# Ecology and Management of a Forested Landscape

## Fifty Years on the Savannah River Site

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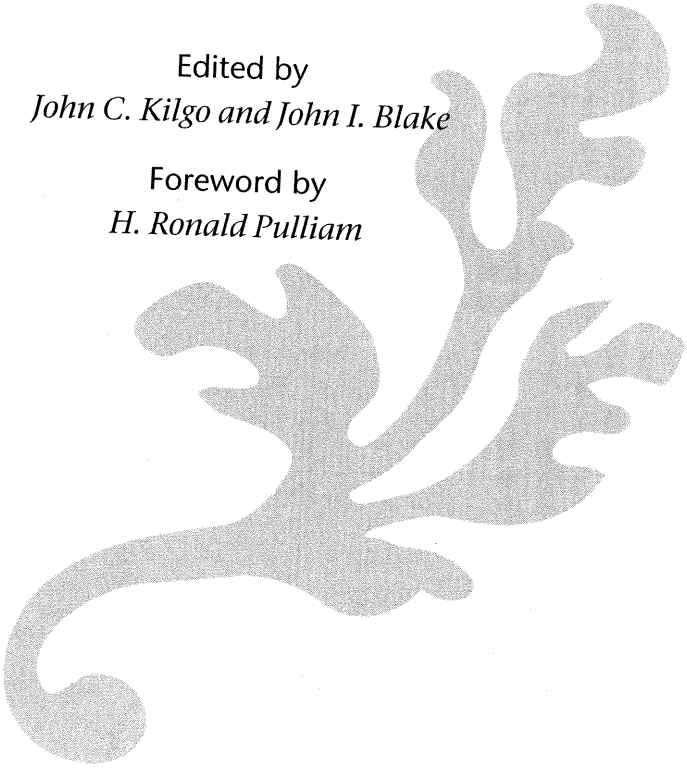

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forested; only 12 percent of the forest stands were less than ten years old, and 72 percent were more than thirty years old. Satellite imagery of the region illustrates the impacts of reforestation of the SRS (figure 1.7, in color insert). The green, forested SRS contrasts sharply with the surrounding landscape, dominated by agriculture and urbanization.

## Industrial Operations and Current Land Use

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The management of natural resources at the Savannah River Site (SRS) has been variously executed over the years to meet conservation and restoration objectives, to provide research and educational opportunities, and to generate revenue from the sale of forest products. However, these management activities have been implemented under the constraints imposed by the Site's nuclear mission and the objectives for which the SRS was established. This management challenge has been further complicated by the vast area encompassed by the Site, as well as the complex spatial mosaic of operational facilities and natural features. This section provides a general description of both the operational infrastructure and the land-use framework within which natural resource management activities occur.

### SRS Background and Operations

The SRS is one of several government-owned, contractor-operated sites within the U.S. Department of Energy's nuclear defense complex. It is managed as a controlled area with limited public access. It was constructed during the 1950s to produce basic materials (e.g., plutonium-237 and tritium) used in nuclear weapons. Responsibility for these activities was initially assigned to the Atomic Energy Commission, whose mission was later assumed by the Department of Energy. Following the end of the Cold War, the Site's mission changed to stewardship of the nation's nuclear weapons stockpile, nuclear materials, and the environment (Mamatey 2004).

Activities associated with the nuclear mission at SRS occur in several industrialized or developed areas located around the site. There are five nuclear production reactors; two chemical separations facilities; a heavy water extraction plant; a nuclear fuel and target fabrication facility; a tritium extraction facility; waste processing, storage, and disposal facilities;



and various administrative support facilities. The production reactors, the heavy water extraction plant, and the nuclear fuel and target fabrication facility are no longer operational. The last reactor was shut down in 1988. Several of these latter facilities have been decommissioned, and the remainder are scheduled to be decommissioned by 2026 (Austin, Noah, and Nelson 2003).

SRS facilities are located in twenty separate developed areas around the site, which encompass a total of 1,781 ha (4,403 ac). The administrative areas are situated around the periphery of the site, while the industrialized operations areas (e.g., nuclear reactors, separations and waste management facilities) are in the inner core of the 803-km$^2$ (310-mi$^2$) footprint, with sufficient buffer lands to protect both the surrounding communities and the security of these classified operations (figure 1.8, in color insert). Additionally, remote facilities, less than 1 to 2 ha (1–5 ac) in size, are scattered around the site. They include power substations, sanitary wastewater treatment facilities and lift stations, cooling water intake and pump stations, field laboratories, maintenance buildings, and various security facilities. Perimeter security barricades control personnel and vehicle access.

The infrastructure necessary to support these various administrative and operations areas is massive. Site utilities provide electricity, steam, cooling water, domestic water, service water, and sanitary waste treatment. The SRS has an extensive internal transportation infrastructure, which consists of approximately 225 km (140 mi) of primary roads and 2,253 km (1,400 mi) of secondary roads (including logging roads and jeep trails). Recent traffic flow on primary roadways has been in the thousands of vehicles per hour during periods of worker shift change. The SRS has a railway system consisting of approximately 96 km (60 mi) of track. It also has used the Savannah River to transport large, heavy loads to the site. The various pipelines, transmission lines, roads, and railways all have maintained rights-of-way associated with them (Noah 1995).

Buffer zones between industrialized areas and surrounding undeveloped habitats are minimal (figure 1.9). Most transitions are abrupt, with maintained lawns or parking lots ending at the forest edge. Due largely to the close proximity of industrialized and undeveloped areas, the industrialized areas are used by various wildlife species. The presence of a number of medium-sized species (e.g., opossum, eastern cottontail, gray fox, and raccoon) within facility areas demonstrates that perimeter fences do not effectively deter wildlife movement. Mayer and Wike (1997) documented 153 species in and around developed portions of the site. However, they considered most (58.3 percent) uncommon in these areas, and

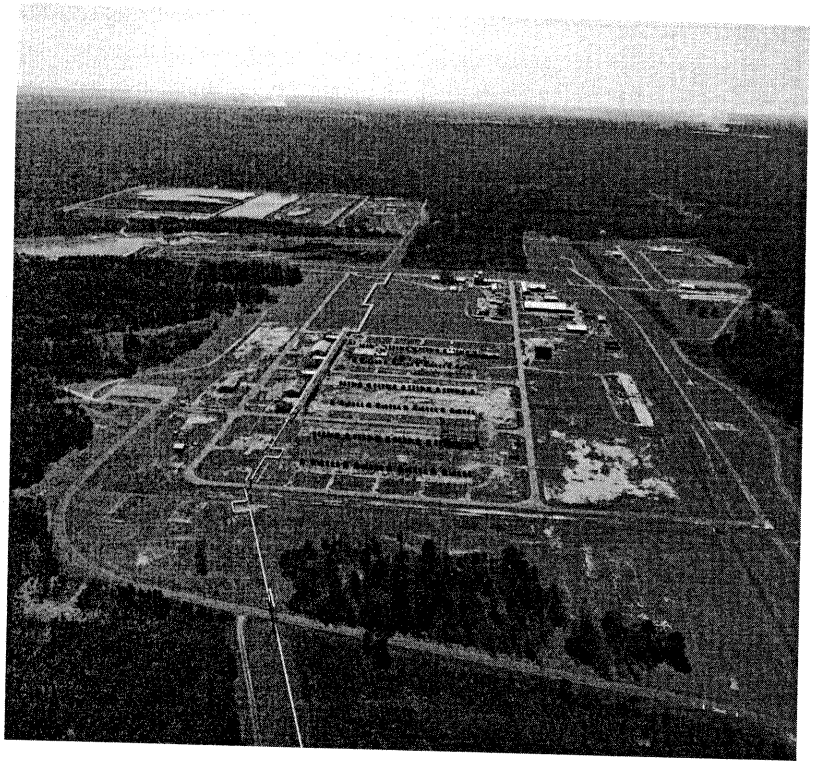

**Figure 1.9.** Aerial view of a developed area and surrounding forest on the Savannah River Site (Westinghouse Savannah River Co. files).

introduced or invasive species made up 50 percent of the abundant species. Foraging and feeding were the most commonly observed activities. Of the eight subhabitats surveyed, landscaped areas away from buildings and structures were the most heavily used. Potential impacts to humans from such urban wildlife include contaminant transport, physical injury, disease transmission, and destruction of property. Potential impacts to wildlife in these areas include physical harm and contaminant exposure (Mayer and Wike 1997).

In an effort to fulfill its nuclear operations in a safe, secure, and environmentally responsible manner, the SRS has operated an extensive environmental monitoring program since 1951. Both on-site and off-site locations and media are monitored for potential impacts. Monitoring programs cover a suite of potential contamination pathways, including surface water, groundwater, drinking water, ingestion, contact, and air.



Annually, thousands of samples (air, water, soil, sediment, food, vegetation, and animal tissue) from both within and around the site are taken to support different analyses, and the potential human dose impacts are calculated for the different pathways. In 2003, the estimated dose to the maximally exposed individual from all pathways was 0.19 millirem (mrem; Mamatey 2004), which is 0.05 percent of the dose (360 mrem) received annually by people from natural and other manufactured sources of radiation (e.g., x-ray, television; Arnett and Mamatey 2000). Screening of both aquatic and terrestrial biota doses for 2003, the most recent year available, resulted in all sampled sites passing the pathway screening (Mamatey 2004).

The SRS has significant social and economic effects on the area outside of its boundary. It contributes to South Carolina and Georgia through employment and purchasing and through educational, research, technology transfer, business development, and community assistance programs. The site is located in the Central Savannah River Area, consisting of eight counties in South Carolina and Georgia. The region contains eight county governments and thirty-eight incorporated municipalities. SRS employment has varied over the life of the Site, with a maximum of 38,582 employees during the peak construction period in 1952. During the early 1990s, the SRS was the largest single employer in South Carolina (Reed et al. 2002; Grewal and Noah 2004). However, employment has declined in recent years with the Site's reduced post–Cold War missions (figure 1.10).

Stewardship plans for the SRS have been developed for the next fifty years. In the near term, work will continue to improve environmental quality, clean up legacy waste sites, and manage any future waste produced from Site operations. This effort will include the construction of new facilities, retooling of existing Site facilities for new missions, and reconfiguration of the Site to a form that is more conducive to meeting mission requirements. In the decades ahead, SRS will consolidate its functions toward the center of the site. As new missions are funded, facilities will be placed near areas of current industrialization to minimize maintenance costs, infrastructure needs, and developmental and environmental impacts. Natural resource management is an integral component of the SRS Long Range Comprehensive Plan (U.S. Department of Energy 2000). Specifically, the plan defines three natural resource goals: demonstrate excellence in environmental stewardship; provide natural resource information critical to the Department of Energy's science base; and provide cost-effective, flexible, and compatible programs to support SRS missions.

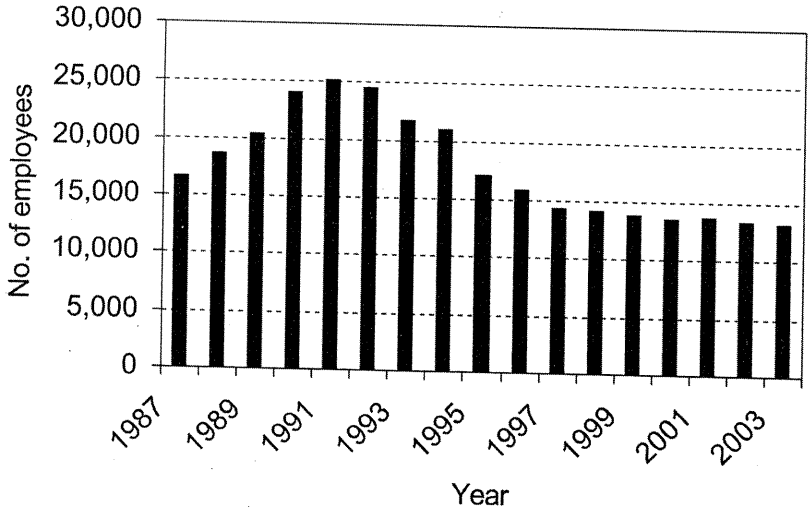


**Figure 1.10.** Size of the workforce on the Savannah River Site, 1987–2003.

Current cleanup efforts at many Department of Energy sites, including SRS, cannot restore those federal lands to acceptable levels for unrestricted public use. This is due in part to the nature of the contamination and the lack of proven cleanup and treatment technologies. Some hazards may require attention for many centuries. Consequently, long-term stewardship will be needed at those sites to ensure that the selected remedies will remain protective for future generations (U.S. Department of Energy 2000).

## Natural Resource Management

Because the SRS conducts natural resource management within the framework of several land-use areas (see figure 1.8), knowledge of the objectives for those areas is important in understanding SRS land management. The SRS Long Range Comprehensive Plan (U.S. Department of Energy 2000), the Land Use Baseline Report (Noah 1995), and the Natural Resource Management Plan (U.S. Department of Energy 2005) provide overviews of land-use conditions, strategies, and activities. More detailed information on specific management objectives and practices within particular zones can be found elsewhere (NUS 1984; Davis and Janecek 1997; Edwards et al. 2000; Caudell 2000). Here we provide general background information on natural resource management in the major land-use areas and the rationale for partitioning the site.



The various programs and entities with land-use areas include the red-cockaded woodpecker (*Picoides borealis*) management program, the Crackerneck Wildlife Management Area and Ecological Reserve, and the Department of Energy Set-Aside Program. Although other endangered and threatened species occur on SRS, the red-cockaded woodpecker recovery program influences the largest portion of the landscape (Edwards et al. 2000). About two thirds of the upland forest areas are managed for this species and for the associated fire-maintained savanna conditions that support a great diversity of species. In the mid-1980s, the first woodpecker management plan delineated the SRS roughly as a donut shape, with the outer perimeter as the recovery area and the core containing the industrial areas. In 1997, a new plan detailed the current red-cockaded woodpecker habitat management areas (see figure 1.8). Primary factors considered from a landscape perspective included minimizing smoke problems from prescribed burning, optimizing savanna restoration opportunities through compatibility with ecological land classification, increasing management flexibility, and retaining prime industrial development sites. The plan incorporated the Department of Defense concept of including a "supplemental habitat management area" where lower woodpecker population densities are accepted to achieve greater flexibility. The woodpecker management plan provides specific guidelines on the kind and amount of timber harvest, development, and other activity allowed in each zone (Edwards et al. 2000).

Within the industrial core or "Other Use Area" (figure 1.8) are most of the original industrial facilities. Infrastructure developments that dissect the area heavily impact wildlife (Mayer and Wike 1997) and other natural resources. They include transportation, power, and communications facilities; monitoring equipment; soil and groundwater closure projects; and support facilities. In order to minimize mission conflicts, there is a need to maintain industrial management flexibility and to limit natural resource goals in this zone. However, at least one population of an endangered plant, numerous sensitive species, and considerable wetland habitat occur near the industrial facilities.

The South Carolina Department of Natural Resources, in conjunction with the U.S. Department of Energy, manages the Crackerneck Wildlife Management Area and Ecological Reserve primarily as wildlife habitat to enhance recreational hunting, fishing, and nonconsumptive use (Caudell 2000). Objectives are similar to those on many state lands and wildlife management areas. The Crackerneck area encompasses about 4,450 ha (11,000 ac) of wetland and mesic land with predominately pine forest,

bottomland hardwood, and cypress-tupelo swamp habitats. Prior to SRS establishment, agriculture and logging activities heavily impacted this zone. No industrial facilities exist within it. Forest and wildlife management activities include traditional practices designed to enhance wildlife habitat for game species, such as frequent burning, maintenance of food plots, thinning of pine stands, creation of edge habitat, and protection of mast-producing oaks.

The Savannah River swamp and the Lower Three Runs corridor are designated as separate zones. Resource management objectives are primarily wetland protection, access control, and minimization of contaminated sediment movement. Frequent flooding and wet soils limit access. Although logging impacted these areas prior to 1951 and reactor operations after 1951, limited timber harvesting or silviculture still occurs. Management activities that occur often include restoration programs, such as the Pen Branch restoration project (see chapter 3).

The Department of Energy Set-Aside Program is implemented through designated land-use areas that cover about 5,665 ha (14,000 ac) in multiple parcels. Activities are restricted to nonmanipulative research and monitoring (Davis and Janecek 1997). A wide range of land uses, including logging, impacted the individual areas prior to 1951, but most have suffered relatively minimal disturbance since that period. The set-aside areas cover a range of ecological conditions. They include unique ecological areas such as Carolina bays and major stream systems (e.g., Upper Three Runs and Meyers Branch), as well as old fields and experimental sites. The SRS began selecting set-aside areas in the 1950s for protection from land management. In addition to meeting research and monitoring objectives, these areas provide habitat for a number of sensitive plants and animals. The streams and wetlands frequently provide baseline data on metals, radioactive elements, and organic compounds on noncontaminated sites and serve as reference areas for assessing biological impacts from industrial facilities.

Identification of SRS land-use area objectives and boundaries, as well as evaluation of activities compatible with those objectives, is a continually evolving process. Land management objectives must not compromise the evolving missions of the Site. In addition, land management activities on site, as elsewhere, are subject to applicable federal laws and regulations governing land use. While these varied objectives and constraints present a challenge to land management on SRS, they are designed to allow for compatibility between the primary SRS missions and the responsible stewardship of the vast natural resources of the site.