for range and soil conservationists to provide technical assistance to owners of grazing land through the Natural Resource Conservation Service.

Foresters involved with timber harvesting will find good opportunities in the Southeast, where much forested land is privately owned. However, the recent opening of public lands, especially in the West, to commercial activity will also help the outlook for foresters. Salaried foresters working for private industry—such as paper companies, sawmills, and pulpwood mills—and consulting foresters will be needed to provide technical assistance and management plans to landowners.

Scientific research and development services have increased their hiring of conservation scientists and foresters in recent years in response to demand for professionals to prepare environmental impact statements and erosion and sediment control plans, monitor water quality near logging sites, and advise on tree harvesting practices required by Federal, State, or local regulations. Hiring in these firms should continue during the 2004-14 period.

Environmental Studies: Conservation Scientists and Foresters: Earnings

Median annual earnings of conservation scientists in May 2004 were \$52,480. The middle 50 percent earned between \$39,660 and \$65,550. The lowest 10 percent earned less than \$30,740, and the highest 10 percent earned more than \$78,470.

Median annual earnings of foresters in 2004 were \$48,230. The middle 50 percent earned between \$37,260 and \$60,500. The lowest 10 percent earned less than \$29,770, and the highest 10 percent earned more than \$72,050.

In 2005, most bachelor's degree graduates entering the Federal Government as foresters, range managers, or soil conservationists started at \$24,677 or \$30,567, depending on academic achievement. Those with a master's degree could start at \$37,390 or \$45,239. Holders of doctorates could start at \$54,221. Beginning salaries were slightly higher in selected areas where the prevailing local pay level was higher. In 2005, the average Federal salary for foresters in nonsupervisory, supervisory, and managerial positions was \$63,492; for soil conservationists, \$60,671; and for rangeland managers, \$58,162.

According to the National Association of Colleges and Employers, graduates with a bachelor's degree in conservation and renewable natural resources received an average starting salary offer of \$27,950 in 2005.

In private industry, starting salaries for students with a bachelor's degree were comparable with starting salaries in the Federal Government, but starting salaries in State and local governments were usually lower.

Conservation scientists and foresters who work for Federal, State, and local governments and large private firms generally receive more generous benefits than do those working for smaller firms.

ENVIRONMENTAL STUDIES: Geoscientists

Environmental Studies: Geoscientists

Work at remote field sites is common.

Federal, State, and local governments employ 24 percent of all geoscientists.

A master's degree is usually the minimum educational requirement; a Ph.D. degree is required for most high-level research and college teaching positions.

Although employment of geoscientists is expected to grow more slowly than average, good job opportunities are expected in most areas of geosciences.

Environmental Studies: Geoscientists: Nature of the Work

Geoscientists study the composition, structure, and other physical aspects of the Earth. With the use of sophisticated instruments and by analyzing the composition of the earth and water, geoscientists study the Earth's geologic past and present. Many geoscientists are involved in searching for adequate supplies of natural resources such as groundwater, metals, and petroleum, while others work closely with environmental and other scientists in preserving and cleaning up the environment.

Geoscientists usually study, and are subsequently classified into, one of several closely related fields of geoscience. *Geologists* study the composition, processes, and history of the Earth. They try to find out how rocks were formed and what has happened to them since their formation. They also study the evolution of life by analyzing plant and animal fossils. *Geophysicists* use the principles of physics, mathematics, and chemistry to study not only the Earth's surface, but also its internal composition; ground and surface waters; atmosphere; oceans; and magnetic, electrical, and gravitational forces.

Oceanographers use their knowledge of geology and geophysics, in addition to biology and chemistry, to study the world's oceans and coastal waters. They study the motion and circulation of the ocean waters; the physical and chemical properties of the oceans; and how these properties affect coastal areas, climate, and weather. Oceanographers are further broken down according to their areas of expertise. For example, *physical oceanographers* study the tides, waves, currents, temperatures, density, and salinity of the ocean. They examine the interaction of various forms of energy, such as light, radar, sound, heat, and wind, with the sea, in addition to investigating the relationship between the sea, weather, and climate. *Chemical oceanographers* study the distribution of chemical compounds and chemical interactions that occur in the ocean and on the sea floor. They may investigate how pollution affects the chemistry of the ocean. *Geological and geophysical oceanographers* study the topographic features and the physical makeup of the ocean floor. Their knowledge can help companies find oil and gas off coastal waters. (*Biological oceanographers*, often called marine biologists, study the distribution and migration patterns of the many diverse forms of sea life in the ocean, but because they are considered biological scientists, they are not covered in this statement on geoscientists. See the statement on [biological scientists](#) elsewhere in the *Handbook*.)

Geoscientists can spend a large part of their time in the field, identifying and examining rocks, studying information collected by remote sensing instruments in satellites, conducting geological surveys, constructing field maps, and using instruments to measure the Earth's gravity and magnetic field. For example, they often perform seismic studies, which involve bouncing energy waves off buried layers of rock, to search for oil and gas or to understand the structure of the subsurface layers. Seismic signals generated by an earthquake are used to determine the earthquake's location and intensity. In laboratories, geologists and geophysicists examine the chemical and physical properties of specimens. They study fossil remains of animal and plant life or experiment with the flow of water and oil through rocks.

Numerous specialties that further differentiate the type of work geoscientists do fall under the two major disciplines of geology and geophysics. For example, *petroleum geologists* map the subsurface of the ocean or land as they explore the terrain for oil and gas deposits. They use sophisticated geophysical instrumentation and computers to interpret geological information. *Engineering geologists* apply geologic principles to the fields of civil and environmental engineering, offering advice on major construction projects and assisting in environmental remediation and natural hazard-reduction projects. *Mineralogists* analyze and classify minerals and precious stones according to their composition and structure. They study the environment surrounding rocks in order to find new mineral resources. *Sedimentologists* study the nature, origin, distribution, and alteration of sediments, such as sand, silt, and mud. These sediments may contain oil, gas, coal, and many other mineral deposits. *Paleontologists* study fossils found in geological formations to trace the evolution of plant and animal life and the geologic history of the Earth. *Stratigraphers* examine the formation and layering of rocks to understand the environment in which they were formed. *Volcanologists* investigate volcanoes and volcanic phenomena to try to predict the potential for future eruptions and hazards to human health and welfare. *Glacial geologists* study the physical properties and

movement of glaciers and ice sheets. *Geochemists* study the nature and distribution of chemical elements in groundwater and earth materials.

Geophysicists specialize in areas such as geodesy, seismology, and magnetic geophysics. *Geodesists* study the Earth's size, shape, gravitational field, tides, polar motion, and rotation. *Seismologists* interpret data from seismographs and other geophysical instruments to detect earthquakes and locate earthquake-related faults. *Geomagnetists* measure the Earth's magnetic field and use measurements taken over the past few centuries to devise theoretical models that explain the Earth's origin. *Paleomagnetists* interpret fossil magnetization in rocks and sediments from the continents and oceans to record the spreading of the sea floor, the wandering of the continents, and the many reversals of polarity that the Earth's magnetic field has undergone through time. Other geophysicists study atmospheric sciences and space physics. (See the statement on [atmospheric scientists](#), and [physicists and astronomers](#), elsewhere in the *Handbook*.)

Environmental Studies: Geoscientists: Working Conditions

Some geoscientists spend the majority of their time in an office, but many others divide their time between fieldwork and office or laboratory work. Work at remote field sites is common. Many geoscientists, such as volcanologists, often take field trips that involve physical activity. Geoscientists in the field may work in warm or cold climates and in all kinds of weather. In their research, they may dig or chip with a hammer, scoop with a net, and carry equipment in a backpack. Oceanographers may spend considerable time at sea on academic research ships. Fieldwork often requires working long hours. Geologists frequently travel to remote field sites by helicopter or four-wheel-drive vehicles and cover large areas on foot. An increasing number of exploration geologists and geophysicists work in foreign countries, sometimes in remote areas and under difficult conditions. Travel often is required to meet with prospective clients or investors.

Geoscientists in research positions with the Federal Government or in colleges and universities frequently are required to design programs and write grant proposals in order to continue their data collection and research. Geoscientists in consulting jobs face similar pressures to market their skills and write proposals so that they will have steady work.

Environmental Studies: Geoscientists: Training, Other Qualifications, and Advancement

A bachelor's degree is adequate for a few entry-level positions, but most geoscientists need at least a master's degree in general geology or earth science. A master's degree also is the minimum educational requirement for most entry-level research positions in private industry, Federal agencies, and State geological surveys. A Ph.D. degree is necessary for most high-level research and college teaching positions.

Many colleges and universities offer a bachelor's or higher degree in a geoscience. In 2005, more than 100 universities offered accredited bachelor's degree programs in

geoscience, about 80 universities had master's degree programs, and about 60 offered doctoral degree programs.

Traditional geoscience courses emphasizing classical geologic methods and topics (such as mineralogy, petrology, paleontology, stratigraphy, and structural geology) are important for all geoscientists. Persons studying physics, chemistry, biology, mathematics, engineering, or computer science may also qualify for some geoscience positions if their course work includes study in geology or natural sciences.

Computer skills are essential for prospective geoscientists; students who have experience with computer modeling, data analysis and integration, digital mapping, remote sensing, and geographic information systems will be the most prepared entering the job market. A knowledge of the Global Information System (GIS) and Global Positioning System (GPS)—a locator system that uses satellites—has also become essential. Some employers seek applicants with field experience, so a summer internship may be beneficial to prospective geoscientists.

Geoscientists must have excellent interpersonal skills, because they usually work as part of a team with other geoscientists and with environmental scientists, engineers, and technicians. Strong oral and written communication skills also are important, because writing technical reports and research proposals, as well as communicating research results to others, are important aspects of the work. Because many jobs require foreign travel, knowledge of a second language is becoming an important attribute to employers. Geoscientists must be inquisitive, be able to think logically, and be capable of complex analytical thinking, including spatial visualization and the ability to develop comprehensive conclusions often from sparse data. Those involved in fieldwork must have physical stamina.

Geoscientists often begin their careers in field exploration or as research assistants or technicians in laboratories or offices. They are given more difficult assignments as they gain experience. Eventually, they may be promoted to project leader, program manager, or some other management or research position.

Environmental Studies: Geoscientists: Employment

Geoscientists held about 28,000 jobs in 2004. Many more individuals held geoscience faculty positions in colleges and universities, but they are classified as college and university faculty. (See the statement on [teachers—postsecondary](#) elsewhere in the *Handbook*.)

About 25 percent of geoscientists were employed in architectural, engineering, and related services, and 20 percent worked for oil and gas extraction companies. In 2004, State agencies such as State geological surveys and State departments of conservation employed about 3,600 geoscientists. Another 2,900 worked for the Federal Government, including geologists, geophysicists, and oceanographers, mostly within the U.S. Department of the Interior for the U.S. Geological Survey (USGS) and within the U.S.

Department of Defense. About 5 percent of geoscientists were self-employed, most as consultants to industry or government.

Environmental Studies: Geoscientists: Job Outlook

Although employment growth will vary by occupational specialty, overall employment of geoscientists is expected to grow [more slowly than average](#) for all occupations through 2014. However, due to the relatively low number of qualified geoscience graduates and the large number of expected retirements, opportunities are expected to be good in most areas of geoscience.

Graduates with a master's degree may have the best opportunities. Those with a Ph.D. who wish to become college and university faculty or to do advanced research may face competition. There are few openings for graduates with only a bachelor's degree in geoscience, but these graduates may find excellent opportunities as high school science teachers. They also can become science technicians, or enter a wide variety of related occupations.

Few opportunities for geoscientists are expected in Federal and State Government, mostly because of budgetary constraints at key agencies, such as the USGS, and the trend among governments toward contracting out to consulting firms. However, departures of geoscientists who retire or leave the Government for other reasons will result in some job openings over the next decade. A small number of new jobs will result from the need for oceanographers to conduct research for the military or for Federal agencies such as the National Oceanic and Atmospheric Administration (NOAA) on issues related to maintaining healthy and productive oceans.

Many geoscientists work in the exploration and production of oil and gas. Historically, employment of petroleum geologists, geophysicists, and some other geoscientists has been cyclical and affected considerably by the price of oil and gas. When prices were low, oil and gas producers curtailed exploration activities and laid off geologists. When prices were higher, companies had the funds and incentive to renew exploration efforts and hire geoscientists in larger numbers. In recent years, a growing worldwide demand for oil and gas and for new exploration and recovery techniques—particularly in deep water and previously inaccessible sites in Alaska and the Gulf of Mexico—has returned some stability to the petroleum industry. Growth in this area, though, will be limited due to increasing efficiencies in finding oil and gas. geoscientists who speak a foreign language and who are willing to work abroad should enjoy the best opportunities, as the need for energy, construction materials, and a broad range of geoscience expertise grows in developing nations.

Job growth is expected within management, scientific, and technical consulting services. Demand will be spurred by a continuing emphasis on the need for energy, environmental protection, responsible land management, and water-related issues. Management, scientific, and technical consulting services have increased their hiring of many geoscientists in recent years due to increased government contracting, and also in

response to demand for professionals to provide technical assistance and management plans to corporations. Moreover, many of these workers will be needed to monitor the quality of the environment, including aquatic ecosystems, issues related to water conservation, deteriorating coastal environments, and rising sea levels—all of which will stimulate employment growth of geoscientists.

An expected increase in highway building and other infrastructure projects will be a source of jobs for engineering geologists.

During periods of economic recession, geoscientists may be laid off. Especially vulnerable to layoffs are those in consulting and, to a lesser extent, workers in Government. Employment for those working in the production of oil and gas, however, will largely be dictated by the cyclical nature of the energy sector and changes in government policy.

Environmental Studies: Geoscientists: Earnings

Median annual earnings of geoscientists were \$68,730 in May 2004. The middle 50 percent earned between \$49,260 and \$98,380; the lowest 10 percent earned less than \$37,700, the highest 10 percent more than \$130,750.

According to the National Association of Colleges and Employers, beginning salary offers in July 2005 for graduates with bachelor's degrees in geology and related sciences averaged \$39,365 a year.

In 2005, the Federal Government's average salary for managerial, supervisory, and nonsupervisory positions was \$83,178 for geologists, \$94,836 for geophysicists, and \$87,007 for oceanographers.

The petroleum, mineral, and mining industries are vulnerable to recessions and to changes in oil and gas prices, among other factors, and usually release workers when exploration and drilling slow down. Consequently, they offer higher salaries, but less job security, than other industries.

ENVIRONMENTAL STUDIES: Farmers, Ranchers, and Agricultural Managers

Environmental Studies: Farmers, Ranchers, and Agricultural Managers

Modern farming requires knowledge of new developments in agriculture, as well as work experience acquired through growing up on a farm or through postsecondary education.

Overall employment is projected to decline because of increasing productivity and consolidation of farms.

Horticulture and organic farming will provide better employment opportunities.

Small-scale farming is a major growth area and offers the best opportunity for entering the occupation.

Environmental Studies: Farmers, Ranchers, and Agricultural Managers: Nature of the Work

American farmers, ranchers, and agricultural managers direct the activities of one of the world's largest and most productive agricultural sectors. They produce enough food and fiber to meet the needs of the United States and for export.

Farmers and ranchers own and operate mainly family-owned farms. They also may lease land from a landowner and operate it as a working farm. The type of farm they operate determines their specific tasks. On crop farms—farms growing grain, cotton, other fibers, fruit, and vegetables—farmers are responsible for preparing, tilling, planting, fertilizing, cultivating, spraying, and harvesting. After the harvest, they make sure that the crops are properly packaged, stored, or marketed. Livestock, dairy, and poultry farmers must feed and care for the animals and keep barns, pens, coops, and other farm buildings clean and in good condition. They also plan and oversee breeding and marketing activities. Horticultural specialty farmers oversee the production of ornamental plants, nursery products—such as flowers, bulbs, shrubbery, and sod—and fruits and vegetables grown in greenhouses. Aquaculture farmers raise fish and shellfish in marine, brackish, or fresh water, usually in ponds, floating net pens, raceways, or recirculating systems. They stock, feed, protect, and otherwise manage aquatic life sold for consumption or used for recreational fishing.

Responsibilities of farmers and ranchers range from caring for livestock, to operating machinery, to maintaining equipment and facilities. The size of the farm or ranch often determines which of these tasks farmers and ranchers will handle themselves. Operators of small farms usually perform all tasks, physical and administrative. They keep records for management and tax purposes, service machinery, maintain buildings, and grow vegetables and raise animals. Operators of large farms, by contrast, have employees who help with the physical work that small-farm operators do themselves. Although employment on most farms is limited to the farmer and one or two family workers or hired employees, some large farms have 100 or more full-time and seasonal workers. Some of these employees are in nonfarm occupations, working as truck drivers, sales representatives, bookkeepers, and computer specialists.

Agricultural managers manage the day-to-day activities of one or more farms, ranches, nurseries, timber tracts, greenhouses, and other agricultural establishments for farmers, absentee landowners, or corporations. Their duties and responsibilities vary widely, but focus on the business aspects of running a farm. On small farms, they may oversee the

entire operation; on larger farms, they may oversee a single activity, such as marketing. Agricultural managers usually do not perform production activities; instead, they hire and supervise farm and livestock workers, who perform most of the daily production tasks. In these cases, managers may establish output goals; determine financial constraints; monitor production and marketing; hire, assign, and supervise workers; determine crop transportation and storage requirements; and oversee maintenance of the property and equipment.

Farmers, ranchers, and agricultural managers make many managerial decisions. Farm output and income are strongly influenced by the weather, disease, fluctuations in prices of domestic and foreign farm products, and Federal farm programs. In crop production operations, farmers and managers usually determine the best time to plant seed, apply fertilizer and chemicals, and harvest and market the crops. They use different strategies to protect themselves from unpredictable changes in the markets for agricultural products. Many farmers and managers carefully plan the combination of crops they grow, so that if the price of one crop drops, they will have sufficient income from another crop to make up for the loss. While most farm output is sold directly to food-processing companies, some farmers—particularly operators of smaller farms—may choose to sell their goods directly through farmers' markets or may use coöperatives to reduce their financial risk and to gain a larger share of the retail dollar. For example, in community-supported agriculture (CSA), coöperatives sell shares of a harvest to consumers prior to the planting season, thus freeing the farmer from having to bear all the financial risks and ensuring the farmer a market for the produce of the coming season.

Farmers, ranchers, and agricultural managers also negotiate with banks and other credit lenders to get the best financing deals for their equipment, livestock, and seed. They also must keep abreast of constantly changing prices for their products and manage the risk of fluctuating prices. Those who plan ahead may be able to store their crops or keep their livestock to take advantage of higher prices later in the year. Those who participate in the risky futures market, where contracts on future production of agricultural goods are bought and sold, can minimize the risk of sudden price changes by buying futures contracts which guarantee that they will get at least a certain price for their agricultural goods when they are ready to sell.

Like other businesses, farming operations have become more complex in recent years, so many farmers use computers to keep financial and inventory records. They also use computer databases and spreadsheets to manage breeding, dairy, and other farm operations.

Environmental Studies: Farmers, Ranchers, and Agricultural Managers: Working Conditions

The work of full-time farmers, ranchers, and agricultural managers is often strenuous; work hours are frequently long, and they rarely have days off during the planting, growing, and harvesting seasons. Nevertheless, for those who enter farming or ranching, the disadvantages are counterbalanced by the quality of life in a rural area, working

outdoors, being self-employed, and making a living off the land. Farmers and farm managers on crop farms usually work from sunrise to sunset during the planting and harvesting seasons. The rest of the year, they plan next season's crops, market their output, and repair machinery.

On livestock-producing farms and ranches, work goes on throughout the year. Animals, unless they are grazing, must be fed and watered every day, and dairy cows must be milked two or three times a day. Many livestock and dairy farmers monitor and attend to the health of their herds, which may include assisting in the birthing of animals. Such farmers rarely get the chance to get away, unless they hire an assistant or arrange for a temporary substitute.

Farmers who grow produce and perishables have different demands on their time. For example, organic farmers must maintain cover crops during the cold months, thus keeping them occupied with farming beyond the typical growing season.

Farmwork also can be hazardous. Tractors and other farm machinery can cause serious injury, and workers must be constantly alert on the job. The proper operation of equipment and handling of chemicals are necessary to avoid accidents, safeguard one's health, and protect the environment.

On very large farms, farmers spend substantial time meeting with farm managers or farm supervisors in charge of various activities. Professional farm managers overseeing several farms may divide their time between traveling to meet farmers or landowners and planning the farm operations in their offices. As farming practices and agricultural technology become more sophisticated, farmers and farm managers are spending more time in offices and at computers, where they electronically manage many aspects of their businesses. Some farmers also spend time at conferences exchanging information, particularly during the winter months.

Environmental Studies: Farmers, Ranchers, and Agricultural Managers: Training, Other Qualifications, and Advancement

Growing up on a family farm and participating in agricultural programs for young people, such as the National FFA Organization or the 4-H youth educational programs, are important sources of training for those interested in pursuing agriculture as a career. However, modern farming requires increasingly complex scientific, business, and financial decisions, so postsecondary education in agriculture is important even for people who were raised on farms.

The completion of a 2-year degree, or better, a 4-year bachelor's degree program in a college of agriculture, is becoming increasingly important for farm managers and for farmers and ranchers who expect to make a living at farming. A degree in business or farm management with a concentration in agriculture is important, but even after obtaining formal education, novices may need to spend time working under an experienced farmer to learn how to put into practice the skills learned through academic

training. A small number of farms offer, on a formal basis, apprenticeships to help young people acquire such practical skills.

Students should select the college most appropriate to their specific interests and location. All State university systems have at least one land-grant college or university with a school of agriculture. Common programs of study include agronomy, dairy science, agricultural economics and business, horticulture, crop and fruit science, and animal science. For students interested in aquaculture, formal programs also are available and include coursework in fisheries biology, fish culture, hatchery management and maintenance, and hydrology. Whatever one's interest, the college curriculum should include courses in agricultural production, marketing, and economics.

Agricultural managers can enhance their professional status through voluntary certification as an Accredited Farm Manager (AFM) by the American Society of Farm Managers and Rural Appraisers. Accreditation requires several years of farm management experience, the appropriate academic background—a bachelor's degree or, preferably, a master's degree in a field of agricultural science—and the passing of courses and examinations relating to the business, financial, and legal aspects of farm and ranch management.

Farmers, ranchers, and agricultural managers need to keep abreast of continuing advances in agricultural methods both in the United States and abroad, as well as monitor changes in governmental regulations that may affect methods or markets for particular crops. Besides print journals that inform the agricultural community, the spread of the Internet allows quick access to the latest developments in areas such as agricultural marketing, legal arrangements, and growing crops, vegetables, and livestock. Electronic mail, online journals, and newsletters from agricultural organizations also speed the exchange of information directly between farming associations and individual farmers.

Farmers, ranchers, and agricultural managers also must have enough technical knowledge of crops, growing conditions, and plant diseases to make decisions that ensure the successful operation of their farms. A rudimentary knowledge of veterinary science, as well as animal husbandry, is important for livestock and dairy farmers. Knowledge of the relationship between farm operations—for example, the use of pesticides—and environmental conditions is essential. Mechanical aptitude and the ability to work with tools of all kinds also are valuable skills for a small-farm operator, who often maintains and repairs machinery or farm structures.

Farmers, ranchers, and agricultural managers need the managerial skills necessary to organize and operate a business. A basic knowledge of accounting and bookkeeping is essential in keeping financial records, while knowledge of sources of credit is vital for buying seed, fertilizer, and other inputs necessary for planting. It also is necessary to be familiar with complex safety regulations and requirements of governmental agricultural support programs. Computer skills are becoming increasingly important, especially on large farms, where computers are widely used for recordkeeping and business analysis. For example, some farmers, ranchers, and agricultural managers use personal computers

to access the Internet to get the latest information on prices of farm products and other agricultural news. In addition, skills in personnel management, communication, and conflict resolution are equally important in the operation of a farm or ranch business.

Environmental Studies: Farmers, Ranchers, and Agricultural Managers: Employment

Farmers, ranchers, and agricultural managers held nearly 1.3 million jobs in 2004. About 83 percent were self-employed. Most farmers, ranchers, and agricultural managers oversee crop production activities, while others manage livestock and dairy production. Most farmers and ranchers operate small farms on a part-time basis.

The soil, topography of the land, and climate often determine the type of farming and ranching done in a particular area. California, Texas, Iowa, Nebraska, and Kansas are the leading agricultural States.

Environmental Studies: Farmers, Ranchers, and Agricultural Managers: Job Outlook

Market pressures and low prices for many agricultural goods will cause more farms to go out of business over the 2004–14 period. The complexity of modern farming and keen competition among farmers leave little room for the marginally successful farmer. Therefore, the long-term trend toward the consolidation of farms into fewer and larger ones is expected to continue over the 2004–14 period and result in a continued [decline](#) in employment of self-employed farmers and ranchers and slower-than-average growth in employment of salaried agricultural managers. As land, machinery, seed, and chemicals become more expensive, only well-capitalized farmers and corporations will be able to acquire many of the farms that become available. The larger, more productive farms are better able to withstand the adverse effects of climate and price fluctuations upon farm output and income. Larger farms also may have advantages in obtaining government subsidies and payments as these payments are usually based on per-unit production.

In addition, the agriculture sector continues to produce more with fewer workers. Increasing productivity in the U.S. agriculture industry is expected to allow greater domestic consumption needs and export requirements to be met with fewer farmers, ranchers, and agricultural managers overall. The overwhelming majority of job openings for self-employed farmers and ranchers will result from the need to replace farmers who retire or leave the occupation for economic or other reasons.

Despite the expected continued consolidation of farmland and the projected decline in overall employment of farmers, ranchers, and agricultural managers, an increasing number of small-scale farmers have developed successful market niches that involve personalized, direct contact with their customers. Many are finding opportunities in organic food production, as more consumers demand food grown without pesticides or chemicals. Others use farmers' markets that cater directly to urban and suburban consumers, allowing the farmers to capture a greater share of consumers' food dollars. Some small-scale farmers belong to collectively owned marketing coöperatives that process and sell their product. Other farmers participate in community-supported

agriculture cooperatives that allow consumers to directly buy a share of the farmer's harvest.

Aquaculture may continue to provide some new employment opportunities over the 2004–14 period. New concerns about overfishing and the depletion of the stock of some wild fish species will likely lead to more restrictions on deep-sea fishing, even as public demand for the consumption of seafood continues to grow. This demand has spurred the growth of aquaculture farms that raise selected aquatic species—such as shrimp, salmon, trout and catfish—in pens or ponds. Aquaculture's presence even in landlocked States has increased as farmers attempt to diversify and cater to the growing demand for fish by consumers. In addition, growing demand for horticulture products, such as flowers, ornamentals, trees, shrubs, and other nonedibles, is expected to produce better employment opportunities for greenhouse and nursery farmers and managers.

Environmental Studies: Farmers, Ranchers, and Agricultural Managers: Earnings

Incomes of farmers and ranchers vary greatly from year to year because prices of farm products fluctuate with weather conditions and other factors influencing the quantity and quality of farm output and the demand for those products. A farm that shows a large profit one year may show a loss the following year. According to the U.S. Department of Agriculture, the average net cash farm business income for farm operator households in 2004 was \$15,603. This figure, however, does not reflect that farmers often receive government subsidies or other payments that supplement their incomes and reduce some of the risk of farming. Additionally, most farmers—primarily operators of small farms—have income from off-farm business activities or careers, often greater than that of their farm income.

Full-time, salaried farm managers had median weekly earnings of \$621 in 2004. The middle half earned between \$464 and \$890. The highest paid 10 percent earned more than \$1,264, and the lowest paid 10 percent earned less than \$350.

Farmers and self-employed farm managers make their own provisions for benefits. As members of farm organizations, they may derive benefits such as group discounts on health and life insurance premiums.

Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2006-07 Edition*, on the Internet at <http://www.bls.gov/oco/> (visited November 08, 2007).