

Survey of Ecological Resources at Selected U.S. Department of Energy Sites

C. McAllister
H. Beckert
C. Abrams
G. Bilyard
K. Cadwell
S. Friant
C. Glantz
R. Mazaika
K. Miller

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Pacific Northwest National Laboratory
Richland, Washington 99352

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Summary

The U.S. Department of Energy (DOE) owns and manages a wide range of ecological resources, ranging from relatively undisturbed, sensitive ecosystems (e.g., wetlands) to former agricultural lands. During the next 30 years, DOE Headquarters and Field Offices will make land-use planning decisions and conduct environmental remediation and restoration activities in response to the National Environmental Policy Act (NEPA); Resource Conservation and Recovery Act (RCRA); Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); and other federal and state statutes. These remediation and restoration activities must consider the health of ecological resources, particularly within the framework of applicable regulatory requirements, such as the Natural Resource Damage Assessment (NRDA) provisions of CERCLA, or other legally binding agreements, such as Native American treaties. These decisions and activities, which will often be based in part on the results of ecological risk assessments, will affect the health of DOE's ecological resources.

This document fulfills, in part, DOE's need to know what types of ecological resources it currently owns and manages by synthesizing information on the types and locations of ecological resources at 10 DOE sites nationwide: Hanford Site, Idaho National Engineering Laboratory, Lawrence Livermore National Laboratory, Sandia National Laboratory, Rocky Flats Plant, Los Alamos National Laboratory, Savannah River Site, Oak Ridge National Laboratory, Argonne National Laboratory, and Fernald Environmental Management Project. These sites constitute a significant portion of the ecological resources managed by DOE. Although the sites discussed in this document are located in various parts of the country, many of them support plant and animal communities with significant similarities. This report summarizes information on ecosystems, habitats, and federally listed threatened, endangered, and candidate species that could be stressed by contaminants or physical activity during the restoration process, or by the natural or anthropogenic transport of contaminants from presently contaminated areas into presently uncontaminated areas.

This report provides summary information on the ecosystems, habitats, and threatened and endangered species that exist on each of the 10 aforementioned sites. One chapter is devoted to each site. Each chapter contains a general description of a particular site, including information on size, location, history, geology, hydrology, and climate. Descriptions of the major vegetation and animal communities and of aquatic resources are also provided, as well as discussions of the threatened or endangered plant or animal species that are present. The last section in each chapter discusses ecological issues that pertain to that specific site.

This report represents a composite of existing information from across the DOE complex. The narrative relies completely upon information supplied by the sites. No additional field data were gathered as part of this effort.

Acronyms

AIRFA	American Indian Religious Freedom Act
ALE	Arid Lands Ecology Reserve (Hanford Site)
ANL	Argonne National Laboratory
BLM	Bureau of Land Management
CAA	Clean Air Act of 1986
CDF&G	California Department of Fish and Game
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CWA	Clean Water Act
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FEMP	Fernald Environmental Management Project
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
INEL	Idaho National Engineering Laboratory
KAFB	Kirtland Air Force Base
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
MM	Mitigation Measures
NEPA	National Environmental Policy Act
NERP	National Environmental Research Park
NRDA	Natural Resource Damage Assessments
NWR	National Wildlife Refuge
ORGDP	Oak Ridge Gaseous Diffusion Plant
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PCB	polychlorinated biphenyl
RCRA	Resource Conservation and Recovery Act
RFP	Rocky Flats Plant
SARA	Superfund Amendments and Reauthorization Act
SNL	Sandia National Laboratory
SRS	Savannah River Site
TSCA	Toxic Substances Control Act
USACE	U.S. Army Corps of Engineers

Terms and Definitions

alluvial - Relating to material deposited by moving water.

aquitard - A layer of sediment or rock with very low permeability that slows or stops the vertical flow of ground water.

arroyo - A gully formed by running water or a waterway in a dry area.

benthic - Pertaining to organisms that live on or near the bottom of bodies of water.

biome - A large, easily recognizable land community, defined by the interaction of the regional climate, biota, and substrate (Odum 1959).

bryophytes - Plants belonging to the phylum Bryophyta, such as mosses and liverworts.

candidate species - A species that, based on preliminary information regarding species viability, is considered for addition to the list of endangered and threatened wildlife and plants by the U.S. Fish and Wildlife Service.

carnivore - An animal that consumes other animals.

carrying capacity - The number of organisms that a specific habitat can support.

climax community - The stable end community of succession; the plant and animal community that is capable of sustaining itself under prevailing environmental conditions.

community - All the populations of organisms within a specific geographic area (Odum 1959).

cryptogam - A nonvascular plant, including algae, fungi, lichens, and mosses, reproducing by spores, and not producing flowers or seeds.

depredation - Damage to human-maintained habitat (such as lawns or agricultural crops) caused by wildlife (particularly in regard to waterfowl and big game).

ecological resources - Those resources that constitute one or the other of the biological resources or their physical surroundings, and the inter-relationship of each.

ecological risk assessment - "Process that evaluates the likelihood that undesirable ecological effects may occur or are occurring as a result of exposure to one or more stressors" (EPA 1992). Importantly, the "likelihood" of undesirable effects may be expressed quantitatively or qualitatively (EPA 1989b, 1992). In this report, the process of "ecological risk assessment" refers specifically to the framework that the U.S. Environmental Protection Agency (EPA) developed for ecological risk assessment (EPA 1992). The EPA framework provides a process for conducting ecological risk

assessments that is extrapolated from the human health risk assessment model published earlier by EPA. (See EPA [1989a] for a comprehensive discussion of the human health risk assessment process.)

ecosystem - "Any area of nature that includes living organisms and non-living substances interacting to produce and exchange materials between the living and non-living parts" (Odum 1959). The key concept in this definition is that interactive processes among living and nonliving entities occur within an ecosystem. All of the communities in an area, when interacting with the surrounding abiotic components of the environment, constitute an ecosystem.

ecotone - The boundary zone between two different habitats or ecosystems.

endangered species - "...Any species which is in danger of extinction throughout all or a significant portion of its range..." (16 USC 1532).

endemic - Something that occurs only in a specific region.

ephemeral - Lasting for only a short time.

eyrie - The nest of a predatory bird, built on a crag or other high place.

Federal Category 1 (FC1) - "Taxa for which the Service [U.S. Fish and Wildlife Service] has on file enough substantial information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened species" (56 FR 58805).

Federal Category 2 (FC2) - "Taxa for which information now in the possession of the Service [U.S. Fish and Wildlife Service] indicates that proposing to list as endangered or threatened is possibly appropriate, but for which conclusive data on biological vulnerability and threat are not currently available to support proposed rules" (56 FR 58805).

Federal Endangered (FE) - Any species in danger of extinction throughout all or a significant portion of its range.

Federal Threatened (FT) - Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

forb - A nonwoody, seed-bearing annual other than grass or legume.

habitat - "The place where [an organism] lives, or the place where one would go to find it" (Odum 1959). Hence, a habitat is the sum total of environmental conditions of a specific place where one would find a certain organism. In contrast to the ecosystem, no interactions or ongoing processes are implied in this definition.

herbaceous - Nonwoody vegetation.

herpetofauna - Pertaining to reptiles and amphibians.

hydric - Having or requiring much water.

hydrophyte - A plant that grows in water.

lichen - An organism that is a symbiotic association between an alga and a fungus.

mesa - A flat-topped, elevated area of land.

mesic - Having or requiring a moderate amount of water.

microhabitat - The portion of habitat that an individual organism uses.

National Environmental Research Park - A designation of the U.S. Department of Energy (DOE) to areas with significant ecological resource value within the DOE complex.

natural resources - Ecological (biological) resources, as well as nonbiological resources such as water or mineral resources.

palustrine - With reference to vegetation, of or related to river or stream.

perennials - Plants that live for more than one year.

population - All of the individuals of a given species that occur within a specified geographic area (Odum 1959).

predatory - Pertaining to an animal that kills and consumes other animals.

raptor - A bird of prey.

remediation - Off-setting the loss of numbers, value, or quality with regard to ecological resources; cleaning up to "applicable or relevant and appropriate requirements" with regard to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

reservation - See definition of "site."

riparian - An area that borders a lake or river.

risk assessment - "A set of formal scientific methods for estimating the probabilities and magnitudes of undesired effects resulting from release of chemicals, other human actions, or natural catastrophes. Risk assessment includes quantitative or qualitative determinations of both exposure and effects" (SETAC 1987). Therefore, risk assessment is a technical procedure that can be used to estimate the probability and amount of loss or injury from any of a variety of existing conditions or potential actions.

rookery - A nesting/breeding area for colonial nesting birds such as great blue herons.

savannah - A grassland with widely spaced trees.

site - The generic term for all Department of Energy land parcels discussed in this document. Although some of the sites may be officially referred to as a "National Laboratory", "site" is generally meant to include all lands surrounding the laboratory itself. In this document, each location is referred to as a "site" unless it is referred to in the literature as something different (e.g., the Oak Ridge Reservation).

slough - A creek in a marsh or tide flat.

sward - A grass-covered portion of land.

synchrotron - A piece of equipment that produces high-energy x-rays and/or ultraviolet light.

taxa - Particular groups in a biological classification system.

threatened and endangered species - In this document, any species (or subspecies) listed pursuant to the Federal Endangered Species Act, or pursuant to any similar state statute. Such species are listed because they are in danger of becoming extinct, either through direct adverse impacts on their populations (e.g., inadvertent poisoning by legally applied rodenticides) or through indirect impacts on the ecosystems of which they are a part (e.g., habitat destruction). (See DOE [1993] for further information.)

threatened species - "...Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (16 USC 1532).

transuranic - An element whose atomic number is greater than that of uranium.

vascular - A type of plant that has specialized conducting systems for transporting fluids throughout the plant.

vernal pool - A temporary pond or pool that contains water only in the springtime.

xeric - Having or requiring very little water.

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1.0 Introduction

The U.S. Department of Energy (DOE) is currently conducting environmental restoration, remediation, and waste management activities at many of its sites across the nation. These sites contain valuable ecological resources including wetlands, endangered species, and pristine ecosystems. These resources are protected by various environmental statutes and regulations, including the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Resource Conservation Recovery Act (RCRA), National Environmental Policy Act (NEPA), and the Endangered Species Act. These statutes, and others, put forth broad management responsibilities for which DOE is accountable. For example, under CERCLA, DOE is subject to Natural Resource Damage Assessment (NRDA), in which trustees may pursue compensation for injury to natural resources resulting from DOE activities. For DOE, the first step to determining whether the environment has been damaged is to understand what ecological resources currently exist at its sites. Ecological resources are defined as either or both the biological resources or their physical surroundings and their interrelationships.

This report synthesizes information on the types and locations of ecological resources that are or could be at risk from environmental restoration and waste management activities across the DOE complex. Emphasis is placed on information related to ecosystems, communities, habitats, and threatened and endangered species. In addition, some issues related to the existence or management of ecological resources are discussed briefly. Although none of the information in this report is new, this report represents the first attempt to synthesize such information for the DOE complex.

This overview is sufficiently detailed to be used in supporting environmental management decisions. By providing site-wide and complex-wide listings, the report provides resources information in a site-wide holistic manner to project managers, planners, and decision makers. Because resources can be compared across the DOE complex, project managers can identify similarities with other sites and can exchange information with project managers at those sites about approaches to natural resource management. For example, managers could identify sites where proven remediation technologies and measures for protection of natural resources are being implemented.

The 10 DOE sites discussed here (see Figure 1.1), of a possible 100 sites, represent a majority of the ecological resources managed by DOE. They are the Hanford Site, Idaho National Engineering Laboratory, Lawrence Livermore National Laboratory, Sandia National Laboratory, Rocky Flats Plant, Los Alamos National Laboratory, Savannah River Site, Oak Ridge National Laboratory, Argonne National Laboratory, and Fernald Environmental Management Project.

Information on ecological resources was gathered from numerous, diverse sources. The most important sources include site environmental surveillance and monitoring reports, environmental impact statements, site baseline studies, and reports on ecological studies.



Figure 1.1 DOE Sites Discussed in this Document

2.0 Background

The DOE manages a diversity of ecological resources, ranging from formerly agricultural lands, to sensitive habitats, to relatively pristine, undisturbed ecosystems that can be considered natural treasures. Over the next 30 years, DOE Headquarters and Field Offices will make land-use planning decisions and conduct environmental restoration and waste management activities that will affect these ecological resources. Many of these decisions will be made in response to regulatory requirements (e.g., Federal Facility Agreements, CERCLA remediation activities, the NRDA provisions of CERCLA) or other legally binding agreements (e.g., Native American treaty rights). These decisions will often be based on ecological risk assessments and/or the setting of ecological-risk-based standards.

2.1 New Emphasis on Ecological Risk Assessment

It is anticipated that DOE will formally adopt ecological risk assessment as the primary technical tool for providing information on ecological resources to environmental restoration and waste management decision-makers. This practice corresponds to that of the U.S. Environmental Protection Agency (EPA), which is increasingly emphasizing the use of ecological risk assessment as a tool for making management decisions regarding ecological resources. The EPA has developed a "Framework for Ecological Risk Assessment" (EPA 1992) and two reports that provide site-specific case studies (EPA 1993, 1994). Additional guidance may be provided in future publications.

2.2 The Importance of Ecological Resources Within DOE's New Mission

Information on DOE's ecological resources is playing an increasingly larger role in developing programs and working decisions. The primary reason for this increase is that, in 1989, the mission of DOE's defense materials production sites changed from nuclear materials production to environmental restoration and waste management. The primary goals of the new mission include the protection of human health and the health of ecological resources.

The DOE manages diverse ecological resources, with sites scattered throughout the country, often encompassing large tracts of land. There are nearly 100 sites currently under DOE management located in 31 states and United States territories (DOE 1990c). Among these, 45 sites located in 26 different states were established and operated to produce and support production of nuclear materials for defense, to conduct energy research, and to support other national security interests. Management and engineering practices used at these sites over the past 50 years often did not sufficiently protect the natural environment and have resulted in environmental and ecological degradation.

On the other hand, these production and research sites have had limited access for decades, and only certain portions of the facilities have been subjected to human activity. As a result of limited human disturbance and limited DOE activities across many parts of these sites, DOE now manages some extremely rare and valuable ecosystems, habitats, and threatened and endangered species.

The DOE's challenge in the next 30 years is to manage these resources wisely and in accordance with federal and state laws, and with pertinent regulations, DOE Orders, and Executive Orders (see DOE 1993a). Public and stakeholder interests will be considered in the management process, as required by the implementing regulations of many of the major federal environmental statutes (see DOE 1991c).

2.3 Environmental Compliance

The following state and federal environmental protection statutes are those under which DOE sites are operated.

- **Resource Conservation and Recovery Act** - The Resource Conservation and Recovery Act (RCRA) establishes regulatory standards that are imposed on the generators and transporters of hazardous materials. It also provides regulatory standards for the treatment, storage, and disposal of hazardous materials (Arbuckle et al. 1989).
- **Comprehensive Environmental Response, Compensation, and Liability Act** - CERCLA establishes a program that provides funding and enforcement authority for the cleanup of sites contaminated by hazardous substances. The Superfund Amendments and Reauthorization Act (SARA) broadened the scope of CERCLA to include provisions for federal facilities. The CERCLA joins with RCRA to provide complete regulatory coverage of hazardous waste disposal: RCRA focuses on a "cradle-to-grave" approach to present hazardous waste activities; CERCLA establishes a response program to past hazardous waste activities (Arbuckle et al. 1989).
- **Clean Air Act** - The Clean Air Act of 1986 (CAA) is designed to protect public health by establishing national air quality standards. Although the primary regulatory control for the CAA rests with state and local governments, the CAA gave the EPA the authority to establish minimum air quality standards and outline air pollution control measures for state and local governments to achieve (Arbuckle et al. 1989).
- **Clean Water Act** - The Clean Water Act (CWA) provides the basic framework for federal water pollution control regulations. As stated in Section 101, the CWA is designed to "restore and maintain the chemical, physical, and biological integrity of the nation's waters." The five main elements of the Act include a permit program, national effluent standards for specific industries, water quality standards, provisions for occurrences such as toxics and oil spills, and a grant program for construction of publicly owned treatment facilities (Arbuckle et al. 1989).
- **Federal Insecticide, Fungicide, and Rodenticide Act** - The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) establishes regulations for the storage and use of pesticides.
- **National Environmental Policy Act** - The National Environmental Policy Act (NEPA) was designed to lessen or eliminate damages to the environment and to protect natural resources. The NEPA requires that the impacts to the environment of any major federal project be carefully reviewed and reported in environmental impact statements, environmental assessments, or other NEPA-generated documents (Woodruff et al. 1992).

- **Toxic Substances Control Act** - The Toxic Substances Control Act (TSCA) gives the EPA authority to require testing of substances that enter the environment, as well as the authority to regulate those substances. This regulation supplements the Clean Air Act's and the Clean Water Act's regulatory control over toxic substances. It also regulates the development and use of biotechnology and genetic engineering (Woodruff et al. 1992).
- **Endangered Species Act** - The Endangered Species Act provides for conservation, restoration, propagation, and protection of species that have been declared threatened or endangered. The Act requires all federal agencies to conserve endangered wildlife and provides for the listing of critical habitats essential to species survival.
- **National Historic Preservation Act** - This Act establishes national policy on historic preservation. It was designed to protect, restore, and reconstruct sites, buildings, and objects that are significant to American history or culture. It also requires that impacts to any historical or archaeological site by any federal activity be studied.
- **Archaeological Resources Protection Act** - This Act was designed to protect and regulate the use of archaeological resources on federal and Native American lands by prohibiting excavation or removal of resources without a permit.
- **American Indian Religious Freedom Act** - The American Indian Religious Freedom Act (AIRFA) requires that no federal agency interfere with the right of any Native American to exercise their traditional religious beliefs. This Act also states that the Native American's right to worship includes access to religious sites and possession and use of traditional religious objects (Sharples and Salk 1988).
- **Native American Graves Protection and Repatriation Act** - The Native American Graves Protection and Repatriation Act (NAGPRA) establishes a process for the return of certain human remains and other cultural items presently held by federal agencies or other institutions to American Indians, Native Hawaiians, and Native Alaskans. The law also gives these groups a formal role in decisions about activities carried out on federal and tribal lands that may affect archeological resources of importance.
- **Executive Order 11988 (Floodplain Management)** - Executive Order 11988 is designed to lessen or eliminate impacts to floodplains. Executive Order 11988 regulates floodplain use and modification.
- **Executive Order 11990 (Protection of Wetlands)** - Executive Order 11990 is designed to lessen or eliminate damages to wetland areas by preventing new construction in wetland areas whenever possible and by requiring any damages to be mitigated.

3.0 Hanford Site

This section discusses ecological resources managed by DOE at the Hanford Site in southeastern Washington State (Figure 3.1). Included is a brief description of the Hanford Site, its climate, the sources for its ecological resources information, its major habitats (i.e., common associated plant and animal species), and its plant and wildlife species of concern. Species of concern include federally listed species and state-listed sensitive species. Also included is a brief discussion of the background of Hanford ecological resource data and key ecological issues.

3.1 Site Description

The Hanford Site is located in southeastern Washington approximately 9 km (5 mi) northwest of Richland, Washington, in portions of Benton, Franklin, and Grant counties. It occupies an area of approximately 1450 km² (560 mi²), most of which lie in Benton County. The Site is located in the Pasco Basin area of the Columbia Plateau and is characterized by relatively flat terrain. Elevations of the alluvial plain covering much of the Hanford Site range from 105 m (345 ft) above mean sea level in the southeast corner to 244 m (803 ft) in the northwest (Cushing 1991). The topography generally becomes steeper and more broken toward the northern and western parts of the Site.

The Hanford Site was acquired in 1943 and designated for plutonium production for nuclear weapons and energy development. The Site was also designated for waste management activities. Over the years, the Site mission has diversified to include technological development and research in the areas of waste management, energy, and environmental restoration (Woodruff et al. 1992). Today, the primary Site mission is to clean up the Hanford Site and serve as the DOE model in environmental restoration.

Major geologic features of the Hanford Site include the Rattlesnake Hills (elevation 1092 m [3585 ft]), located along the southwest boundary, and Gable Mountain and Gable Butte near the center of the Site. Other prominent features include the Columbia River, which borders the Site on the north and east, and the Yakima River, which runs through the south end of the Site before entering the Columbia River near Richland, Washington.

The Site is mainly undeveloped land with major facilities and activities occupying only about 6% of the total land area. Nonindustrial activities, such as livestock grazing and farming, have not occurred since the early 1940s (Cushing 1991). Several areas on-site totaling 665 km² (257 mi²) have been designated as study areas or wildlife refuges. These include the Fitzner/Eberhardt Arid Lands Ecology (ALE) Reserve; the U.S. Fish and Wildlife Service Saddle Mountain National Wildlife Refuge (NWR); and the Washington State Department of Wildlife, Wahluke Slope Wildlife Reserve Area (Woodruff et al. 1992). The ALE Reserve was established as a National Environmental Research Park in 1977.

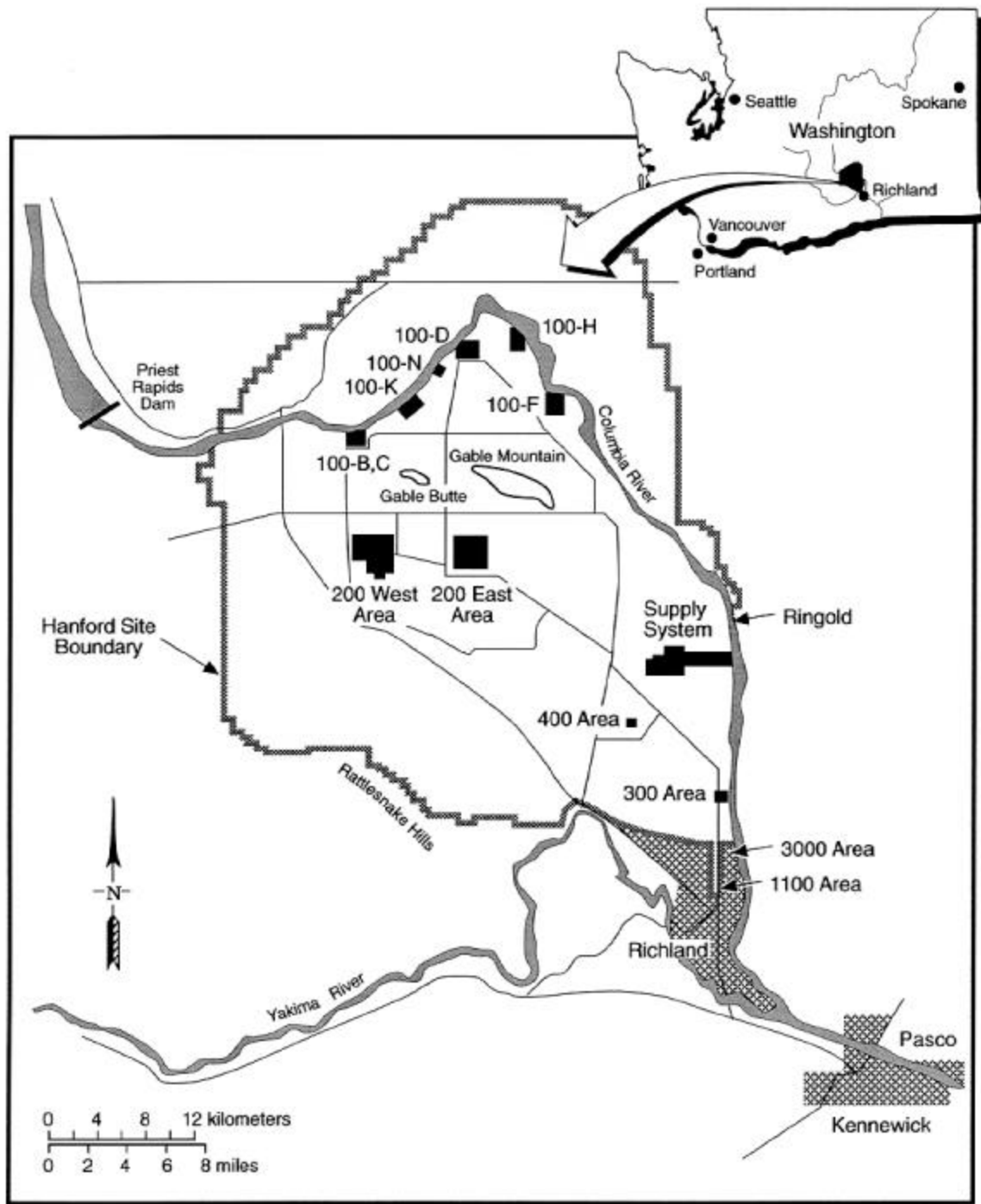


Figure 3.1. Hanford Site, Washington

3.2 Climate

The Hanford Site has a mid-latitude semiarid climate (Critchfield 1974). Meteorological data are available from on-site measurements at the Hanford Meteorology Station (located between the 200 West and East Areas near the center of the Site) and other on-site monitoring locations (Glantz and Islam 1988). On average, the maximum daily temperature exceeds 32°C (90°F) 55 days per year and is below 0°C (32°F) 24 days per year; the minimum daily temperature is below 0°C (32°F) 115 days per year and is below -18°C (0°F) 4 days per year (Stone et al. 1983). July is the warmest month, with daily maximum and minimum temperatures averaging 33°C (92°F) and 16°C (61°F), respectively. January is the coolest month, with daily maximum and minimum temperatures averaging 3°C (37°F) and -6°C (22°F), respectively (Stone et al. 1983). Annual precipitation is approximately 16 cm (6 in.), with over 40% falling during November, December, and January (Stone et al. 1983). Measurable precipitation (defined as 0.025 cm [0.01 in.] or greater) is recorded on an average of 68 days per year and the area experiences an average of 10 thunderstorm days per year. The average annual snowfall is 34 cm (13 in.) and daily snowfall accumulations of 2.5 cm (1 in.) or greater occur an average of 6 days per year (Stone et al. 1983). At higher elevations (e.g., on the slope and summit of Rattlesnake Mountain), increased levels of precipitation and lower temperatures are found in comparison with the rest of the Hanford Site (Glantz et al. 1990). Additional climatological information is summarized in Holdren et al. (1994), and reported in detail in Stone et al. (1983) and Glantz et al. (1990).

3.3 Sources for Ecological Resource Information

Ecological resource data have been gathered at the Hanford Site since the Site was established in 1943. Wildlife research, in particular, has been conducted for many years, with studies occurring between 1943 and 1970 emphasizing the role of wildlife in uptake and transport of radionuclides (Fitzner and Gray 1991). Routine wildlife surveys continue through the present as part of Hanford's environmental surveillance program. Other sources of ecological resource data have been generated by universities and contractors at the Hanford Site. Some of these studies have continued over two decades. For example, the Hanford Great Basin Canada goose study (Hanson and Eberhardt 1971), initiated in 1953, continues today.

The principal sources of information on Hanford ecological resources include environmentally related reports and documents produced by Pacific Northwest Laboratory and Westinghouse Hanford Company. Prior to 1943, ecological impacts associated with homesteading, grazing, oil and gas production, and road building from 1880 to 1940 on ALE have been described in Hinds and Rogers (1991). Comprehensive listings of these information resources covering most of the time period from 1952 through 1994 are found in Pacific Northwest Laboratory (1977), Becker and Gray (1989), and Gray (1994a, 1994b).

3.4 Terrestrial Vegetation Types

The Hanford Site has been classified botanically as a shrub-steppe ecosystem (Daubenmire 1970). Such ecosystems are typically dominated by a shrub overstory with an understory of grasses.

A total of 590 species of vascular plants have been recorded at the Hanford Site. Of these, approximately 20% are considered non-native, or introduced (Sackschewsky et al. 1992). The majority of the tree species found at Hanford, and many noxious herbaceous species, have been introduced. Not all of the 590 species at Hanford occur commonly on the Site.

An alternative perspective to vegetation types for classifying ecological spatial variation of the landscape is by habitat classification analysis. Habitats are a combination of vegetation types and topographical landform setting. The Hanford Site has been mapped into seven habitat types: basalt outcrops, scarps, and scree; riparian streams and springs; shrub steppe on slopes; riverine and riparian habitat along the Columbia River; sand dunes and blowouts; abandoned fields and disturbed areas; and shrub steppe on the Columbia River Plain (Downs et al. 1993).

Within the broadly defined shrub-steppe ecosystem are four recognizable vegetation types: shrublands, grasslands, tree zones, and riparian areas. Table 13.1 identifies the vegetation types found at Hanford and at all other sites discussed in this document.

3.4.1 Shrublands

Shrublands occupy the largest area in terms of acreage on the Hanford Site. Six of the nine vegetation types found on the Hanford Site occur in the shrublands, and most terrestrial wildlife species use these areas. Important habitats within shrublands include canyons, upland habitats, basalt outcrops, and cliffs.

The shrubland type comprises seven of the nine major plant communities recognized at Hanford (Sackschewsky et al. 1992):

- sagebrush/cheatgrass/Sandberg's bluegrass^(a)
- sagebrush/bitterbrush/Sandberg's bluegrass/cheatgrass
- sagebrush/bluebunch wheatgrass/Sandberg's bluegrass
- spiny hopsage
- greasewood/cheatgrass/saltgrass
- winterfat/sandberg's bluegrass
- thyme buckwheat/Sandberg's bluegrass.

Sagebrush-dominated plant communities are the largest plant communities in terms of acreage at the Hanford Site. The other shrub communities are much smaller in size and reflect differences in soil type and location. Greasewood and hopsage, for example, occupy sites on alkaline clayey soils, while buckwheat is found on rocky areas with shallow soils at higher elevations.

(a) Generally, only common names (when available) are used in this report. See Appendix A for scientific names.

3.4.2 Grasslands

Most grasses occur as an understory in shrub-dominated plant communities. Before the area was settled in the 1800s, the dominant plant association was big sagebrush with an understory of native perennial grasses, such as bluebunch wheatgrass or Sandberg's bluegrass (Cushing 1991). Today, cheatgrass has replaced native perennial grass species in many lower elevations on the Hanford Site, particularly on disturbed areas. It has also dominated many old field locations that have not been cultivated in over 50 years.

Native grass species found at Hanford include bluebunch wheatgrass, Sandberg's bluegrass, needle-and-thread grass, Indian ricegrass, thick-spike wheatgrass, and sand dropseed. Bluebunch wheatgrass, a common native grass, is generally found at higher elevations in association with sagebrush. Sandberg's bluegrass is more widespread, occurring in several plant community types across the Site. Some native perennials such as needle-and-thread grass and thick-spike wheatgrass prefer sandy soils and often grow on sand dunes. Grasses preferring moist locations, particularly along the Columbia River (riparian areas), include bentgrasses, meadow foxtail, lovegrasses, and reed canarygrass.

Many of the grass species found at Hanford are introduced species. The most common introduced annual grass is cheatgrass, which was brought into the area during early settlement. It can be found in pure stands on areas farmed before 1943 and on those areas extensively modified by wildfire. Cheatgrass is one of the first species to invade disturbed areas at Hanford.

3.4.3 Tree Zones

The third major vegetation type at Hanford consists of groves or stands of trees. The dryland areas of Hanford lacked trees before settlement but were planted with trees before 1943 as windbreaks and to provide shade for irrigated farmland. Approximately 23 species of trees occur on the Hanford Site. Some of the more commonly occurring tree species include black locust, Russian olive, cottonwood, mulberry, sycamore, and poplar. Although introduced, trees now provide critical habitat for a variety of wildlife, including nest sites for raptors and songbirds, and hiding and thermal cover for several other species of wildlife. Some species (e.g., cottonwood, poplar, and Russian olive) have become established along perennial waters of the Columbia River and are a functional component of riparian areas.

3.4.4 Riparian Areas

The majority of riparian habitat occurs along the Columbia River, where species of willow dominate. Other areas that support riparian vegetation include perennial springs and seeps and artificial water sources, including ponds and ditches. Although small in terms of acreage, riparian areas are very important not only for food and cover but as nesting sites for a variety of wildlife species.

3.5 Terrestrial Wildlife

Almost 240 species of terrestrial vertebrates have been observed on the Hanford Site. Included are 40 species of mammals, 187 species of birds, 3 species of amphibians, and 9 species of reptiles. All four terrestrial habitats on the Hanford Site are important, including riparian areas along the Columbia River, native shrub and grasslands, canyons, upland habitats, basalt outcroppings and cliffs, and abandoned buildings (Fitzner and Gray 1991).

3.5.1 Shrubland and Grassland Wildlife

All major groups of terrestrial wildlife, except amphibians, can be found in the shrublands and grasslands. Common mammal species include mule deer and Rocky Mountain elk; predators such as coyotes, bobcats, and badgers; and a variety of small mammals including mice, ground squirrels, voles, and rabbits. Both deer and elk use shrub and grasslands at least a portion of the year to satisfy specific habitat needs.

Elk first appeared on the Hanford Site in 1972. Since that time, elk numbers have increased from approximately 8 animals in 1975 to over 180 in 1992. Elk are dependent on sagebrush areas for cover during the summer months and open grassland areas for foraging (Fitzner and Gray 1991). The herd of elk that inhabit the Hanford Site lives primarily on the ALE Reserve. A few pronghorn antelope were seen on the Wahluke Slope Wildlife Recreation Area and Saddle Mountain NWR in the late 1970s. None have been observed on-site since the winter of 1980-1981 (Fitzner and Gray 1991).

Among the more common species of birds that use the shrub- and grassland habitats are a variety of raptors, including the northern harrier, sharp-shinned hawk, rough-legged hawk, ferruginous hawk, Swainson's hawk, and golden eagle. Only the northern harrier, red-tailed hawk, and golden eagle occur year-round on the Hanford Site.

Other shrub-steppe bird species found at the Hanford Site include the sage sparrow, sage thrasher, and loggerhead shrike. These species depend on relatively undisturbed shrub-steppe habitat for nesting. Both the sage sparrow and loggerhead shrike nest in branches of shrubs like sagebrush and bitterbrush at lower elevations. Sage thrashers are more commonly found nesting in higher-elevation shrub communities.

Common upland bird species found in shrub- and grassland habitats include the chukar partridge, California quail, and Chinese ring-necked pheasant. Less common and rarely seen are sage grouse, gray partridge (aka Hungarian partridge), and scaled quail. Sage grouse, once more common, are now limited in distribution to the higher elevations on Rattlesnake Mountain. None of the upland birds are native to the area except the sage grouse (Fitzner and Gray 1991).

3.5.2 Tree Zone Wildlife

Trees found on the Hanford Site provide nesting sites and thermal cover for many wildlife species. Birds, including raptors, are known to use trees for nesting, perching, and roosting. Bald eagles use trees along the Columbia River as daytime perches and in some cases as communal night roosts. Several years of study indicate that bald eagle use of the Hanford Site during winter has increased. During the 1960s, 4

to 6 bald eagles were reported to use the Site (Cushing 1991), whereas 48 bald eagles have been counted at one time along the Hanford Reach during the winter months of October-January 1992-1993.^(a)

Other bird species that nest in trees on the Hanford Site include the ferruginous hawk, red-tailed hawk, and Swainson's hawk. Great blue herons also nest in groves of trees, called rookeries, on the Hanford Site. One well-established heron rookery is located in a grove of trees along the Columbia River in the vicinity of the White Bluffs boat launch.

3.5.3 Riparian Wildlife

Riparian areas provide nesting sites, food, and cover for a variety of wildlife species occurring on the Hanford Site. Approximately 9 species of mammals, 36 species of birds, and all 3 species of amphibians occur in riparian areas at Hanford (Fitzner and Gray 1991). Mammals include rodents, bats, furbearers (e.g., mink and weasels), and deer. White-tailed deer have been sighted on occasion along the Columbia River and at the Yakima River Delta near Richland, but are not common. Mule deer prefer habitats along the Columbia River and Rattlesnake Hills, but can be found almost anywhere on-site. Bird species that occur in riparian habitats include the common barn owl, northern saw-whet owl, California quail, Chinese ring-necked pheasant, and 28 species of passerine birds.

3.6 Aquatic Resources

Aquatic habitats and communities occur in association with the Columbia River, natural seeps, springs, and artificial ponds and ditches. Some of the typical aquatic vascular plant species found in these locations include water milfoil, water smartweed, pondweed, persistent sepal yellowcress, watercress, and duckweed (Cushing 1991).

The Columbia River is the primary aquatic ecosystem of the Hanford Site and supports a diverse community of plankton, benthic invertebrates, and fish species. It is the fifth largest river in North America, travelling approximately 2058 km (1240 mi) from the headwaters in Canada to the mouth at the Pacific Ocean. Forty-three species of fish are known to occur in the Columbia River (Cushing 1991). Among these are five species of anadromous fish; warm-water game species such as bass, crappie, and perch; and large populations of rough fish such as carp, suckers, and squawfish.

The Hanford Reach of the Columbia is the last free-flowing stretch of the Columbia River in the United States upstream from Bonneville Dam. Economically important salmonids like chinook, sockeye, coho, and steelhead migrate up the Hanford Reach to upstream spawning areas (Cushing 1991). Both chinook salmon and steelhead are known to spawn in the Hanford Reach of the Columbia River. The Hanford Reach is vital to the survival of the fall chinook salmon. It is the last major spawning site on the river that has not been affected by hydrological development (i.e., dams).

(a) Personal Communication, January 1993, Brett Tiller, Technical Specialist, Pacific Northwest Laboratory, Richland, Washington.

Other perennial water sources on the Hanford Site that provide aquatic habitat include Rattlesnake Springs, Snively Springs, and several artificial ponds and ditches. Ponds located north of the Columbia River are the result of irrigation runoff and support typical pond vegetation such as cattails. Other ponds located on-site are temporary and result from ponded wastewater.

3.7 Wildlife and Plant Species of Concern

Species of concern include federally listed threatened or endangered species, state-listed threatened or endangered species, and state species of concern.

3.7.1 Wildlife

Twenty-two animal species of concern are known to occur on the Hanford Site (Fitzner et al. 1991; Downs et al. 1993). These include federally-listed endangered, threatened and candidate species, as well as state-listed endangered and threatened species. Included are 2 invertebrates, 2 fish, 1 lizard, 12 birds, and 7 mammals:

- The California floater (mussel) and the Columbia pebblesnail, both federal candidate species, are found in the Columbia River along the Site.
- The river lamprey and the bull (Dolly varden) trout are both federal candidate species that are found in the Hanford Reach of the Columbia River.
- The northern sagebrush lizard, a federal candidate species, is found on the Hanford Site.
- Several federally listed raptor species occur on the Site. These include the northern goshawk (federal candidate species), the ferruginous hawk (federal candidate and state threatened), the American peregrine falcon (federal and state-listed endangered), and the bald eagle (federal and state-listed threatened). Other bird species of concern are the American white pelican (state endangered), the Aleutian Canada goose (federally listed threatened and state-listed endangered), the western sage grouse (federal candidate), the sandhill crane (state endangered), the black tern (federal candidate), the long-billed curlew (federal candidate), and the western burrowing owl (federal candidate). The loggerhead shrike is also potentially listed as a federal and state candidate species.
- Five species of bats found on the Hanford Site are federal candidate species. These include the small-footed myotis, fringed myotis, long-legged myotis, yuma myotis, and Pale Townsend's big-eared bat. Other mammal species of concern found on the Site include the Washington ground squirrel (federal candidate) and the pygmy rabbit (federal candidate and state endangered).
- In addition to state-listed endangered or threatened species, seven state candidate bird species have been found on the Hanford Site including the common loon, the Golden Eagle, the sage sparrow, the sage thrasher, the flammulated owl, Lewis' woodpecker, and the Swainson's hawk.

3.7.2 Plants

Currently, seven species of plants found on the Hanford Site are listed as sensitive, threatened, or endangered species by Washington State or are federal candidates for listing as threatened or endangered (Sackschewsky et al. 1992). An additional 5 species are found nearby off-site (Downs et al. 1993).

Wetland plants of concern on the Hanford Site include five species known to occur along the shoreline of the Columbia River. These include persistent sepal (Columbia) yellowcress, a state endangered and federal candidate species, and four state sensitive species: southern mudwort, dense sedge, false pimpernel, and shining flatsedge (Washington Natural Heritage Program 1990).

Other species of concern on or nearby the Hanford Site include seven plant species that occur in upland habitats. These include northern wormwood, a state endangered and federal candidate species, Columbia milk-vetch, and Hoover's deserts parsley, both state threatened and federal candidate species; Piper's daisy, gray cryptantha, bristly cryplantha, and dwarf evening primrose are all state sensitive species.

3.8 Ecological Management Issues at Hanford

Key ecological issues at the Hanford Site include the protection and management of important habitats and the management of sensitive species and restoration of key habitats. This includes protection and management of the extensive shrublands that provide essential habitat to most of Hanford's terrestrial vertebrates, of native shrubs and grasses, and of the riparian areas along the Hanford Reach, one of the few remaining free-flowing stretches of the Columbia River.

3.8.1 Shrublands

The primary issue regarding shrublands is the expanding elk herd on the Hanford Site. At current rates of expansion, the Hanford elk population has the potential to exceed the carrying capacity of the Site. This increase in herd numbers would have implications for adjoining private lands. In the past, crop damage on pasture lands adjoining the Hanford Site prompted the Washington State Department of Wildlife to implement a restricted elk hunt on private land bordering the ALE Reserve (Woodruff et al. 1990).

3.8.2 Grasslands

The most extensive grasslands on the Hanford Site are dominated by cheatgrass, an introduced annual noxious grass species. These areas include lands disturbed by farming before 1943 and areas burned by large wildfires within the last 15 years. Expansion of cheatgrass as a result of wildfire or management activities on the Hanford Site could result in the loss of native shrub/grass communities. This could contribute to an additional loss of critical wildlife habitat and could affect native plant cover in the watershed. Native vegetation, including sagebrush, is currently being restored to some of these burned areas, with various degrees of success (Sackschewsky et al. 1992).

3.8.3 Aquatic Resources

Currently, the Hanford Reach of the Columbia River is being considered for inclusion into the Wild and Scenic Rivers Program (National Park Service 1992). Public Law 100-605, passed in 1988, requires an inventory and evaluation of the Hanford Reach's resources and analysis of alternatives for protection, including Wild and Scenic designation. By virtue of its proximity to the Hanford Site, the Hanford Reach and its diverse resources receive a high degree of protection from human disturbance. Designation of the Hanford Reach within the Wild and Scenic Rivers Program will perpetuate the resource management priority that has been established for this part of the Columbia River.

4.0 Idaho National Engineering Laboratory

This section discusses ecological resources managed by DOE at the Idaho National Engineering Laboratory (INEL) Site in southeastern Idaho (Figure 4.1). Included is a brief description of the INEL Site; its climate; sources for its ecological resource information, the major ecological groups, and common associated plant and animal species (both terrestrial and aquatic); plant and wildlife species of concern; and key ecological management issues. Species of concern include federally listed species, federal candidate species, and other special-status species (e.g., Bureau of Land Management sensitive species).

4.1 Site Description

The INEL Site occupies an area of approximately 2300 km² (890 mi²) in portions of Butte, Bonneville, Bingham, Jefferson, and Clark counties in southeastern Idaho, 35 km (22 mi) west of Idaho Falls. The INEL was established in 1949 to further the development of nuclear energy as a reliable resource. DOE programs at the Site include uranium recovery from highly enriched spent fuels, operation of research reactors, and storage of solid transuranic wastes.

The Site is located on the upper Snake River Plain and is characterized by flat to gently rolling topography with frequent lava outcrops typical of the Columbia Plateau Province (Arthur et al. 1984). The average elevation of the Site is 1500 m (4900 ft). Prominent geologic features include two large buttes of volcanic origin located near the southeastern boundary of the Site. East Butte is 1952 m (6402 ft) and Middle Butte is 2014 m (6606 ft) in elevation. Big Southern Butte, located off-site, but near the south boundary of the INEL Site, is 2309 m (7574 ft) in elevation. Other topographical features of the Site include several small cinder cones, craters, and exposed lava ridges (Reynolds et al. 1986).

The INEL Site is mainly undeveloped land with major facilities and activities occupying approximately 2% to 3% of the total land area. The Site was established in the late 1940s and has been closed to the public since 1949. Nonindustrial activities, such as livestock grazing, have occurred on portions of the Site since before its establishment. Domestic livestock, including sheep and cattle, currently graze approximately 119,782 ha (295,863 acres) on-site.^(a) The Bureau of Land Management (BLM), Idaho Falls District, administers livestock grazing on-site through management of eight grazing allotments. Livestock use of these grazing allotments is regulated by limiting the number of livestock that can use each allotment and by establishing seasons of use for each area.

(a) Personal Communication, March 1993, Joe Lowe, Bureau of Land Management, Idaho Falls District, Idaho Falls, Idaho.

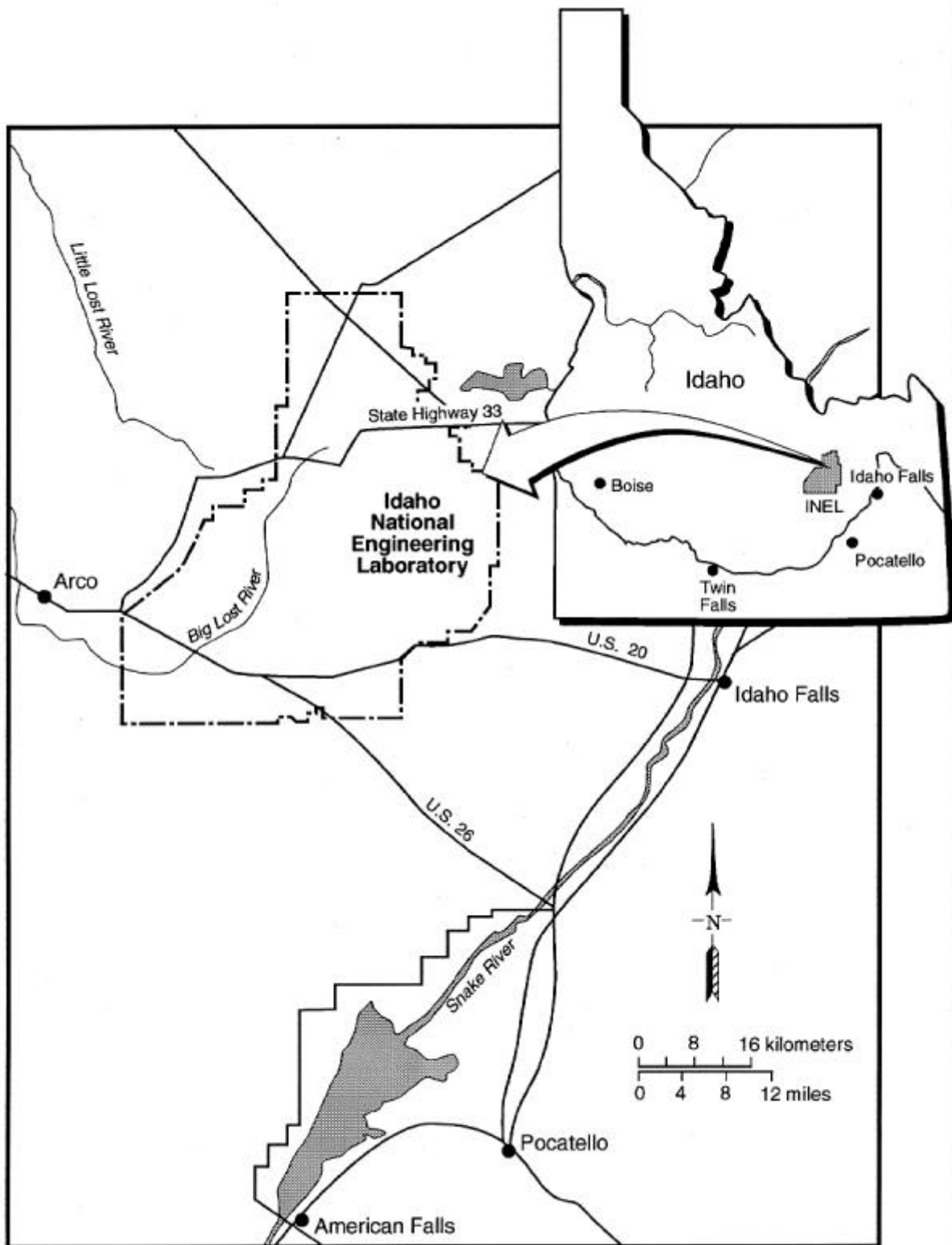


Figure 4.1. Idaho National Engineering Laboratory, Idaho

4.2 Climate

The INEL has a mid-latitude semiarid climate (Critchfield 1974). Meteorological data are available from on-site measurements at the Central Facilities Area Meteorology Station and other on-site monitoring locations (Clawson et al. 1989). On average, the maximum daily temperature exceeds 32°C (90°F) 25 days per year and is below 0°C (32°F) 60 days per year; the minimum daily temperature is below 0°C (32°F) 214 days per year and is below -18°C (0°F) 34 days per year (Clawson et al. 1989). July is the warmest month, with daily maximum and minimum temperatures averaging 31°C (87°F) and 9°C (49°F), respectively. January is the coolest month, with daily maximum and minimum temperatures averaging -3°C (27°F) and -15°C (5°F), respectively (Clawson et al. 1989). Average annual precipitation on the Site is 22 cm (8.6 in.) Measurable precipitation (defined as 0.025 cm [0.01 in.] or greater) is recorded on an average of 69 days per year, and the area experiences an average of 23 thunderstorm days per year. The average annual snowfall is 70 cm (28 in.) and daily snowfall accumulations of 2.5 cm (1 in.) or greater occur an average of 10 days per year (Clawson et al. 1989). Additional climatological information is summarized in Holdren et al. (1994) and presented in detail in Clawson et al. (1989).

4.3 Sources for Ecological Resource Information

The Environmental Science and Research Foundation (formerly the INEL Radioecology and Ecology Program) has been active in conducting ecological-related research at the Site. In 1975, the Site was designated a National Environmental Research Park (NERP), with a mission to study the effects of energy development and technology on a cool desert biome. Since 1975, both state and federal agencies, and several colleges and universities, have participated in research in the INEL Radioecology and Ecology Program.

4.4 Terrestrial Vegetation Types

The INEL Site and surrounding Snake River Plain are located in a cool desert-shrub biome. Shrub-steppe vegetation covers a majority of the Site, with shrubs such as big sagebrush occurring as the overstory with an understory of grasses. Reynolds et al. (1986) reported that almost 87% of the NERP is shrub-steppe, with the remainder of the Site being grassland (7%), juniper woodland (3%), and aquatic, riparian, or irrigated acreage (3%). A total of 406 plant species are known to occur on the INEL Site.^(a) Four distinct vegetation types occur within the cool desert-shrub biome at the Site: shrublands, grasslands, juniper woodlands, and riparian areas (McBride et al. 1978). Table 13.1 identifies the vegetation types found at INEL and at all other sites discussed in this document.

4.4.1 Shrublands

Shrub-dominated plant communities occupy a majority of the INEL Site, with species such as sagebrush occurring over much of the area. Of the 20 vegetation types discussed in McBride et al.

(a) Personal communication, December 1994, Randall Morris, INEL, Idaho Falls, Idaho.

(1978), 13 are predominately shrub communities with grass species occurring in the understory. Differences in the shrub species that characterize these communities reflect changes in precipitation, soils, and elevation. The following shrub communities are included within the shrubland group:

- **Sagebrush vegetation types** - Sagebrush is the predominate shrub in 9 of the 13 shrub communities (McBride et al. 1978). Included are big sagebrush and low sage. Other shrub species that occur in association with big sagebrush and low sage include green rabbitbrush, winterfat, shadscale, and threetip sagebrush. Perennial grasses occurring in the understory in association with big sagebrush and low sage include bluebunch wheatgrass, bottlebrush squirreltail, thickspike wheatgrass, needle-and-thread grass, and Indian ricegrass.
- **Gray horsebrush-green rabbitbrush-big sagebrush vegetation type** - Gray horsebrush, green rabbitbrush, and big sagebrush occur in association in the northwest and northeast portions of the Site. Associated grasses include bottlebrush squirreltail and thickspike wheatgrass.
- **Green rabbitbrush-big sagebrush-grass vegetation type**. Green rabbitbrush, occurring in association with big sagebrush and grasses such as bluebunch wheatgrass, bottlebrush squirreltail, and western wheatgrass compose a third vegetation type. Within this type, some variation in shrub dominance occurs, with big sagebrush occurring more frequently than rabbitbrush in several locations.
- **Saltsage-winterfat-Indian ricegrass vegetation type** - This vegetation type is characterized by saltsage and winterfat with an understory of Indian ricegrass. In certain locations within this type, big sagebrush and shadscale are more abundant, as are perennial grasses such as thickspike wheatgrass, and western wheatgrass.
- **Mixed shrub vegetation type** - This type is restricted to lava flows that occur along the southcentral portion of the Site. Shrubs, such as big sagebrush, occur in crevices and depressions in the lava.

4.4.2 Grasslands

Although grasses typically occur as an understory in component shrub habitats, there are some areas of the INEL Site where grass species predominate. McBride et al. (1978) discuss five grassland vegetation types occurring on the INEL Site, including native and introduced perennial grassland areas:

- **Bluebunch wheatgrass-threetip sagebrush-green rabbitbrush vegetation type** - This grassland type is limited to one area adjacent to East Butte in the southeast corner of the Site.
- **Western wheatgrass-poverty weed-Baltic rush vegetation type** - This grassland type occupies a limited area along the Big Lost River, which is seasonally flooded. The predominant plant species occurring in this type are western wheatgrass, poverty weed, and Baltic rush.
- **Indian ricegrass-green rabbitbrush-prickly pear vegetation type** - Predominant species typical of this vegetation type include Indian ricegrass, green rabbitbrush, and prickly pear. Also common in this type is gray horsebrush and needle-and-thread grass. This vegetation type occurs in sandy soils.

- **Giant wildrye-green rabbitbrush-big sagebrush vegetation type** - Giant wildrye is a tall native perennial grass that can occur in nearly pure stands. A majority of the giant wildrye on the INEL Site occurs in scattered locations across the southern half of the Site. These areas are typified by deep clayey soils, usually in depressions between lava ridges where seasonal moisture accumulates. Green rabbitbrush and big sagebrush may also occur in this vegetation type.
- **Crested wheatgrass vegetation type** - This introduced species typifies several areas on-site. During the late 1950s and early 1960s, approximately 4000 ha (9880 acres) were seeded with crested wheatgrass to control noxious weeds, increase the grazing capacity for livestock, and rehabilitate areas burned by wildfire.

4.4.3 Juniper Woodlands

Juniper woodland occupies approximately 3% of the southeast and northwest portions of the INEL Site (Reynolds et al. 1986). Both Utah juniper and Rocky Mountain juniper occur in this vegetation type. Big sagebrush, threetip sagebrush, green rabbitbrush, and shrubby buckwheat also occur in this type. Perennial grasses found in the juniper woodland type include bluebunch wheatgrass and Indian ricegrass. The occurrence of grasses and forbs in this type can vary considerably because of competition with juniper for available moisture.

4.4.4 Riparian Areas

Surface water and associated riparian vegetation occur in association with Big Lost River, Birch Creek, and Little Lost River (Reynolds et al. 1986). The Big Lost River enters the Site from the southwest and flows northward before percolating into sinks at the northwest corner of the Site. Birch Creek and Little Lost River flow from the northwest but are diverted off-site for irrigation purposes before entering the Site. Off-site irrigation demands and annual snowpack regulate the flow of the Big Lost River, which may not flow onto the Site every year. Riparian vegetation occurring along the Big Lost River and Birch Creek includes cottonwood and willow.

4.5 Terrestrial Wildlife

A total of 262 terrestrial vertebrate species have been recorded at the INEL Site. Included are 46 species of mammals, 204 species of birds, 2 species of amphibians, and 10 species of reptiles.^(a) Terrestrial habitats, taken from Arthur et al. (1984) and described below with their associated wildlife, include shrubland and grassland habitats, riparian zones, and juniper foothills; other areas, such as agricultural areas and irrigated lawns near facilities, also host various species. Agricultural areas are located off-site on adjacent private lands at the northwest and northeast boundaries of the Site.

(a) Personal communication, December 1994, Randall Morris, INEL, Idaho Falls, Idaho.

4.5.1 Shrubland and Grassland Wildlife

All major groups of terrestrial wildlife, except amphibians, occur in shrub- and grassland habitats on the INEL Site (Reynolds et al. 1986). Large herbivores known to occur on-site include pronghorn antelope and mule deer. Other large herbivores that may occur on a transient or occasional basis are elk, moose, and mountain sheep.

Carnivores include predatory species such as coyote, long-tailed weasel, and bobcat. There have also been two confirmed sightings of mountain lions on-site.^(a)

A variety of small mammals have also been recorded on-site. Small mammals from four taxa known to occur on the Site are chiropterans (i.e., bats), insectivores (i.e., shrews), lagomorphs (i.e., rabbits), and rodents (i.e., ground squirrels, chipmunks, mice, and voles). Allred (1973) reported the deer mouse to be the most abundant small mammal found in 10 of 12 plant communities examined on-site. The pygmy rabbit, a federal candidate species, is common in shrub-steppe and rocky outcrop habitats.

Over 204 species of birds are known to occur on-site at various times of the year. Among the more common species that utilize shrubland and grassland habitats are a variety of raptor species, including northern harrier, rough-legged hawk, golden eagle, and American kestrel.

Less common or rarely observed raptor species recorded include Swainson's hawk, red-tailed hawk, ferruginous hawk, sharp-shinned hawk, Cooper's hawk, northern goshawk, osprey, merlin, prairie falcon, and gyrfalcon. Six species of owls have also been recorded but most occur infrequently. Only the great horned owl is a year-round resident. The bald eagle also occurs as an uncommon winter migrant. The peregrine falcon has been sighted, but only rarely. Raptors generally occur sitewide, using a variety of habitats, including shrub- and grasslands.

Other common bird species occurring in shrub- and grassland habitats on the INEL Site include the horned lark, sage thrasher, Brewer's sparrow, sage sparrow, and western meadowlark. Bird species commonly found sitewide include the killdeer, rock dove, mourning dove, common nighthawk, black-billed magpie, American robin, and Brewer's blackbird.

Upland game bird species found on-site include the gray partridge, chukar, Chinese ring-necked pheasant, and sage grouse. The blue grouse occurs only occasionally at the INEL.

Ten species of reptiles occur in shrub-steppe habitats, including the short-horned lizard, sagebrush lizard, striped whipsnake, gopher snake, western terrestrial garter snake, and western rattlesnake. Most of these species occur sitewide where suitable habitat exists (Reynolds et al. 1986).

(a) Personal communication, December 1994, Randall Morris, INEL, Idaho Falls, Idaho.

4.5.2 Riparian Wildlife

Riparian habitat is quite limited at the INEL Site, accounting for less than 3% of the Site. A majority of this habitat is located along the Big Lost River and Birch Creek. Approximately 41 species of birds are known to use riparian areas there. Included are several species of perching birds that use riparian vegetation such as cottonwood and willow for cover and nesting during the breeding season. One mammal species, the hoary bat, is also reported to use riparian habitats on-site.

4.5.3 Juniper Woodland Wildlife

Juniper woodlands found on the INEL Site provide nest and cover for many wildlife species (Reynolds et al. 1986). Mammals that occur in juniper woodland habitats include the long-eared myotis, hoary bat, bobcat, deer mouse, coyote, and badger.

Birds known to use junipers for nesting include several species of perching birds, such as Say's phoebe, western kingbird, eastern kingbird, tree swallow, violet-green swallow, northern rough-winged swallow, bank swallow, cliff swallow, and barn swallow. The Clark's nutcracker also uses juniper habitats but is not known to breed on-site. The northern mockingbird has been observed infrequently on-site in juniper woodlands during the summer. Reynolds et al. (1986) reported that the Clark's nutcracker and northern mockingbird are the only bird species that occur exclusively in juniper woodlands. Craig (1979) reported that red-tailed hawks also nest in junipers on the INEL Site.

4.6 Aquatic Resources

Shallow ephemeral lakes at the terminus of the Big Lost River and at flood control areas created by diversion dams in the south provide most of the aquatic habitat at the INEL Site. Several species of migratory waterfowl and shore birds use these shallow lakes during the breeding season. Mammals reported to use these areas include beaver and muskrat. One amphibian species, the Great Basin spadefoot toad, has also been documented utilizing shallow lakes and ponds located at the sinks and flood control areas (Sehman and Linder 1978). Reynolds et al. (1986) reported six fish species, all in the Big Lost River: kokanee salmon, rainbow trout, brook trout, mountain whitefish, speckled dace, and shorthead sculpin. Only the rainbow trout and shorthead sculpin are commonly found on-site.

4.7 Wildlife and Plant Species of Concern

4.7.1 Wildlife

Species of concern include federally listed threatened or endangered species, federal candidate species, and other categories of sensitive species. Twelve animal species of concern are known to occur on the INEL Site (Moseley and Groves 1992). These include two species of mammals and 10 species of birds.

Mammal species of concern occurring on-site include the Townsend's big-eared bat and pygmy rabbit, both federal candidate species. The big-eared bat is reported to be abundant and occurs statewide

where suitable habitat, such as caves and lava tubes, exist (Reynolds et al. 1986). The pygmy rabbit, also common on INEL, occurs in shrub-steppe and rocky outcrop habitats.

Federally listed raptor species include the bald eagle and peregrine falcon, both federal endangered species. Bald eagles are infrequent visitors to the Site, occurring mainly during the winter. The peregrine falcon has been sighted infrequently and does not commonly occur on-site.

The ferruginous hawk and northern goshawk, both federal candidate species, occur on-site. Ferruginous hawks occur primarily during the breeding season. The number of ferruginous hawks nesting on-site suffered a decline in the recent past due to lack of suitable nest sites or a decline in prey species abundance (Craig 1979). However, since that time, the population of ferruginous hawks nesting on-site has increased (Hansen 1994). The northern goshawk, normally associated with forested settings, occurs only rarely on-site as a winter migrant.

Raptor species classified as sensitive by the BLM and known to occur on-site include Swainson's hawk, merlin, gyrfalcon, and burrowing owl. Swainson's hawk is an uncommon raptor that nests on-site, but occurs only rarely during the winter. Craig (1979) reported that nest sites for this species were located primarily in cottonwood trees along the Big Lost River or adjacent to agricultural areas. Both the merlin and gyrfalcon have been rarely observed on-site. The gyrfalcon is a raptor species not normally expected to occur on-site. Burrowing owls, uncommon on-site, may use shrub-steppe habitats. Reynolds et al. (1986) reported that on-site raptor populations varied in numbers, particularly in the winter, in response to fluctuations in prey species such as the black-tailed jackrabbit.

Other bird species of concern include the loggerhead shrike and the long-billed curlew. The loggerhead shrike, a federal candidate species, occurs at the INEL Site during the summer breeding season and is found in shrub-steppe habitats sitewide. The long-billed curlew, a BLM sensitive species, is an uncommon summer visitor to the Site, occurring in shrub-steppe habitat in association with water.

4.7.2 Plants

Currently, nine species of plants occurring on the Site are considered species of concern (Moseley and Groves 1992). None are currently listed as federally threatened or endangered. Federal Category 3 candidates are generally more abundant and, therefore, are not subject to identifiable threats (Moseley and Groves 1992).

Other species of concern include 10 plants classified as sensitive by the BLM: Lemhi milkvetch, plains milkvetch, thistle milkvetch, winged-seed evening primrose, nipple cactus, large-flowered gymnosteris, spreading gilia, king's bladderpod, and tree-like oxytheca.

4.8 Ecological Management Issues at INEL

Key ecological issues at INEL include the management and protection of sensitive shrub-steppe habitats (including the control of noxious weeds and the effects of reduced water supply in streams on-site), crop depredation of adjoining agricultural lands, and protection of riparian and aquatic habitats.

4.8.1 Shrub-Steppe Habitats

The shrub-steppe habitat is identified as sensitive sitewide because of potential loss or fragmentation through both natural and human disturbances such as facility and roadway expansion, off-road vehicle travel, wildfire, and spread of noxious weeds. The arid climate of the INEL Site makes recovery of any disturbed native habitat, particularly shrub-steppe, a very slow process.

The spread of noxious weeds such as cheatgrass is a primary concern because of the aggressive nature of this plant and its ability to outcompete native plants for moisture. In areas of the Site, conversions to communities dominated by annual plant species appear to be irreversible (Anderson and Shumar 1989). Areas where native vegetation has been eliminated following wildfire may be especially subject to cheatgrass invasion.

4.8.2 Wildlife Management

Another major issue involving ecological resources on-site is crop depredation of adjacent agricultural lands by large ungulates such as elk and pronghorn antelope that reside on-site. Past efforts to limit crop depredation by these species included depredation hunts for pronghorn antelope in the Mud Lake area (Strohmeier 1992) and the recent capture and removal of 200 elk from the Site.

4.8.3 Riparian/Aquatic Habitats

Surface water and associated riparian vegetation provide critical habitat for a variety of wildlife species on INEL. Several years of drought and off-site agricultural diversion of water from the Big Lost River and Birch Creek have reduced the amount of water available to support aquatic and riparian habitats. Except for a short period of time in 1992, water has not flowed in the Big Lost River on-site since 1984, eliminating the shallow ephemeral lakes normally available for wildlife. Artificial ponds located near on-site facilities are heavily used by waterfowl. Riparian vegetation located along the Big Lost River is dying as a result of the lack of water in this stream. Wildlife species dependent on riparian habitats include a variety of shorebirds, raptors, perching birds, and small mammals.

4.8.4 Management of Caves

An unknown number of caves on the INEL Site provide habitat for Townsend's big-eared bats, western rattlesnakes, owls, and several other species. In addition, valuable archeological resources are frequently found in caves. The biological and archeological resources in the caves are sensitive to disturbance by human activities. The habitat needs of the Townsend's big-eared bats and some other cave-visiting species are poorly understood and experiments are underway to improve the knowledge base. The results of these experiments will be important to help determine how to manage the caves for the protection of all the resources contained therein.

5.0 Lawrence Livermore National Laboratory Site 300

This section discusses ecological resources managed by DOE at the Lawrence Livermore National Laboratory (LLNL) Site 300 in northern California (Figure 5.1). Included are brief descriptions of LLNL Site 300, its climate, sources for the ecological resource information used here, the major habitat types, and associated plant and animal species, as well as plant and animal species of concern and ecological management issues. The species of concern include federally listed threatened or endangered species, federal candidate species, and species of statewide significance.

5.1 Site Description

The LLNL Site 300 is located 27 km (17 mi) southeast of Livermore and 13 km (8.5 mi) southwest of Tracy, California, in portions of San Joaquin and Alameda Counties. The Site occupies 28 km² (11 mi²), most which lies in San Joaquin County. The Site is located in the southeastern Altamont Hills of the Diablo Range of the Coast Range Physiographic Province. Topography of the Site is irregular with ridges oriented northwest to southeast. Elevations range between 152 and 533 m (500 to 1750 ft).

The LLNL Site 300 is a high-explosive test facility that has supported the LLNL Weapons Program mission since the 1950s. Programmatic operations conducted at the Site include high-explosive formulations and machinations, dynamics testing, weapons testing, and other experimentation that does not involve high explosives (Webster-Scholten 1994).

Before use by the University of California Radiation Laboratory, the area was grazed by sheep and cattle. In addition to areas developed for facility operations, LLNL Site 300 includes a 3.01-ha (7.44-acre) parcel and a 4.69-ha (11.6-acre) parcel located at the area's eastern and southeastern edges, respectively.^(a) Currently, these areas are not developed for facility operations, with proposals for uses of the land incidental to remediation of General Service Areas.^(b)

The California Department of Fish and Game (CDF&G) owns approximately 90 acres of land originally owned by DOE adjacent to the southeast boundary of Site 300. This property is managed for various sensitive herpetofauna species and the habitat is characterized as northern riparian woodland. This property is commonly referred to as the CDF&G "Ecoreserve" or Ecological Reserve.

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- (a) K. Graham, 1990, Assistant Laboratory Counsel, LLNL, personal communication with L. Glick, Weiss Associates.
 - (b) K. Graham, 1991, Assistant Laboratory Counsel, LLNL, personal communication with E. Hill, geologist, Weiss Associates.

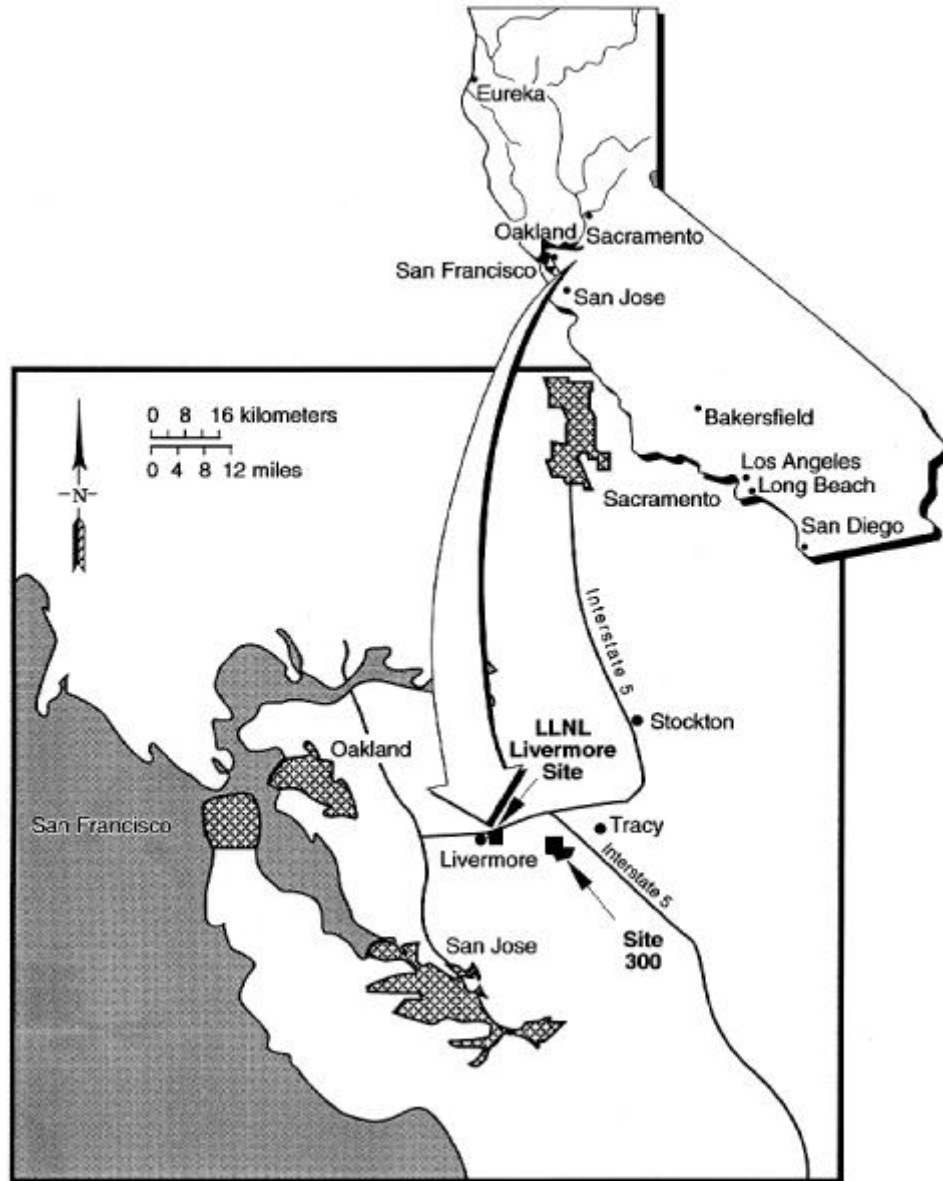


Figure 5.1. Lawrence Livermore National Laboratory Site, California

5.2 Climate

The LLNL Site 300 area has a dry summer subtropics climate (a Mediterranean-type climate regime) (Critchfield 1974). Meteorological data for the area are available from on-site measurements and from measurements at Stockton Metropolitan Airport in Stockton, California. On average, the maximum daily temperature exceeds 32°C (90°F) 86 days per year and fails to rise above 0°C (32°F) only once

every 10 years; the minimum daily temperature is below 0°C (32°F) 22 days per year and a temperature below -18°C (0°F) has not been recorded (DOC 1987d). July is the warmest month, with daily maximum and minimum temperatures averaging 35°C (95°F) and 16°C (61°F), respectively. January is the coolest month, with daily maximum and minimum temperatures averaging 12°C (53°F) and 3°C (38°F), respectively (DOC 1987d). Annual precipitation at Stockton is approximately 36 cm (14 in.), with about 90% falling from November through April (DOC 1987d). Measurable precipitation (defined as 0.025 cm [0.01 in.] or greater) is recorded on an average of 52 days per year and the area experiences an average of three thunderstorm days per year. The average annual snowfall is less than 1 cm (0.4 in.) and a daily snowfall accumulation of 2.5 cm (1 in.) or greater occurs less than once every 20 years (DOC 1987d). Monitoring at LLNL Site 300 indicates that annual precipitation is approximately 27 cm (11 in.), 25% less than at Stockton. Additional climatological information is summarized in Holdren et al. (1994).

5.3 Ecological Resource Background

Most ecological resource monitoring at LLNL Site 300 has taken place in the last 10 years. The principal sources of information are Site environmental reports, as well as sitewide remedial investigation reports and environmental impact statements. Some wildlife studies that focus on more specific areas of the Site are also available.

5.4 Terrestrial Vegetation Types

The LLNL Site 300 lies within the California biotic province (Munz and Keck 1968), which includes the interior valleys and surrounding hills in the central and northern parts of the state, the southern coastal area, and the coast ranges south of the San Francisco Bay. The primary vegetation is a grassland association bordered by blue oak woodlands to the south. Grassland habitat extends east, west, and north of LLNL Site 300, with northern riparian woodland, montane, and woodland habitats lying farther to the west, east, and south, respectively.

The landscape surrounding Site 300 has been extensively grazed by cattle and sheep or has been developed for vehicular recreation. The result has been degradation of riparian woodland and native bunch grass habitats. The LLNL Site 300, on the other hand, has received relatively minimal disturbance over the previous 40 years. The LLNL Site 300 is characterized by four upland and three wetland vegetation associations. Several unique habitats that cannot be classified as upland or wetland include a clay scald or scabland, a landslide, and a melicgrass sward (i.e., sod-grass grassland). Table 13.1 identifies the main vegetation types found at LLNL, as well as those found at all other sites discussed in this document.

Four primary areas of vegetation are discussed below: coastal sage scrub areas, grasslands, oak woodlands, and wetlands.

5.4.1 Coastal Sage Scrub

The scrub communities of LLNL Site 300 are characterized by a mixture of soft-chaparral shrubs. Coastal sage scrub habitat, a declining vegetation association in California, occurs on rocky areas of southwest-facing slopes in the southern portion of the Site. This association is dominated by California sage-brush, California buckwheat, black sage, and snakeweed. Coastal sage scrub occurs as three types, as defined by the percentage of grasses comprising the association. This association occupies approximately 43 ha (108 acres) of LLNL Site 300.

5.4.2 Grassland

Grasslands that dominate the landscape on LLNL Site 300 include native perennial pine bluegrass or introduced annual wild oat and brome. Annual grasslands comprise approximately 2287 ha (5647 acres). Species composition of non-native grassland habitats varies along successional gradients and with changing soil type.

The non-native grassland communities generally lack overstory vegetation. Species composition of non-native grassland communities has been influenced by historic cattle grazing, fire, and facility operations. Abundance and distribution of dominant vegetation species generally reflect the type and intensity of these disturbances.

Native grassland communities comprise 292 ha (723 acres) of LLNL Site 300. The dominant perennial species that occurs on the Site is pine bluegrass, whose occurrence is influenced by controlled burns that are used to manage 810 ha (2000 acres) of native and non-native grassland communities on the Site. Distribution of native and non-native grass species and occurrence of a forb component in the native grassland types vary with soil, slope, and aspect. The occurrence of native grasslands on LLNL Site 300 represents a unique feature of the Site because of its potential for research into native grassland systems that are declining in California.

5.4.3 Oak Woodlands

Woodland habitats are dominated by blue oak, which occurs on the more mesic north and west facing steep slopes in the southern portion of LLNL Site 300. The oak woodlands comprise approximately 60 ha (150 acres) of the Site, with annual grasslands occurring on drier sites.

5.4.4 Wetlands

The LLNL Site 300 has 2.74 ha (6.76 acres) of wetlands located in association with springs, runoff, and one vernal pool. Wetlands on-site are identifiable as herbaceous wetlands, riparian woodlands, and vernal pools. Herbaceous wetlands occur most frequently and have developed around natural springs or discharges from Site 300 facilities.

Herbaceous wetlands that can be characterized as one of three distinct types are influenced by the degree of soil saturation and include, in decreasing order of saturation, stands of cattail, alkali ryegrass, and rush (DOE 1992d).

Riparian woodlands are limited to isolated stands of Fremont cottonwood and willow that occur in canyons or shrublands (e.g., currant, elderberry, chokecherry) in association with springs.

Vernal pools occur as unique features within grassland habitats. Species such as annual hairgrass occur in these pools.

5.5 Terrestrial Wildlife

More than 116 terrestrial vertebrate species have been identified on LLNL Site 300. A total of 20 species of amphibians and reptiles, over 70 species of birds, and 26 species of mammals occur on the Site. Terrestrial habitats that support LLNL Site 300 wildlife include grassland areas, coastal sage scrub areas, oak woodlands, wetlands, and northern riparian woodlands (DOE 1992d).

Biological surveys are conducted on a project-by-project basis. LLNL has a Mitigation Monitoring and Reporting Program, which has specific Mitigation Measures (MM) requiring LLNL to minimize the potential impact of laboratory projects on the environment. For example, one MM requires a preconstruction survey for San Joaquin kit fox, American badger, burrowing owl, and blue elderberry bush habitat prior to ground disturbance. Therefore, LLNL is actively monitoring these species throughout the year.^(a)

5.5.1 Grassland Wildlife

Grasslands on LLNL Site 300 provide suitable habitat for mammals, birds, and reptiles. Mammal species include California ground squirrel, house mouse, deer mouse, Hermann's kangaroo rat, pocket gopher, California vole, and western harvest mouse. Lagomorphs include black-tailed jack rabbit and desert cottontail rabbit. Predatory species that are supported by the diverse prey base include long-tailed weasel, western spotted skunk, striped skunk, coyote, and badger.

Western meadowlark, horned lark, white-tailed kite, savannah sparrow, and northern harrier are common grassland bird species that frequent LLNL Site 300 (DOE 1992d). Short-eared owls and burrowing owls also prefer areas of tall grass cover. Site 300 is a vital foraging area for the region's golden eagle population and supports large numbers of these birds. Migratory raptors such as Swainson's hawk and ferruginous hawk have been observed during the winter months.^(a)

Reptiles that occur frequently within grasslands include racers and gopher snakes. Species that are adapted to open vegetation and more sandy soils (e.g., side-blotched lizards, California horned lizard) occur less frequently.

5.5.2 Coastal Sage Scrub Wildlife

Rocky areas within coastal sage scrub habitat support the California pocket mouse and desert woodrat. Cougar and bobcat are frequently observed on rocky areas. Coastal sage scrub supports Anna's hummingbird, rufous-crowned sparrow, and white-crowned sparrow. Rocky outcrops and cliffs

(a) Personal communication, January 1995, Jim Woollett, Jr., LLNL, Livermore, California.

provide breeding sites for white-throated swift, cliff swallow, Say's phoebe, and rock wren. Common raptor species that use rock ledges and cliffs include red-tailed hawk, peregrine falcon, great horned owl, and barn owl. Rocky soils characteristic of coastal sage scrub communities provide suitable habitat for species such as the western fence lizard, the western rattlesnake, and the Alameda whipsnake.

5.5.3 Oak Woodland Wildlife

Species that occur more frequently in nongrassland habitats include bobcat, gray fox, raccoon, western spotted skunk, and cougar. One species that has expanded its range in response to human disturbance and occurs more frequently near Site 300 is the red fox.

Woodlands also provide nesting habitat for western kingbird, northern oriole, loggerhead shrike, American goldfinch, and long-eared owl.

5.5.4 Wetland Wildlife

Riparian mammal species include striped skunk, western spotted skunk, and black-tailed deer.

Typical of other semiarid systems, water sources on the Site attract a variety of water-dependent species, including red-winged blackbird, tri-colored blackbird,

(a) Personal communication, December 1994, Tina Carlsen, LLNL, Livermore, California.

Bird species of concern found on the Site include the peregrine falcon, the golden eagle, the ferruginous hawk, and the swainson's hawk. Tricolored blackbirds, loggerhead shrikes, and horned larks, all federal candidate species, have also been observed.^(a)

Potential habitat exists on the Site for the San Joaquin kit fox, a federally-listed endangered species. No foxes have been observed on the Site, but individuals have been observed within 1.5 miles of the Site, at Carnegie New Town and the Tracy Hills proposed developments (Webster-Scholten 1994).

5.6.2 Plants

One plant species of concern has been observed on LLNL Site 300: large-flowered fiddleneck, a state and federal endangered species. An annual census is conducted at all known on-site populations of this plant. The 1994 survey showed a total population of over 1500 plants.^(b)

5.7 Ecological Management Issues at LLNL Site 300

Major ecological issues at LLNL Site 300 include management practices such as controlled habitat disturbances on the Site that affect the distribution and quality of vegetation and populations of wildlife.

5.7.1 Current Operations

Several management practices that affect LLNL Site 300 vegetation have been identified. Livestock grazing has historically occurred on LLNL Site 300 land, but was discontinued after 1953. Various studies describing the effects of livestock grazing discuss benefits and impacts to granivorous small mammals, songbirds, and raptors, and to wetland and riparian habitats. Maintenance of fire breaks on LLNL Site 300 includes annual disking and herbicide applications that affect vegetation as well. Currently, herbicide application is restricted on LLNL Site 300, but before 1980, many areas that are currently disked were treated with herbicides. Controlled burning is now used to control fuel loading of grass species.

5.7.2 Wildlife

Some operations of LLNL Site 300 may affect area wildlife. The flying debris or shock over pressure from outdoor explosives testing could impact certain species. In an effort to reduce those impacts, testing is limited to daylight hours, warning sounds are broadcast before testing, and explosions are conducted at infrequent intervals. Another potential impact to wildlife on LLNL Site 300 is ground squirrel poisoning, which is implemented on an as-needed basis. The rodenticide zinc phosphide is a grain bait that, upon ingestion, releases a phosphine gas internally. This control method has the lowest potential for impacting special-status species on-site of any commercially available pesticide. Use of the poison is confined to two fenced, high-explosive waste water impoundments and a landscaped area on the Site.

(a) Personal communication, January 1995, Jim Woollett, LLNL, Livermore, California.

(b) Personal communication, December 1994, Tina Carlsen, LLNL, Livermore, California.

6.0 Sandia National Laboratory

This section discusses ecological resources managed by DOE at the Sandia National Laboratory (SNL) Site in central New Mexico (Figure 6.1). Included are brief descriptions of the SNL Site, its climate, the background of the Site's ecological resources, the major habitats and their associated plant and animal species, the wildlife and plant species of concern, and key ecological management issues at SNL. The species of concern discussed include federal and state listed species.

6.1 Site Description

The SNL Site, located approximately 11 km (7 mi) east of Albuquerque, New Mexico, is surrounded by Kirtland Air Force Base (KAFB) East in Bernalillo County, with co-use agreements on some U.S. Air Force property. An 8505-ha (21,000-acre) area of the Manzano Mountains east of KAFB has been withdrawn from the Cibola National Forest for exclusive use by the Air Force and DOE. The SNL Site consists of five technical areas and several remote test areas situated in the eastern half of the 190-km² (73-mi²) KAFB military reservation. The KAFB is located on two broad mesas bisected by the Manzano Mountains to the east and the Rio Grande River to the west. Elevations range from 1500 m (4920 ft) at the Rio Grande to 3255 m (10,676 ft) at Sandia Crest, which is in the Sandia Mountains adjacent to Albuquerque. The Site is in the Albuquerque-Belen Basin.

The mission of the SNL Site includes adapting nuclear explosives to use as weapons and designing the arming, fusing, and firing systems in nuclear bombs and warheads. Other projects include nuclear reactor safety studies for the U.S. Nuclear Regulatory Commission, development of safe transport and storage systems for special nuclear materials including plutonium and uranium, radioactive waste disposal techniques and site studies, pulsed-power research, thermonuclear fusion research, solar energy research, vertical axis wind turbine research, and fossil fuel energy research (Culp and Cox 1991).

6.2 Climate

The SNL is near the boundary between a mid-latitude semiarid climate and a tropical semiarid climate (Critchfield 1974). Meteorological data are available from measurements at the Albuquerque International Airport, located immediately west of KAFB, with some meteorological monitoring conducted within KAFB. On average, the maximum daily temperature exceeds 32°C (90°F) 64 days per year and is below 0°C (32°F) 5 days per year; the minimum daily temperature is below 0°C (32°F) 120 days per year and is below -18°C (0°F) about once every two years (DOC 1987b). July is the warmest month, with daily maximum and minimum temperatures averaging 34°C (93°F) and 18°C (65°F), respectively. January is the coolest month, with daily maximum and minimum temperatures averaging 8°C (47°F) and -5°C (22°F), respectively (DOC 1987b). Annual precipitation approximately 21 cm (8 in.), with about 55% falling from July through October. Precipitation is about double in the Manzano Mountains to the east. Measurable precipitation (defined as 0.025 cm [0.01 in.] or greater) is recorded on an average of 60 days per year, and the area experiences an average of 42 thunderstorm days per year. The average annual snowfall is 28 cm (11 in.) and daily snowfall

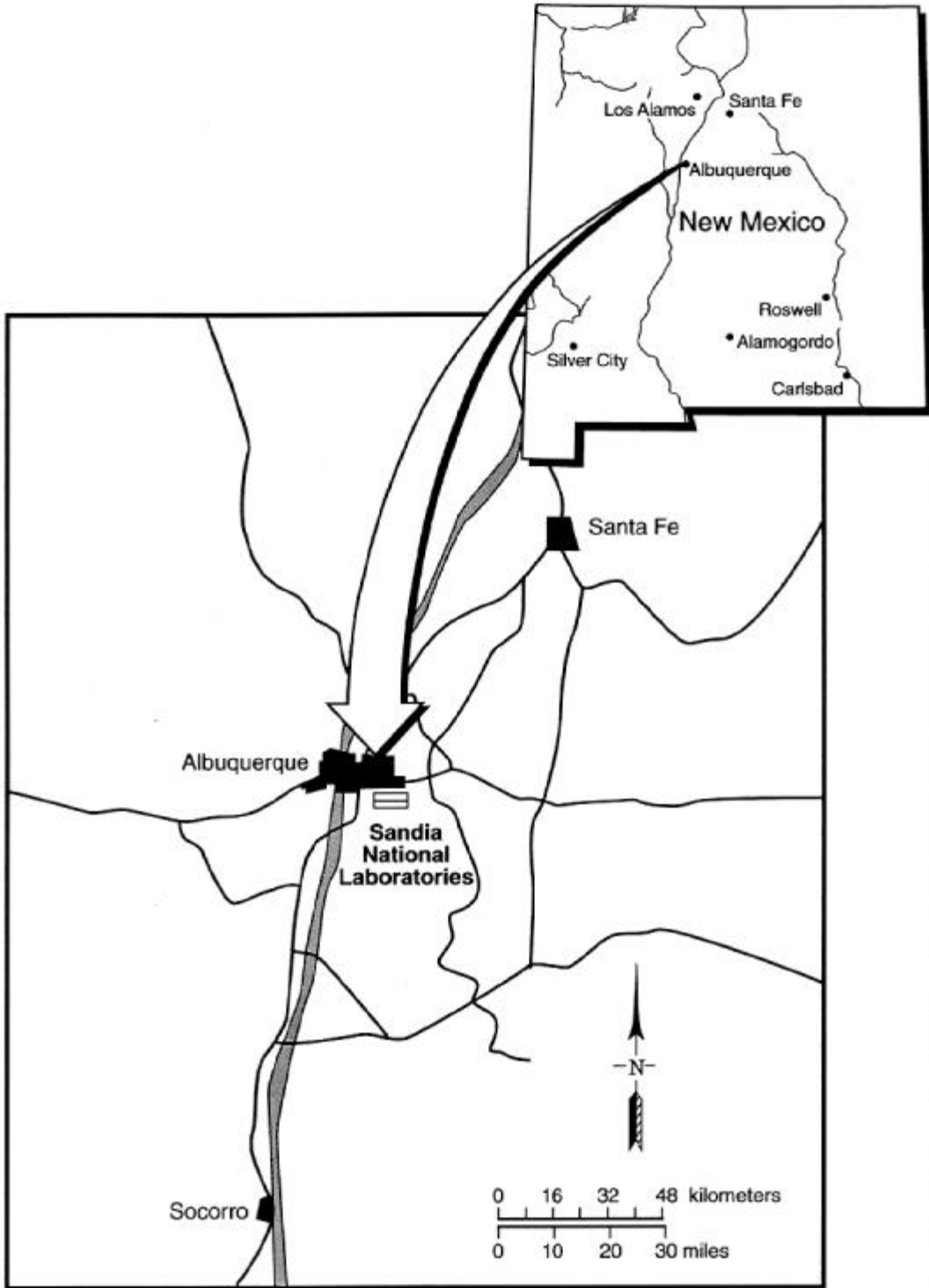


Figure 6.1. Sandia National Laboratory, New Mexico

accumulations of 2.5 cm (1 in.) or greater occur an average of 4 days per year (DOC 1987b). Additional climatological information is summarized in Holdren et al. (1994).

6.3 Sources for Ecological Resource Information

Although separate surveys of biological resources have been undertaken for specific activities at the SNL Site, the information presented in this report is based on information collected for KAFB and the off-site test areas. In addition, information has been derived from the SNL Environmental Baseline Update (IT 1992).

6.4 Terrestrial Vegetation Types

Kirtland Air Force Base (and the SNL Site) is located at the juncture of four major North American physiogeographic and biotic provinces: the Great Basin, the Rocky Mountains, the Great Plains, and the Chihuahuan Desert. The biotic communities, or biomes, within KAFB exhibit influences from each of these provinces, with the Great Basin influence generally dominating.

Five vegetation classifications are present at KAFB: grassland, woodland, riparian scrubland, and riparian woodland, and wetland. Grasslands and woodlands dominate KAFB, while the riparian scrublands and woodlands are limited to drainages of the arroyos and canyons, respectively. Table 13.1 identifies vegetation types found at SNL and at all other sites discussed in this document.

6.4.1 Grasslands

Grassland vegetation covers the lower alluvial slopes and flat terraces of the western half of KAFB. Soils supporting grassland vegetation are typically sandy to gravelly sandy loams with slopes of less than 5%. These sandy soils form dunes stabilized by grasses and shrubs.

The influence of three biomes is evidenced in grassland species occurring on KAFB: the Great Basin grassland biome, the semidesert grassland biome, and the plains grassland biome. The influence of the Great Basin grassland biome predominates. Galleta, associated with the Great Basin grassland biome, is the dominant grass species on KAFB. Other species include sand dropseed, ring muhly, and Indian ricegrass.

The influence of the semidesert grassland biome is typified by the presence of black grama. This grass species is commonly found as a sub- or co-dominant species with galleta and, in places, forms near monocultures. Other grasses associated with this biome area are mesa dropseed, bush muhly, and fluffgrass. Species associated with the semidesert grassland biome occur more frequently on sites with a warmer, drier microclimate, such as south-facing slopes, calcareous soils, and sites exposed to high winds.

A third biome influencing the grassland vegetation at KAFB is the plains grassland biome, which is centered in the Great Plains. Although none of the species associated with this biome reach dominance in the grassland communities on KAFB, species with affinities to this biome that do occur on-site include little bluestem, side-oates grama, blue grama, and soapweed yucca. Several of these species are

also common in the Great Basin grassland biome. Species associated with the plains grassland biome are more common on sites with cooler, moister microclimates, such as those protected from the influences of sun or wind by virtue of slope and direction of exposure.

Where the soil has not been disturbed by construction, the grassland vegetation on KAFB is generally in excellent condition and is relatively free of shrubs and subshrubs because of the long period of protection from grazing within the KAFB boundaries. Periodic burns, both natural and human-caused, are evident in the grassland areas. These fires are fueled and carried by the accumulated dead grasses that cover woody plants. The dominant shrub species in the grasslands are sand sagebrush and four-wing saltbrush, both of which are widespread in the western United States.

6.4.2 Woodlands

Woodland vegetation occurs primarily on the upper alluvial slopes and in the mountainous areas in the eastern half of KAFB. The soils of the woodland areas are coarser than those of the grasslands, ranging from gravelly sand loams to rock outcrops. The growth forms range from very open savannahs, with small, widely scattered trees and shrubs and a grass understory, to a well-developed pinon-juniper woodland, with a nearly closed canopy and scant understory.

Three biomes influence the composition of the woodlands. Predominant among these is the Great Basin conifer woodland, which is characterized by the presence of two tree species: the one-seed juniper and the pinyon pine (aka the Colorado pine). At lower elevations, the former is more abundant than the latter. At higher elevations and in cooler, moister sites, these two species co-dominate. The understory vegetation varies in composition from an extension of the grassland community to a floristic mix of grasses, forbs, and shrubs including mountain muhly, pine dropseed, junegrass, banana yucca, four o'clock, and shrub live oak.

The other two biomes influencing the composition of the woodland communities are the Great Basin montane scrubland biome and the Rocky Mountain montane conifer forest biome. The former is prevalent in warmer, drier microhabitats, while the latter occurs in cooler, moister microhabitats. The Great Basin montane scrubland biome is characterized by the dominance of shrubs, such as gray oak, Gambel oak, mountain mahogany, and skunkbush. The influence of the Rocky Mountain montane conifer forest biome is noted by the presence of ponderosa pine and Rocky Mountain juniper in protected sites at higher elevations on the U.S. Forest Service land to the east.

6.4.3 Riparian Scrublands (Arroyos)

Tijeras Arroyo and Arroyo del Coyote are the two principal arroyos on KAFB. The dissected slopes of the channels are classified as the Bluepoint-Kokan association, which is generally gravelly to stony with steep slopes resulting in drier soils. Vegetation of these sites is a reduced grassland community, characterized by drought-adapted species, such as club cholla, prickly pear, soapweed yucca, and four-wing saltbush.

The vegetation in the arroyo bottoms is characteristic of the Great Basin riparian scrubland, dominated by shrubs such as rabbitbrush, Apache plume, and four-wing saltbush. Alkali sacaton is a dominant grass that is characteristic of the arroyos. Fremont cottonwood and coyote willow are infrequent along the arroyos.

Salt-cedar or tamarisk, an exotic species that has become a nuisance in many drainages in the western United States, is dominant only in isolated places at KAFB. Two other exotic trees, Siberian elm and tree-of-heaven, have also become established locally or as isolated individuals in the arroyos.

A salt-cedar thicket in Arroyo del Coyote at the southern end of the KAFB marks an area of near-surface groundwater. A small spring, called G Spring, has recently been rediscovered at this location. This spring supports a surface flow and wetland grasses for a distance of about 46 m (150 ft) before infiltrating into the sandy arroyo bottom. The permanence of this flow has not been determined.

6.4.4 Riparian Woodlands (Canyons)

The vegetation in the canyons of the Manzano Mountains reflects the influence of all the biomes described previously. Grassland and arroyo elements extend into the lower parts of the major canyons (Lurance, Madera, and Sol de Mete), mixing and eventually being replaced by woodland species.

Canyon vegetation is largely woody. Trees include one-seed juniper, pinon pine, ponderosa pine, Gambel oak, Siberian elm, and tree-of-heaven. A variety of shrubs occur in the canyons, including rabbitbrush, Apache plume, skunkbush, mountain mahogany, New Mexico olive, New Mexico locust, cliff fenderbush, and mock-orange.

Canyons are important as wildlife habitat, providing food, water, and shelter to many species. Although streams in these canyons are ephemeral, catchments in the exposed rock make water available to wildlife for periods beyond the flow events. Sol de Mete Spring, in Sol de Mete Canyon, and Coyote Springs, at the mouth of Lurance Canyon, are permanent sources of water in the canyon areas. In addition to these water sources, the U.S. Forest Service has constructed rainfall catchments or "guzzlers" in scattered locations within the canyons. These provide water to wildlife over extended periods, depending on rainfall.

6.4.5 Wetlands

Three springs on KAFB accommodate natural areas of wetland vegetation. The largest of these, Coyote Springs, is confined to an area of only a few acres and consists of several seeps and springs. One of these has been developed into a rock-lined well. The high water table in the area supports a number of Fremont cottonwoods and salt-cedars. Cattails, rushes, and wetland grasses almost completely cover the areas of shallow standing water and permanently moist soil. The other two springs are small and are located in the canyons above Coyote Springs. These are partially developed and are not associated with significant wetland acreage although they do provide a water source for local wildlife (Fischer 1990).

6.5 Terrestrial Wildlife

Wildlife communities, which include amphibians, reptiles, birds (both breeding and migratory), and mammals, depend upon the quality and quantity of available habitat that meets the needs of individual wildlife species in the community. The lack of water is likely a limiting factor to wildlife in this area. Lack of permanent water in the grasslands, where wildlife populations appear smaller and less diverse, may limit forage production for these species. In the Manzano Mountains, several springs have been lost to some or all species of wildlife as a result of development. This loss has been mitigated by the installation of wildlife guzzlers. About 214 species of terrestrial vertebrates occur on the SNL Site, including 7 species of amphibians, 30 species of reptiles, 125 species of birds, and 52 species of mammals (Fischer 1990). The following sections describe grassland, woodland, and arroyo and canyon wildlife species.

6.5.1 Grassland Wildlife

Mammal species that occur in the grasslands include rodents and lagomorphs (e.g., rabbits and hares), such as desert cottontail rabbit, black-tailed jack rabbit, spotted ground squirrel, Gunnison's prairie dog, pocket gopher (aka Botta's pocket gopher), silky pocket mouse, Ord's kangaroo rat, banner-tailed kangaroo rat, Merriam's kangaroo rat, western harvest mouse, deer mouse, white-footed mouse, and northern grasshopper mouse. Other small mammals with a high probability of occurrence include the desert shrew, southern plains woodrat, and the white-tailed antelope squirrel (Fischer 1990).

Mammalian predators occurring in the grassland community include the coyote, kit fox, long-tailed weasel, badger, striped skunk, and bobcat. Although the black-footed ferret once may have occurred in this area, no recent records of this federally listed endangered species exist for New Mexico. No large prairie dog "towns," upon which the ferret depends, remain on KAFB although active prairie dog towns occur commonly throughout the Coyote Canyon Test Complex (Sullivan and Knight 1992). Mule deer are the only large herbivores that use the grasslands.

Raptors use grasslands for hunting throughout the year, but a lack of nesting habitat (e.g., trees and cliffs) limits use of the grasslands for breeding. Structures may occasionally be used by some species for nesting. Raptor species known or expected to occur in the grasslands are golden eagle, northern harrier, red-tailed hawk, Swainson's hawk, ferruginous hawk, American kestrel, prairie falcon, barn owl, long-eared owl, great horned owl, and burrowing owl. Turkey vultures are common scavengers in this habitat.

Other common grassland birds include the scaled quail, mourning dove, greater roadrunner, horned lark, American crow, northern mockingbird, crissal thrasher, loggerhead shrike, lark sparrow, black-throated sparrow, western meadowlark, brown-headed cowbird, and house finch.

Amphibians of the grasslands are limited to species that are adapted to long periods of dormancy during dry conditions and rapid breeding cycles when ephemeral water is available. These include the western spadefoot toad, plains spadefoot toad, Woodhouse's toad, and Great Plains toad. Other species of amphibians with a moderate-to-high probability of occurrence on KAFB include the green toad and the red-spotted toad (Fischer 1990).

Reptiles common to the grasslands include the western box turtle, many-lined skink, Great Plains skink, whiptail lizard, side-blotched lizard, short horned lizard, lesser earless lizard, bullsnake, coachwhip, western diamondback rattlesnake, and western rattlesnake. Other reptiles with a high probability of occurrence include the longnose leopard lizard, longnose snake, western hognose snake, and the plains blackhead snake (Fischer 1990).

6.5.2 Woodland Wildlife

Most of the grassland species described in the previous section occur in the woodland habitat, at least into the open savannahs of the lower elevations.

Mammal species shift their distribution in the transition between grassland and woodland vegetation types. Coupled with this transition is an increase in the coarseness of the soil and increased occurrence of rock outcrops, which is the primary habitat of several mammal species. Mammals found primarily in the woodlands include mountain cottontail rabbit, Colorado chipmunk, Texas antelope squirrel, rock squirrel, rock pocket mouse, brush mouse, pinon mouse, rock mouse, white-throated woodrat, porcupine, black bear, and cougar.

As the vertical habitat diversity increases in the woodlands, the diversity of bird species using the habitat also increases. Some of the more common birds found in the woodland habitat are the sharp-shinned hawk, western screech owl, long-eared owl, common poor-will, black-chinned hummingbird, northern flicker, Lewis' woodpecker, red-naped sapsucker, Cassin's kingbird, ash-throated flycatcher, western wood-pewee, western flycatcher, scrub jay, pinon jay, Stellar's jay, common raven, plain titmouse, mountain chickadee, bushtit, house wren, Bewick's wren, ruby-crowned kinglet, western bluebird, mountain bluebird, Townsend's solitaire, American robin, northern mockingbird, yellow-rumped warbler, yellow warbler, MacGillivray's warbler, Wilson's warbler, common yellowthroat, western tanager, black-headed grosbeak, rufous-sided towhee, lark sparrow, chipping sparrow, and Scott's oriole.

The peregrine falcon is a federally listed endangered species that may occur in the area. This species prefers cliff faces for nesting and often hunts in wooded areas.

Amphibians are generally absent from the woodland community because of the rapid drainage of the coarser soils. Among the reptiles that are more prevalent in the woodlands are the collared lizard, tree lizard, eastern fence lizard, night snake, and mountain patchnose snake.

6.5.3 Arroyo and Canyon Wildlife

Wildlife species that occur in the arroyos and canyons occupy adjacent grass and woodland communities. The presence of ephemeral or permanent water and the increased diversity of trees and shrubs afford unique microhabitats that accommodate a variety of species. True wetland habitat is extremely limited on KAFB. The arroyo and canyon systems, however, do contain small wetland areas, such as at Coyote Springs and Sol se Mete Spring, where wetland species may occur.

Mammal species that use the canyons and arroyos for feeding, water, travel corridors, or shelter are essentially limited in range to these habitats. These species include the gray fox, ringtail, western spotted skunk, and raccoon.

Bats range over various habitats although the greatest diversity is in the canyons and riparian areas. Bat species include Yuma myotis, little brown myotis, southwestern myotis, fringed myotis, long-legged myotis, California myotis, small-footed myotis, silver-haired bat, big brown bat, hoary bat, Townsend's big-eared bat, pallid bat, and Brazilian free-tailed bat.

Birds that are generally limited to these habitats include Cooper's hawk, spotted owl, flammulated owl, northern pygmy owl, northern saw-whet owl, killdeer, whip-poor-will, broad-tailed hummingbird, white-throated swift, Williamson's sapsucker, black phoebe, Say's phoebe, violet-green swallow, northern rough-winged swallow, canyon wren, warbling vireo, yellow-breasted chat, summer tanager, northern oriole, green-tailed towhee, lesser goldfinch, dark-eyed junco, and song sparrow.

Amphibian and reptile species that are limited to the arroyos and canyons include the red-spotted toad, tiger salamander, western terrestrial garter snake, and blackneck garter snake. Other reptiles with a high probability of occurrence on KAFB include the striped whipsnake and the regal ringneck snake (Fischer 1990).

6.6 Wildlife and Plant Species of Concern

There are no federally listed threatened or endangered species known to occur within KAFB; however, there are five state-listed species that may occur (Fischer 1990).

6.6.1 Wildlife

Two wildlife species considered federally sensitive, or candidates for federal listing, are the Swainson's hawk and the spotted bat. Swainson's hawk is known to occur on KAFB although it is not known to breed there. The spotted bat has a low probability of occurrence. State-listed endangered-wildlife species that occur, or potentially occur, are the peregrine falcon, Mexican spotted owl, willow flycatcher, loggerhead shrike, and spotted bat. Several species of raptors may occur in the area; among the raptors with moderate to high potential of occurrence are the northern harrier and the American kestrel (Sullivan and Knight 1992). Raptors are fully protected under New Mexico state laws and the Migratory Bird Treaty Act.

6.6.2 Plants

Three New Mexico-listed endangered cacti occur within KAFB: grama grass cactus, Wright's pincushion, and white visnagita. The first is found in grassland and open woodland habitats; the latter two exist primarily in woodland habitats.

Plants that are endemic to New Mexico, or of restricted and decreasing distribution, are classified as State Priority 1. Four plant species categorized as State Priority 1 have been recorded in the vicinity of KAFB: the grayish white giant hyssop, Santa Fe milkvetch, La Jolla prairie clover, and club cholla. Of these, only the club cholla is known to occur on KAFB. This species commonly occurs in the grassland community of central New Mexico. Its status is related to the fact that it is an endemic species in New Mexico. The La Jolla prairie clover is currently a candidate for state protection.

6.7 Ecological Management Issues at KAFB and SNL

The most sensitive habitat types on KAFB are the wetlands and canyons. The three most significant natural wetland sites remaining on KAFB are Coyote Springs, Sol se Mete Spring, and G spring. Coyote Springs was developed as a picnic site by previous land users. Although the springs are reverting to a more natural condition, their proximity to a major roadway and accessibility to human use will limit the extent to which natural conditions will develop through succession. Sol se Mete Spring, which is much smaller than Coyote Springs and has been altered by the construction of a stone tub, is more isolated from human activity and generally represents more natural wetland conditions.

Little information is available on the ecology of G Spring. With the exception of the growth of exotic species at this Site (e.g., salt-cedar), G Spring is the most pristine wetland on KAFB. The more heavily wooded, undisturbed canyons and their adjacent slopes are considered highly sensitive wildlife habitat. This classification is based on the quality of the habitat for travel corridors, bedding areas, wintering areas, and foraging areas, as well as the amount of contiguous undisturbed habitat and its ability to support sensitive species.

Some artificial ponds within developed areas afford wetland habitat and are generally used by migrating waterfowl in the spring or fall. Lake Christian is a 0.8-ha (2-acres) permanent pond adjacent to an Air Force testing facility, 1.6 km (1 mi) northeast of the Inhalation Toxicology Research Institute. The margins of the pond support cattails and the water contains a stocked population of carp. Permanent ponds are also found on the golf course, 1.6 km (1 mi) southeast of Technical Area IV. Wetland areas on-site are a unique resource and provide habitat for various wildlife species. Protection and management of wetlands are critical because of their decline nationwide.

7.0 Rocky Flats Environmental Technology Site

This section discusses ecological resources managed by DOE at the Rocky Flats Environmental Technology Site (RFETS) Site in northern Colorado (Figure 7.1). Included are brief descriptions of the Site, its climate, sources for the Site's ecological resources information, the major vegetation types and associated plant and animal species, aquatic resources, plant and animal species of concern, and ecological management issues at Rocky Flats. Species of concern include federally listed and state-listed threatened and endangered species. Also included is a brief discussion of the background of the Site ecological resource data on key ecological issues.

7.1 Site Description

The RFETS is located in Jefferson County, approximately 16 km (10 mi) from Golden, Colorado, and includes 26 km² (10 mi²) of federal land.

The Site is situated at an elevation of about 1829 m (6000 ft) on the eastern edge of a 8-km-wide (5 mi) geological bench, known as the Rocky Flats. Topography trends to the east, at an average downgrade of 18 m/km (95 ft/mi). Thirty-two kilometers to the west, the continental divide rises to elevations above 4276 m (14,000 ft). The RFETS is situated on an alluvial fan deposit, known as the Rocky Flats Alluvium, which ranges from 0 to 30 m (0 to 100 ft) thick. The deposit covers underlying bedrock formations of claystone with some siltstones. Surface drainage on the Site follows a west-to-east pattern through three ephemeral streams. Groundwater at the RFETS Site consists of a shallow, unconfined system in the alluvium and a confined system in the deeper sandstone bedrock units.

The plant was constructed in the early 1950s. From 1952 until 1992, the RFETS mission was to fabricate nuclear weapons components using plutonium, uranium, beryllium, and stainless steel. The RFETS also processed components of obsolete nuclear weapons to recover plutonium. In addition, the Site has been involved in research and development in metallurgy, machining, nondestructive testing, coatings, and remote engineering (Altman et al. 1992).

Plant facilities occupy 6% of the total acreage, in a centrally located restricted area. The remaining acreage was established as a buffer. Land use adjacent to the Site includes agriculture, low-density residential housing, and industrial development (Altman et al. 1992). The Site also borders roughly 4050 ha (10,000 acres) of open space to the north owned by the City and County of Boulder. This land allows the Site biota to migrate as needed.^(a)

7.2 Climate

The RFETS has a mid-latitude semiarid climate (Critchfield 1974). Meteorological data for the area are available from on-site measurements and from measurements at Stapleton International Airport

(a) Personal communication, January 1995, Kevin Essington, RFETS, Golden, Colorado.

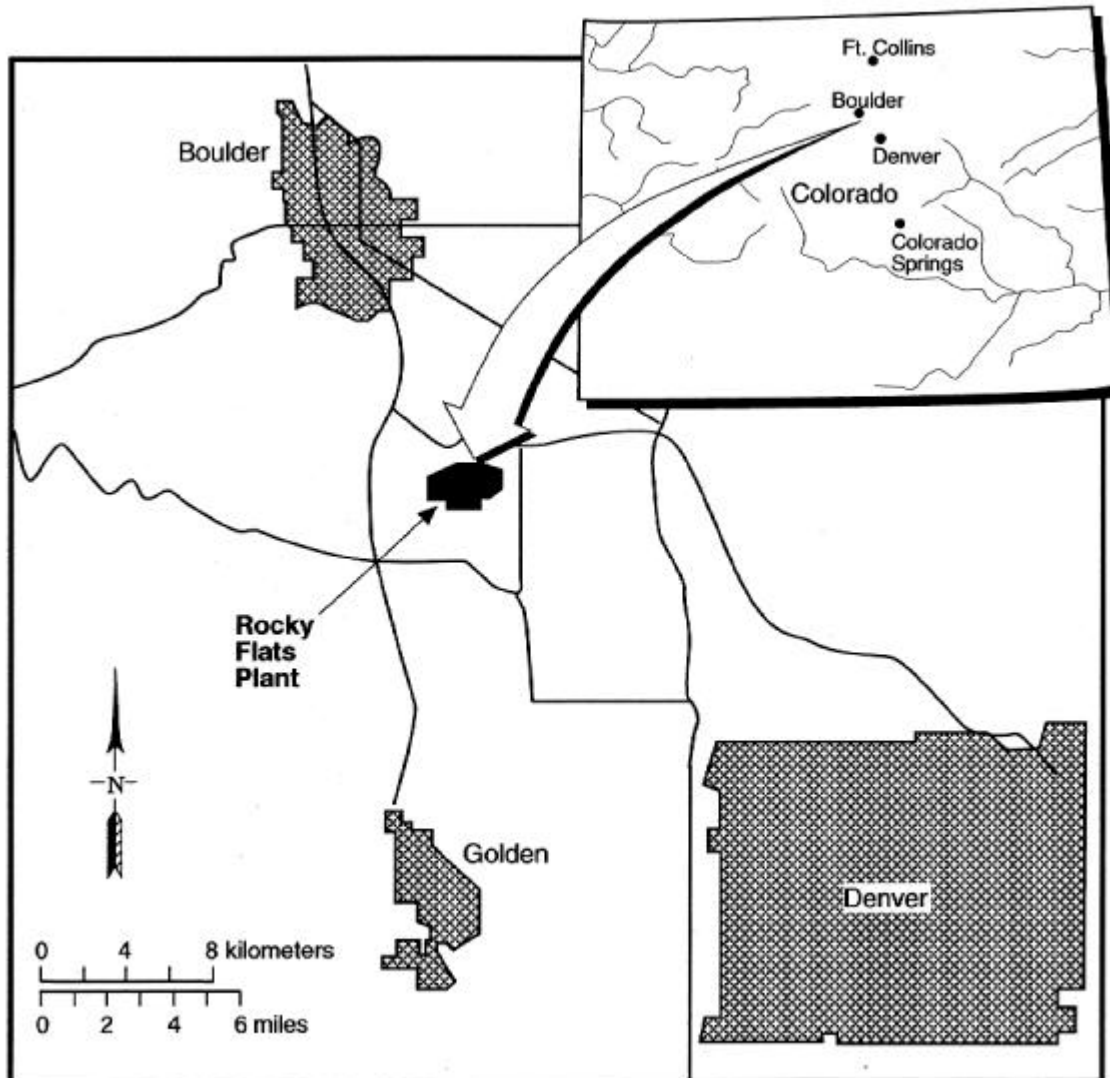


Figure 7.1. Rocky Flats Environmental Technology Site, Colorado

in Denver, Colorado. On average, the maximum daily temperature exceeds 32°C (90°F) 33 days per year and is below 0°C (32°F) 22 days per year; the minimum daily temperature is below 0°C (32°F) 159 days per year and is below -18°C (0°F) 9 days per year (DOC 1987c). July is the warmest month, with daily maximum and minimum temperatures averaging 31°C (88°F) and 15°C (59°F), respectively. January is the coolest month, with daily maximum and minimum temperatures averaging 6°C (43°F) and -9°C (16°F), respectively (DOC 1987c). Annual precipitation is approximately 39 cm (15 in.), with about 80% falling from April through September. Measurable precipitation (defined as 0.025 cm [0.01 in.] or greater) is recorded on an average of 88 days per year, and the area experiences an average of 41 thunderstorm days per year. The average annual snowfall is 160 cm (63 in.) and daily snowfall accumulations of 2.5 cm (1 in.) or greater occur an average of 18 days per year (DOC 1987c). Prevailing on-site winds are from the

northwest. The highest average wind speed, which occurs in the spring, is 16 kilometers per hour (10 miles per hour) (DOE 1992a). Additional climatological information is summarized in Holdren et al. (1994).

7.3 Sources for Ecological Resource Information

Ecological resources at the RFETS have been monitored and catalogued over the past 20 years. Most major vegetation studies were completed in the 1970s. A botanical inventory was completed in 1973, and plant communities were researched in 1973 and 1974. Wildlife research has concentrated primarily on the uptake and transport of contaminants. RFETS environmental reports, environmental impact statements, and environmental monitoring documents are the most recent sources of ecological data. Studies by Colorado State University also provide information. Baseline biological data for the Site was collected in 1990 and 1991 and published in a 1992 final report (DOE 1992a).

7.4 Terrestrial Vegetation Types

The RFETS has been classified as a plains grassland/montane ecotone, a transition zone between the Great Plains and the foothills of the Rocky Mountains. A higher number of plant and animal species occur at the Site because of the ecotone effect. A total of 532 species of terrestrial plants have been identified, including lichens, bryophytes, vascular cryptogams, and vascular plants. The plant communities are divided into groups by soil moisture zones: xeric (dry), mesic (moderate moisture), and hydric zones (wet). Table 13.1 identifies the major vegetation types present at RFETS and at all other sites discussed in this document.

7.4.1 Xeric Zone

The xeric zone, located on ridge tops and terraces, is the area with the lowest soil moisture. Two types of plant communities exist in the xeric zone at the Site:

- **Xeric mixed grasslands** - A mixture of perennial grasses and forbs dominate this community. Wheatgrass, Canadian bluegrass, junegrass, and three-awn grass are the most common species (DOE 1993b). Needle-and-thread grass, mountain muhly, thread-leaved sedge, blue grama, big bluestem, and little bluestem are also commonly observed. Overgrazing in the past resulted in the establishment of numerous species of cacti. Several sagebrush subshrubs are also present (DOE 1992a).
- **Ponderosa pine woodland** - Small, isolated ponderosa pine woodland communities are located in the extreme northwest corner of RFETS, in the Rock Creek watershed, and near the head of Woman Creek's main channel. Canadian bluegrass and junegrass are common in association with the ponderosa pines, as is skunkbrush sumac (DOE 1992a). Ponderosa pines have also established themselves on RFETS in disturbed areas, such as an old railroad grade that crosses the facility, gravel pits, hillside slumps, and roadsides.^(a)

(a) Personal communication, January 1995, Kevin Essington, RFETS, Golden, Colorado.

7.4.2 Mesic Zone

The mesic zone, with moderate moisture, provides a less harsh environment for plant growth. The mesic zones are generally found on the hillsides of valleys and ravines and contain the following plant community:

- **Mesic mixed grassland** - Western wheatgrass, blue grama, and Japanese brome are the dominant species, along with several members of the Aster family. Short grassland subcommunities cover drier areas of the mesic mixed grassland. These areas are dominated by buffalo grass, blue grama, and other native short grasses. Also included in the mesic mixed grassland community type are reclaimed grasslands located in the southeast portion of the Buffer Zone. These areas, previously used for hay and wheat production, were revegetated with smooth brome when the Buffer Zone was expanded in 1974. It remains the dominant species today. Surveys on these sites show very low species diversity.^(a)

7.4.3 Hydric Zone

The hydric zone has the highest soil moisture and occurs near streams, hillside seeps, and springs. The hydric communities include:

- **Riparian woodlands** - These narrow strips of woodland follow stream channels and typically have extremely high species diversity. The most prevalent species in these areas include cottonwood and willow, with an understory of marsh species, including sedge, rushes, and a variety of forbs.
- **Marsh communities** - The marsh complex includes wet meadow, short marsh, and tall marsh communities. These areas are dominated by sedges, rushes, cattails, and other marsh species.
- **Tall upland shrub community** - These communities tend to occur at hillside seeps, especially on steeper hillsides, such as those found in Rock Creek. Hawthorne, wild plum, and chokecherry dominate these unique areas. The Colorado Natural Heritage Program ranks this community type as GU/SU, indicating unknown, and probably rare status globally and state-wide (Kettler et al. 1994). The U.S. Army Corps of Engineers (USACE) has included this community as jurisdictional wetlands (USACE 1994).

7.5 Terrestrial Wildlife

Approximately 186 species of terrestrial vertebrates have been identified at the RFETS, including 4 species of amphibians, 8 species of reptiles, 142 species of birds, and 32 species of mammals.

(a) Personal communication, January 1995, Kevin Essington, RFETS, Golden, Colorado.

7.5.1 Xeric Zone Wildlife

Xeric grasslands support large numbers of small mammals, the most abundant of which is the deer mouse, which afford a substantial prey base for larger predators. The grasslands are also used extensively by mule deer during the breeding season. During winter months, the xeric grasslands remain relatively free of snow, affording foraging habitat for mule deer. Coyotes use the grasslands for hunting and prey on young mule deer and smaller mammals. Mexican woodrats, deer mice, and porcupine are commonly observed in the ponderosa pine communities.

Several passerine birds use the xeric grasslands for nesting, particularly meadowlarks and vesper sparrows. Twelve species of raptors use the grasslands as foraging habitat. The most common raptor species are red-tailed hawk, peregrine falcon, and great horned owl. The ponderosa pine communities are used for food and nesting by several passerine bird species, including green-tailed towhee, dark-eyed junco, and loggerhead shrike.

The most frequently observed reptiles in the xeric grasslands are prairie rattlesnakes and short-horned lizards.

7.5.2 Mesic Zone Wildlife

The mesic areas support the highest diversity of small mammals at the Site. Of particular interest are black-tailed prairie dogs, which have established several colonies. Prairie dogs, rabbits, and other small mammals compose a significant portion of the prey base for larger predators. Long-tailed weasels are commonly found in disturbed areas, particularly rocky areas (i.e., rip-rap and shoreline), where they hunt for smaller mammals. Mule deer and white-tailed deer use open grasslands for foraging.

Common mesic zone birds include meadowlarks, house finches, pine siskins, and mourning doves. Five species of raptors use mesic zone areas, including disturbed areas, for hunting. Ferruginous hawks, turkey vultures, and golden eagles are commonly observed in these areas. Great horned owls frequently use old buildings and gravel pits as nesting areas. Two species of waterfowl, the mallard and the Canada goose, use the mesic grasslands as nesting cover in the spring. Wild turkeys and Chinese ring-necked pheasants forage on the grasslands.

Western (aka Boreal) chorus frogs occur in mesic mixed grasslands, as do gopher snakes (aka bullsnakes) and plains garter snakes. Gopher snakes are especially common in the mesic grasslands, reclaimed grasslands, and disturbed areas, where they hunt small mammals and birds. Woodhouse's toads are common in mesic mixed grasslands.

7.5.3 Hydric Zone Wildlife

Deermouse, hispid pocket mouse, and water shrew occur most commonly in riparian woodlands, while meadow voles are frequently observed in the marsh areas. Preble's meadow jumping mouse, a federal candidate species, is found in riparian areas. Muskrats use the marsh and open water areas as well. Mule deer, white-tailed deer, and elk use the woodland and tall upland shrub areas. Coyotes, raccoons, striped skunk, and long-tailed weasels are common predators of the riparian and marsh areas.

Red-winged blackbirds, barn swallows, northern orioles, and goldfinches are common to the riparian community. A variety of waterfowl and shorebirds also occur in this habitat, including mallards, great blue herons, black-crowned night herons, buffleheads, and snipe. Four red-tailed hawk nests, four great horned owl nests, and one Swainson's hawk nest have been found in the riparian woodlands (DOE 1992a).

Yellowthroat and marsh wren are common species in the marsh communities. The marsh and open water areas of the Site also support 23 species of waterfowl and shorebirds. Mallards occur most commonly, but hooded mergansers, cinnamon teal, northern shoveler, northern pintail, snow goose, and sandhill crane are also observed.

The greatest diversity of amphibians at the RFETS occurs in riparian woodlands and marsh areas. Species include tiger salamanders, Woodhouse's toad, and northern leopard frog. The only species of turtle found on the Site, the western painted turtle, occurs in the marsh community.

7.6 Aquatic Resources

Aquatic vegetation and wildlife is constantly limited by semiarid climatic conditions (DOE 1992a). Many aquatic species have adapted to low streamflow. Streams, impoundments, and wetlands are the primary aquatic habitats on the Site and are located within three main watersheds: Woman Creek, Walnut Creek and Rock Creek. The Woman Creek watershed is characterized by intermittent flows, seeps, and one impounded area that supports fish species such as golden shiners, white suckers, and green sunfish. Walnut Creek watershed contains four surface streams and 12 impoundments. The Rock Creek watershed has one intermittent stream fed by numerous groundwater seeps.

Wetlands occur along drainage on the Site, around edges of ponds and at seep areas. Many occur on steep slopes and are relatively stable, supporting cattails, willows, cottonwoods, grasses, and forbs. Also found in aquatic habitats are watercress, bog yellow cress, and other aquatic vascular plant species.

7.7 Wildlife and Plant Species of Concern

Species of concern include federally listed threatened or endangered species, state-listed species, and other categories of sensitive species.

7.7.1 Wildlife

The RFETS provides potential habitat for 22 animal species of concern, both federally and state listed, including the swift fox, black-footed ferret, and the whooping crane (EG&G 1992). Of the potential 22 species, 6 animal species of concern are known to occur on the Site:

- Preble's meadow jumping mouse is a Federal Category 2 species. The U.S. Fish and Wildlife Service has recently received a petition to list this species as threatened or endangered. Several Preble's meadow jumping mice have been captured in the Woman Creek watershed.
- Loggerhead shrikes, a Federal Category 2 species, have been observed hunting over the Site (DOE 1992a).

- Peregrine falcons are a federal endangered species. Peregrines occur at the Site as migrants and have been observed hunting on-site in the early fall. The U.S. Fish and Wildlife Service Peregrine Falcon Recovery Plan discourages any land use practices that may disturb the habitat or prey base of peregrine falcons in a 16-km (9.9-mi) radius of a nesting cliff. Two potential nesting cliffs occur within 11 km (6.8 mi) of the Site, and a pair of peregrine falcons was reported nesting 10 km (16 mi) northwest of the Site in 1991.
- Bald eagles are a federally endangered species and are irregular visitors to the Site, usually arriving as migrants in the spring and fall. Bald eagles have been observed flying over industrial areas and the Rock Creek drainage, and perching on utility poles around the Site. A pair has wintered at Standley Lake, one mile to the east of the Site, and regularly forage at the prairie dog colonies on the Site.^(a)
- Two other sensitive raptors (ferruginous hawks and Swainson's hawks) have been observed at the Site. Ferruginous hawks, a Federal Category 1 species, have been observed hunting and nesting. They are most commonly sighted near the prairie dog colonies to the southeast. Juveniles were identified on the RFETS Site in 1991. Swainson's hawks, a Federal Category 3 species, have attempted unsuccessfully to nest on the Site; however, they frequently hunt over the shortgrass lands at the Site.

7.7.2 Plants

One plant species of concern, the forktip three-awn, has been observed on the RFETS. The forktip three-awn has been designated as a Colorado Species of Special Concern because it grows in isolated populations in Colorado. One small population of this species was found near an industrial area at the Site. Five other plant species of concern have the potential to occur on-site, including one federally listed species, the Ute lady's tresses, and two federal candidate species, Colorado butterfly plant and Bell's twinpod (DOE 1992a).

7.8 Ecological Management Issues at RFETS

7.8.1 Grasslands

Grassland are the largest plant community in terms of acres (2183 ha, 5393 acres) at the RFETS Site. Recovery of disturbed on-site grasslands is slow. Impacts from cattle grazing before construction of the RFETS, such as the establishment of some cacti and other opportunistic species, and impacts from herbicides and pesticides are visible on-site (Hope 1992). Intrusion of such exotic species as smooth brome, cheatgrass, and Canada thistle affect the grasslands as well. The Colorado Natural Heritage Program has ranked several areas of native grasslands on the RFETS as rare and in need of protection. Occurrences of big bluestem and little bluestem on the Site were declared "very rare, occurring in fewer than about 20 places worldwide." Wheatgrass and grama grass associations were listed as "common, but impacted throughout its range" (Kettler 1994). Kettler (1994) also suggests that the protection of the grassland remnants on the RFETS would provide genetic exchange between fragmented areas of these vegetation communities, which would aid in the persistence of these communities.

(a) Personal communication, January 1995, Kevin Essington, RFETS, Golden, Colorado.

7.8.2 Wetlands

Nearly 1100 individual wetlands areas have been identified on the RFETS, accounting for nearly 77 hectares (191 acres) (USACE 1994). Palustrine emergent wetlands are the most common on the Site. The largest wetland areas occur on the slopes of Rock Creek and Woman Creek drainage. Forested wetlands occur along the Walnut Creek and Rock Creek drainage. Open-water palustrine habitats (ponds) occur in the Walnut Creek drainage. Riverine habitat is very limited, and found mainly along lower Rock Creek.

All wetland habitats are vital for Site wildlife. Many species depend upon these areas for food, cover, and nesting/breeding habitat. Other natural values include erosion control and discharge of high-quality water. The USACE wetland mapping report (USACE 1994) suggests that due to the importance and the sensitivity of these on-site habitats, cleanup construction work within the Rocky Flats Alluvium or the underlying aquifers "should not proceed until surface-ground water relationships are better understood."

7.8.3 Riparian Areas

Two types of riparian areas occur at the RFETS Site: riparian woodlands and bottomland shrub communities. Cottonwood and willow dominate the riparian woodlands, while leadplant, snowberry and shrub willow characterize bottomland shrub communities (DOE 1992a). Riparian areas occupy only 0.5% (13.5 ha, 33 acres) of the total acreage on the Site, but these areas are crucial to wildlife, including the Preble's meadow jumping mouse, a species currently proposed for listing as threatened or endangered (DOE 1992a). Any loss or fragmentation of riparian habitat, which occurs in narrow strips along stream beds serving as wildlife corridors, will affect dispersal of wildlife throughout the corridors and other adjacent habitats (Stoecker 1992). The Colorado Natural Heritage Program has declared riparian vegetation "globally very rare to rare and the same status in Colorado" (Kettler 1994).

8.0 Los Alamos National Laboratory

This section discusses ecological resources managed by DOE at the Los Alamos National Laboratory (LANL) Site in north-central New Mexico (Figure 8.1). Included are brief descriptions of the LANL Site, its climate, sources for ecological resource information, the vegetation types on the Site and their associated plant and animal species, aquatic resources, plant and animal species of concern, and ecological management issues at LANL. Species of concern include federally listed threatened or endangered species, federal candidate species, and species of statewide significance.

8.1 Site Description

The LANL Site is located approximately 259 km (161 mi) north-northeast of Albuquerque and 104 km (65 mi) northwest of Santa Fe, New Mexico, in Los Alamos County. The Site occupies 111 km² (43 mi²), 2.4 km² of which are developed (LANL 1992). The Site is on the Pajarito Plateau, which consists of a series of mesas separated by steeply incised canyons oriented east-west, which drain toward the Rio Grande. Elevations range from 2400 m (7872 ft) at the Jemez Mountains to 1900 m (6232 ft) at the terminus of the Rio Grande Valley.

The primary mission of the LANL has been nuclear weapons research and development. Programs include weapons development, magnetic and inertial fusion, nuclear fission, nuclear safeguards, security, laser isotope separation, and basic research. Developed areas at the LANL Site include buildings, experimental areas, waste disposal sites, roads, and utility rights-of-way.

Most development is confined to mesa tops, with the remaining surrounding land maintained in undeveloped tracts. These areas north, west, and south of the LANL Site are managed by the Santa Fe National Forest, Bureau of Land Management, Bandelier National Monument, and Los Alamos County. The San Ildefonso Pueblo borders the LANL Site to the east.

The LANL Site was dedicated as a National Environmental Research Park in 1977. Access to the LANL Site is largely restricted, except for an area north of Ancho Canyon between the Rio Grande and State Route 4, portions of Mortandad and Pueblo canyons, and the Otowi Tract (an archaeological site). Hiking, rafting, and/or hunting are permitted in these areas.

8.2 Climate

The LANL has a semiarid, temperate mountain climate (Bowen 1990). Meteorological data are available from on-site measurements, with the main monitoring site being located in the TA-59 area (on a mesa). On average, the maximum daily temperature exceeds 32°C (90°F) 2 days per year and is below 0°C (32°F) 19 days per year; the minimum daily temperature is below 0°C (32°F) 154 days per year and is below -18°C (0°F) 2 days per year (Bowen 1990). July is the warmest month, with daily maximum and minimum temperatures averaging 27°C (81°F) and 13°C (55°F), respectively. January is the coolest month, with daily maximum and minimum temperatures averaging 4°C (40°F) and -8°C (17°F), respectively (Bowen 1990). Significant temperature differences will frequently occur between

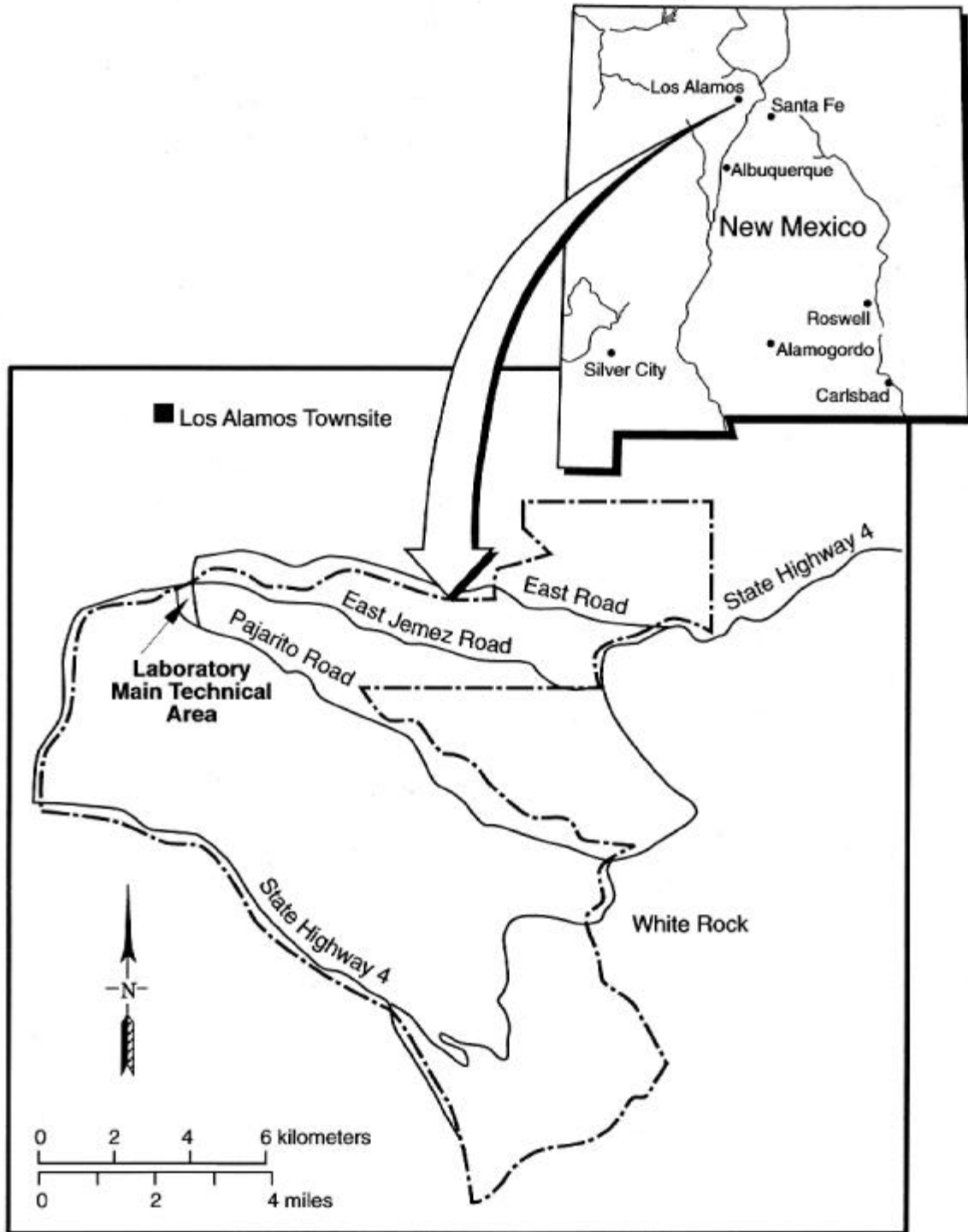


Figure 8.1. Los Alamos National Laboratory, New Mexico

the mesa tops and canyons within LANL, with cooler temperatures in the canyons. Annual precipitation is on the order of 46 cm (33 in.), with about 40% falling in July and August. Measurable precipitation (defined as 0.025 cm [0.01 in.] or greater) is recorded on an average of 89 days per year, and the area experiences an average of 58 thunderstorm days per year. The average annual snowfall is 130 cm (52 in.) and daily snowfall accumulations of 2.5 cm (1 in.) or greater occur an average of 14 days per year (Bowen 1990). Additional climatological information is summarized in Holdren et al. (1994) and presented in detail in Bowen (1990).

8.3 Ecological Resource Background

The principal sources of information for ecological resources include environmentally related reports prepared for the LANL Site operable units and resource reports prepared by the University of California for LANL. Detailed studies to characterize plant and animal populations on-site were compiled beginning in 1972; however, most studies were conducted only in specific radioecological areas. Quantitative information on LANL biota has been collected only in the past six to eight years.

8.4 Terrestrial Vegetation Types

Past and present land uses of the LANL Site maintain biological communities in a state of secondary succession. The diversity of vegetation of the LANL Site is attributable to the extreme elevational gradient between the Rio Grande Valley and the Jemez Mountains Plateau.

Six major upland communities persist in Los Alamos County and include the juniper-grassland, pinyon-juniper forest, ponderosa pine forest, mixed conifer forest, spruce-fir forest, and subalpine grassland (Foxy and Tierney 1980, 1984). The predominant vegetation communities occupy approximately one-third of the LANL Site and include the juniper-grassland, the pinyon-juniper forest, and the ponderosa pine forest communities. Sixty-one families of plants are represented at the LANL Site; the majority of species (i.e., 85) occur at lower (e.g., below 1646-m [5400 ft.]) elevations (Miera 1976). Coniferous trees dominate the vegetation communities, with ponderosa pine and Douglas fir occurring primarily above 2100 m (6890 ft.). Pinyon pine and one-seed juniper occur most frequently at lower elevations. Understory vegetation is generally sparse, with grasses and composites comprising the greatest percentage of ground cover. Ground cover is approximately 15% at lower elevations, increasing to 100% in the subalpine grasslands. Table 13.1 identifies the major vegetation types present at the LANL Site, as well as those present at the other sites discussed in this document.

8.4.1 Juniper-Grassland

The juniper grassland extends along south-facing slopes of the Rio Grande Valley at 1700 to 1900 m (5577 to 6233 ft.). The Rio Grande Gorge is typified by juniper/yucca/cactus grasslands and local riparian habitats where Fremont cottonwoods occur.

8.4.2 Pinyon-Juniper Forest

The pinyon-juniper forest occurs between 1900 and 2100 m (6233 and 6890 ft.) elevation. Open stands of pinyon pine are intermixed with one-seed juniper, scattered alligator juniper, and Rocky mountain juniper in the canyons. Understory vegetation includes blue grama, galleta, and little bluestem.

8.4.3 Ponderosa Pine Forest

The ponderosa pine forest on the Pajarito Plateau occurs between 2100 and 2400 m (6890 and 7874 ft.) elevation. Overstory vegetation includes ponderosa pine interspersed with Gambel oak and wavy leaf oak. Understory vegetation includes mountain muhly, pine dropseed, and little bluestem.

8.4.4 Mixed Conifer Forest/Spruce-Fir Forest/Subalpine Grassland

The mixed conifer forest occurs at approximately 2400 m (7874 ft.) elevation. Overstory vegetation includes Engelmann spruce, Douglas fir, white fir, and limber pine. Understory vegetation includes bearberry, creeping barberry, and grasses. At upper elevations, dense stands of Engelmann spruce, white fir, and subalpine fir typify a spruce-fir assemblage. Poplars (aka aspen) occur in burned or logged-over areas in moist soils or on north slopes. Subalpine meadows dominated by oatgrass and brome grasses occur at upper elevations in rugged terrain.

8.5 Terrestrial Wildlife

The diversity of habitats on the LANL Site accommodates over 228 species of terrestrial vertebrates. Included are 4 species of amphibians and 14 species of lizards. Over 187 species of birds, of which one-half occur on-site throughout the year, are found on LANL. Approximately 23 species of mammals, including 8 species of bats, have been observed on-site.

8.5.1 Juniper-Grassland Wildlife

The majority of reptile and amphibian species on the LANL Site occur in juniper-grassland habitat. Seven lizard, seven snake, two frog, and two toad species have been observed in the juniper-grassland habitat. Deer mice, woodrats, and least chipmunk are common small mammal species in juniper-grassland habitat and likely make up a large component of the raptor prey base. Meadow voles and shrews occur primarily in grass-sedge communities in areas of continuous water flow. The western harvest mouse also occurs in juniper-grasslands on sites characterized by dense stands of grasses and forbs. The riparian canyon bottoms accommodate waterfowl (e.g., mallard), wading birds (e.g., great blue heron, and whooping crane), raptors (e.g., red-tailed hawk, zone-tailed hawk, and American kestrel), and owls (great horned and western screech). The most common passerine species occurring at the lower elevations include gray and dusky flycatchers, scrub jays, Virginia warblers, Grace's warblers, and canyon and rufous-sided towhees. Other passerines include woodpeckers, bushtits, creepers, warblers, tanagers, and sparrows. The four most abundant raptor species that occur in Los Alamos County are concentrated in the juniper-grassland habitation the LANL Site.

8.5.2 Pinyon-Juniper Forest Wildlife

The Rocky Mountain mule deer is the most prevalent big game species occurring on the LANL Site. Deer generally migrate between LANL and adjoining U.S. Forest Service land during spring and fall, residing on LANL primarily during fall and winter. Deeper snows and increased hunting pressure generally influence animal movements on and off the Site. Wintering and fawning occur primarily within ponderosa pine and pinyon-juniper habitats.

Bird species common to the pinyon-juniper forest include the four most abundant raptor species that occur in Los Alamos County (e.g., zone-tailed hawk, red-tailed hawk, American kestrel, and sharp-shinned hawk). Passerines that distribute themselves on an elevational gradient and are common to the pinyon-juniper forest include dusky flycatchers, pinyon jays, and black-throated gray warblers.

Other common passerines include woodpeckers, jays, corvids, flycatchers, nuthatches, titmice, finches, sparrows, grosbeaks, and towhees. These passerines are found in both the pinyon-juniper forest and in the ponderosa pine forest (described in the next section).

Least chipmunks and woodrats occur throughout most habitats. The most common small mammal species occurring in the pinyon-juniper forest is the pinyon mouse.

8.5.3 Ponderosa Pine Forest Wildlife

Bird species common to the ponderosa pine forest include Cooper's hawk, red-tailed hawk, and American kestrel. Passerines that distribute themselves on an elevational gradient and are common in ponderosa pine habitat include Hammond's and Cordilleran flycatchers, dusky flycatchers, Clark's nutcracker, yellow-rumped and orange-crowned warblers, and green towhees. Deer mice and Rocky Mountain mule deer are common mammals in the ponderosa pine forest habitat.

8.5.4 Mixed Conifer Forest/Spruce-Fir Forest/Subalpine Grassland Wildlife

Rocky mountain elk, which were reintroduced to the LANL Site in 1920 and to adjoining U.S. Forest Service land during 1966, occur throughout mixed conifer and spruce fir stands bordering the Site to the east. Gapper's red-backed mouse (aka red-backed vole) and mountain vole occur within meadows and groves of mountain forests.

Bird species common to upper-elevation forests and subalpine grasslands include the pine siskin, evening grosbeak, hermit thrush, green-tailed towhee, dark-eyed junco, warbling vireo, and brown creeper.

8.6 Aquatic Resources

Fish species that occur in the Rio Grande include carp, creek chub, white sucker, and carp-sucker and river carpsucker. Brown trout also inhabit the Rio Grande; however, population densities are generally limited by extreme turbidity of river waters. Largemouth bass and walleye are the primary game fish species that occur within the system.

8.7 Wildlife and Plant Species of Concern

Complete surveys for threatened, endangered, and sensitive species and habitats have been conducted on the LANL Site. Field surveys were conducted for compliance with the Endangered Species Act, New Mexico's Wildlife Conservation Act, New Mexico Endangered Plant Species Act, Executive Orders 11990 and 11988, 10 CFR 1022, DOE Order 5400.1, and the National Environmental Policy Act.

8.7.1 Wildlife

The black-footed ferret is an endangered species with statewide distribution in New Mexico. The likelihood of occurrence of black-footed ferrets on LANL is low.

The peregrine falcon may occur in Los Alamos County. Peregrine falcons use cliffs in forested habitats where wind currents are conducive to foraging. Peregrine falcons have been observed foraging in White Rock Canyon near Ancho and Chaquehui canyons. However, there are no records of eyries in these canyons.

The whooping crane winters in the central Rio Grande Valley and therefore may migrate through Los Alamos County and the LANL Site. Whooping cranes exhibit a high degree of site fidelity, with young learning of traditional foraging areas from parents or foster parents. Foraging areas usually include agricultural fields and valley pastures. Whooping cranes have been observed in the lower canyons of the LANL Site.

The bald eagle, a federal endangered species, has not been reported for Los Alamos County; however, the species occurs as a migrant in the Rio Grande Valley. An eagle nest was observed in Chaquehui Canyon; however, it is undetermined whether the nest was constructed by a bald or a golden eagle.

The broad-billed hummingbird has been observed as an occasional visitor to Los Alamos County. The species occurs in riparian woodlands at low to mid-elevations.

The Mexican spotted owl, a proposed federal threatened species, has been reported for Los Alamos County; however, the species has not been reported for the LANL Site.

The spotted bat occurs in pinyon-juniper, ponderosa, mixed conifer, and riparian habitats. Mist net surveys conducted in Bandelier National Monument and Ancho and Chaquehui canyons on the LANL Site have not yielded capture/siting of spotted bats.

The preble's meadow jumping mouse and the New Mexican jumping mouse, Federal Category 1 candidate species, have been reported for Los Alamos County; however, sitings have not been reported for the LANL Site (NMFG 1992). In the Jemez Mountains and the Rio Grande Valley, meadow jumping mice prefer areas with permanent water, moderate-to-high soil moisture, and dense riparian vegetation consisting of grasses, sedges, and forbs.

The Rio Grande silvery minnow and the bluntnose shiner are endemic to the Rio Grande. The Rio Grande silvery minnow is confined to perennial reaches of the Rio Grande. It is suspected that the bluntnose shiner is extinct. Surveys conducted for both species on the LANL Site did not reveal their presence.

The Goat Peak pika, occult little brown bat, spotted bat, ferruginous hawk, loggerhead shrike, northern goshawk, white-faced ibis, and Jemez Mountain salamander are Federal Category 2 candidate species that have been reported for Los Alamos County. The southwestern willow flycatcher, a Federal Category 1 candidate species, has also been reported for Los Alamos County. These species have not been reported for the LANL Site.

8.7.2 Plants

Wright's fishhook cactus, both a state and federally listed endangered species, and grama grass cactus, a state endangered and federal category 2 species, occur in Los Alamos County. Surveys conducted in Ancho and Chaquehui canyons and Frijoles Mesa did not reveal the presence of either species.

8.8 Ecological Management Issues at LANL

Unique ecological resources on the LANL Site occur within riparian areas. These and other natural areas are subject to disturbance and potential impact from off-road vehicle use and other unregulated activities that may occur on-site.

8.8.1 Riparian Canyons

Areas of consistent water flow create vital habitat for wildlife on the semi-arid LANL Site. Riparian canyon bottoms often support a greater diversity of species than other areas of the Site. The presence of water in canyons in the juniper-grasslands creates grass-sedge communities, as well as some shrub areas. These areas are critical to waterfowl and wading birds that migrate through the Site, including such sensitive species as the whooping crane. These areas also support the large number of small mammals that compose the prey base for predators on the LANL Site. Several species of raptors and owls hunt in the canyon bottoms, as do coyotes. Because riparian canyons are so widely used by LANL wildlife, any disturbances to these areas would adversely affect many species on the Site.

8.8.2 Off-Road Travel

Off-road vehicular travel is particularly damaging to LANL wildlife. Most semi-arid communities are extremely sensitive to physical disturbances. The soil crust in most areas of the Site is very fragile, especially at lower elevations, where understory ground cover is less than 15%. Off-road driving causes severe erosion in those sensitive communities.

9.0 Savannah River Site

This section discusses ecological resources managed by DOE at the Savannah River Site (SRS) in southwestern South Carolina (Figure 9.1). Included are brief descriptions of the SRS, its climate, sources for the ecological resource information, the major vegetation types and associated plant and animal species, aquatic resources, plant and animal species of concern, and the ecological management issues of SRS. Species of concern include federally listed species, federal candidate species, and state-listed species.

9.1 Site Description

The SRS is located approximately 40 km (25 mi) southeast of Augusta, Georgia, and occupies an area of approximately 310 square miles (Wike et al. 1994) in portions of Aiken, Allendale, and Barnwell Counties, South Carolina. The SRS was constructed in 1951 for the production of plutonium, tritium, and other special nuclear materials in support of the United States defense program.

The Site is situated within two physiographic subregions: the Pleistocene coastal terraces and the Aiken plateau (Dukes 1984). The Pleistocene coastal terraces occur at elevations less than 82 m (270 ft) and include floodplain covered by swamp forest along the Savannah River and level to gently rolling terrain. The Aiken plateau occurs at elevations greater than 82 m (270 ft) and is typically hilly with small streams dissecting the region.

The SRS contains a wide variety of habitats including upland terrestrial areas and various types of wetlands including Carolina Bays, bottomland hardwood forests, lake and streams associated wetlands, and the Savannah River swamp system (Wike et al. 1992). Six major streams flow off the Site before draining into the Savannah River, which forms approximately 32 km (20 mi) of the southwest boundary of the SRS. Elevations on the SRS range from 27 to 128 m (89 to 420 ft) above mean sea level.

The SRS is primarily undeveloped land, with facilities, roads, and utility corridors accounting for approximately 5% of the total area (DOE 1990d). The SRS has been a controlled access area since 1952, with public travel across the Site restricted to U.S. Highway 278, State Highway 125, SRS Road 1, and some railroad corridors.

9.2 Climate

The SRS has a humid subtropic climate (Critchfield 1974). Meteorological data for the area are available from on-site measurements (Parker et al. 1992) and from measurements at Bush Field in Augusta, Georgia. On average, the maximum daily temperature exceeds 32°C (90°F) 69 days per year and is below 0°C (32°F) about twice every three years; the minimum daily temperature is below 0°C (32°F) 58 days per year and is below -18°C (0°F) about once every 20 years (DOC 1987b). July is the warmest month, with daily maximum and minimum temperatures averaging 33°C (92°F) and 21°C (70°F), respectively. January is the coolest month, with daily maximum and minimum temperatures

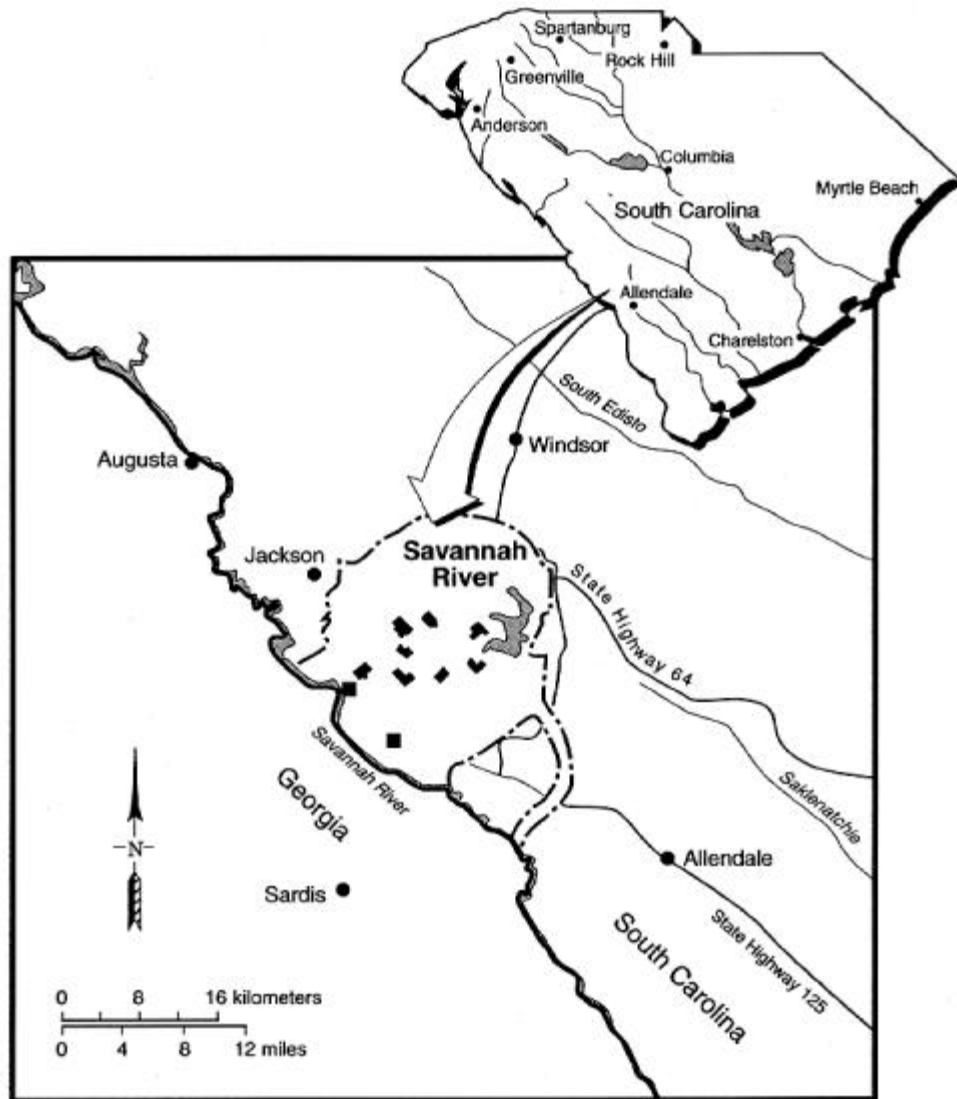


Figure 9.1. Savannah River Site, South Carolina

averaging 12°C (53°F) and 1°C (33°F), respectively (DOC 1987b). Annual precipitation is approximately 110 cm (43 in.). Measurable precipitation (defined as 0.025 cm [0.01 in.] or greater) is recorded on an average of 107 days per year, and the area experiences an average of 54 thunderstorm days per year. The average annual snowfall is 3 cm (1 in.) and daily snowfall accumulations of 2.5 cm (1 in.) or greater occur once every two years (DOC 1987b). Additional climatological information is summarized in Holdren et al. (1994).

9.3 Sources for Ecological Resource Information

The SRS was designated a National Environmental Research Park (NERP) in 1972. This designation encouraged the study of natural resources and the effects of nuclear materials production activities on SRS ecosystems (DOE 1990d). In addition, approximately 5% (4858 ha; 12,000 acres) of undisturbed SRS land was set aside for forest research and management activities (Cummins et al. 1990). Environmental research activities conducted on the NERP are coordinated by the Savannah River Technology Center, Savannah River Ecology Laboratory, and Savannah River Forest Station (Cummins et al. 1990).

The principal sources of information for this report included environmentally related reports and documents produced by DOE contractors.

9.4 Terrestrial Vegetation Types

The SRS and surrounding area are located in a transition zone between the oak-hickory-pine forest and southern mixed forest, with plant species typical of both areas (DOE 1990d). Much of the vegetation currently found on the SRS reflects past disturbances such as farming, which occurred before establishment of the SRS. At the time of government acquisition, approximately 67% of the SRS was forested, and the remainder was cropland and pasture (DOE 1992d). Once the SRS was established, approximately 30,364 ha (75,000 acres) of old farm land was planted with pine seedlings by the U.S. Forest Service.

Wike et al. (1994) lists 5 major forested cover types: evergreen and deciduous upland forests, bottomland hardwood forests, swamp forests, and Carolina Bays. Other vegetative cover types found on-site include grassland/forblands and areas of scrub-shrub. More than 1100 species of vascular plants are known to occur on the SRS (Batso et al. 1985). Table 13.1 identifies the vegetation types found on the SRS, as well as those found at all other sites discussed in this document.

9.4.1 Upland Forest Lands

Upland forest communities occupy approximately 1800 ha (4500 acres) of the Site. Included are both deciduous and evergreen forests, with trees at least 6 m (20 ft) high (Wike et al. 1992). The evergreen forest type is dominated by longleaf pine and loblolly pine. Slash pine and shortleaf pine are also common. These species occur in association with a variety of understory plants such as oak, black cherry, persimmon, and broom sedge. Some examples of native coniferous forest still exist on the Site, but most of the evergreen forest type that exists today is a result of the U.S. Forest Service's pine plantation management plan (Wike et al. 1994). This cover type is generally located on dry upland areas, including former agricultural areas.

Deciduous forests include upland hardwood and mesic hardwood forestlands, where deciduous trees compose at least 70% of the tree canopy (Wike et al. 1994). On dry upland sites, hardwood forests are dominated by turkey oak, bluejack oak, blackjack oak, and longleaf pine. On lower slopes, deciduous forests include laurel oak, blackgum, and red maple. Understory species include various ferns, hollies, sassafras, and dogwood.

9.4.2 Grassland/Forbland

Before establishment of the SRS in 1951, approximately one-third of the area was maintained as cropland and pasture (Wike et al. 1992). Following closure of the Site to the public, much of the agricultural acreage either reverted, through natural succession, to pine or was planted in pine by the U.S. Forest Service. Grassland/forblands now occur along utility corridors, forest openings, and foodplots maintained for wildlife. This cover type is typically dominated by nonwoody plants, with grasses and forbs composing greater than 50% of the cover (Wike et al. 1992).

9.4.3 Wetland Cover Types

The SRS is located in the Southern Bottomland Hardwood Swamp region, as described in Cummins et al. (1990), and contains a variety of wetland cover types, including bottomland hardwood forests, swamp forests, and emergent marsh areas (Workman and McLeod 1990).

Bottomland hardwood forests are the second largest forest type on the SRS, occupying approximately 15% of the Site (12,000 ha; 29,000 acres) (Workman and McLeod 1990). This cover type occurs along islands, banks, and ridges of the Savannah River swamps and drainages. These areas are high enough to avoid prolonged flooding, but are seasonally inundated. Canopy species characteristic of this forest type include water oak, laurel oak, sweet gum, elm, red maple, and tulip tree (Wike et al. 1994). Hackberry and ironwood are common understory species.

Swamp forests occur on the Savannah River floodplain, in areas that are inundated for a substantial portion of the year. Swamp forests encompass approximately 5% of the Site (3800 ha, 9400 acres). Dominant species in the climax swamp forest are bald cypress and water tupelo, with a sapling layer consisting of red ash, water ash, American elm, and sycamore. Vine cover is less dense in the swamp forest than in bottomland hardwood communities. In wetter stands, *Lemna* and *Elodea* are common. Changes in topography and, therefore, soil moisture cause distinct changes in species composition. Low levees and ridges in the swamp are not as saturated as the low-lying swamp areas. The higher areas of the swamp support red ash, sweetgum, and hackberry. Bald cypress and tupelo gum are less frequent in these areas (Workman and McLeod 1990).

Emergent wetlands occupy approximately 3% of the SRS (2500 ha; 6100 acres). Plants found in the persistent emergent wetlands include cattails and knotweed, whereas water smartweed and hydrolea are common nonpersistent emergents (Wike et al. 1994). Carolina bays, a unique type of wetland found on the SRS, occupy approximately 472 ha (1100 acres). These bays are natural shallow depressions that are ovoid or elliptical and have a northwest-to-southeast orientation. The origin of these bays is a mystery. Upland pine, oak, or scrub oak vegetation surround the bays. Depending on the water level in the bays (which fluctuates throughout the year), vegetation within the bays varies from grasses and sedges to pond or lake plants (Workman and McLeod 1990).

9.5 Terrestrial Wildlife

Approximately 351 species of terrestrial vertebrates occur on the SRS (Wike et al. 1992). Included are 48 species of mammals, 213 species of birds, 43 species of amphibians, and 47 species of reptiles. An additional eight species of mammals potentially occurring but not confirmed on the SRS include the

cougar, white-footed mouse, swamp rabbit, and five species of bat. There are also several introduced mammals found on the SRS, including the feral cat, feral dog, feral pig, and Norway rat (DOE 1990d).

9.5.1 Terrestrial Habitat Wildlife

Major terrestrial habitats occurring on the SRS include old fields and clearcuts, pine plantations, scrub oak/longleaf pine habitats, and upland and lowland hardwood habitats (Wike et al. 1992). Disturbed or artificial habitats on the SRS include two abandoned town sites, old farm ponds, manmade reservoirs, roadsides, powerlines, railroad rights-of-way, lawns, and industrial sites (Batson et al. 1985).

Some native mammal species known to occur in all terrestrial habitats include the opossum, bobcat, white-tailed deer, raccoon, eastern cottontail rabbit, short-tailed shrew, and gray fox.

Birds found on the SRS comprise a diverse and mobile group, occurring in natural and man-made habitats of the Site. Of the 213 bird species observed on the SRS (Wike et al. 1992), 88 species are known to occur on-site during the breeding season, whereas the remainder occur as seasonal migrants. Included are a variety of raptors, perching (passerine) birds, wading birds, shorebirds, and waterfowl.

Seventeen species of raptors have been observed on-site, including 10 species known to occur during the breeding season, i.e., Mississippi kite, Cooper's hawk, red-tailed hawk, red-shouldered hawk, broad-winged hawk, American kestrel, barn owl, screech owl, great horned owl, and barred owl.

9.5.2 Wetland Wildlife

The variety of terrestrial and wetland habitats on the SRS supports a diverse herpetofauna, including 43 species of amphibians and 47 species of reptiles (Wike et al. 1992). Wetland habitats on the SRS that support reptiles and amphibians include ponds, streams, lakes, swamps, and Carolina bays. Reptiles and amphibians studied over a period of several years at locations such as PAR Pond, L-Lake, and Steel Creek reflect the diverse nature of this group of wildlife. Species that occur in PAR Pond include salamanders, toads, frogs, and reptiles such as the American alligator, turtles, water snakes, and the cottonmouth (sub. spp. eastern cottonmouth).

Herpetofauna occurring along shoreline habitats adjacent to L-Lake include salamanders, the southern toad, frogs, and reptiles such as the American alligator, turtles, and a variety of lizards, skinks, and snakes.

Thirty-one species of waterfowl occur in bodies of water, such as PAR Pond, L-Lake, and the Savannah River, during migration. Species include Canadian geese, gadwalls, ringneck ducks, lesser scaup and blue winged teal (DOE 1992d). The wood duck and mallard are the primary waterfowl species found on the SRS during the breeding season.

Mammal species known to occur in the wetland and aquatic habitat include beaver, river otter, mink, muskrat, raccoon, marsh rabbit, star-nose mole, and the marsh rice rat (DOE 1992d).

9.6 Aquatic Resources

Aquatic habitats and communities on the SRS are associated with a diversity of water sources on-site, including the Savannah River, streams, ponds, reservoirs, and floodplain swamps. The principal aquatic ecosystem on-site is the Savannah River, which flows approximately 32 km (20 mi) along the southwest boundary of the SRS between South Carolina and Georgia (Cummins et al. 1990).

Six major streams are found on-site and include Upper Three Runs, Beaver Dam Creek, Four Mile Creek, Steel Creek, Lower Three Runs, and Pen Branch. All streams but Pen Branch drain from the Site into the Savannah River. The Pen Branch parallels the Savannah River before eventually emptying into the Savannah River floodplain swamp.

Other aquatic habitats include the Savannah River Swamp, PAR Pond, and L-Lake. Swamp habitat along the Savannah River occupies approximately 3020 ha (7459 acres) and is maintained through flow from the six major streams on-site and seasonal flooding of the Savannah River (Wike et al. 1992). PAR Pond (1012 ha; 2500 acres) and L-Lake (419 ha; 1035 acres) are former cooling reservoirs created by damming Lower Three Runs and Steel Creek. Both of these reservoirs are heavily used by waterfowl during migration.

Biological resources found in aquatic habitats on the SRS include vascular plants (macrophytes), plankton, aquatic invertebrates, and fish.

Common aquatic vascular species include water milfoil, hornwort, alligatorweed, waterweed, and common arrowhead (referred to as duck potato in SRS literature) (DOE 1990d).

Macroinvertebrates include a diverse group of benthic and drift aquatic insects occurring in a variety of aquatic habitats. Aquatic invertebrates collected from the Savannah River, streams, and reservoirs on-site represent 47 insect families and 6 noninsect groups (Dukes 1984). Some of the more common invertebrate taxa occurring in these habitats include midges, mayflies, caddisflies, scuds, water mites, and nematode worms. Other benthic macroinvertebrate organisms include snails and clams.

Wike et al. (1992) reported that 71 species of freshwater and anadromous fish, representing 12 orders and 21 families, occur in the Savannah River adjacent to the SRS. Resident fish important to recreational sport fishing in the Savannah River include channel catfish, largemouth bass, and bream. Anadromous species include striped bass, Atlantic sturgeon, shortnose sturgeon, American shad, and hickory shad. Fish reported to occur in Steel Creek include gar, bowfin, chubs, shiners, suckers, bullheads, sunfish, and darters (Dukes 1984).

9.7 Wildlife and Plant Species of Concern

Species of concern include federally listed threatened or endangered species, federal candidate species, and state-listed species.

9.7.1 Wildlife

Twenty-one animal species of concern are known to occur or previously occurred on the SRS. Included are 1 mammal species, 13 bird species, 3 reptile species, 1 amphibian species, 1 fish species, and 2 invertebrate species.

The U.S. Department of Interior and the State of South Carolina list eight species of mammals as historically residing in South Carolina as endangered or threatened. Only one of these mammals, the Rafinesque's big-eared bat, has been confirmed on the SRS. It is improbable that breeding populations of the other seven species exist on SRS.

Thirteen species of birds listed as threatened or endangered by the Federal or state government are known current or past residents of SRS. This group includes the federally endangered red-cockaded woodpecker, bald eagle, peregrine falcon, Kirtland's warbler, and wood stork. Federal candidate species include the Benwick's wren, loggerhead shrike, and the Backman's sparrow. The State of South Carolina lists the golden eagle, osprey, Cooper's hawk, swallow-tailed kite, and the Savannah sparrow as endangered.

No reptiles found at SRS are listed as threatened or endangered. The American alligator, however, is listed as "threatened due to similarity of appearance" due to its close resemblance to the very rare American crocodile. Other reptilian species found at SRS that are not currently listed as threatened or endangered, but are candidate species for listing, include the Northern pine snake (aka Bull snake) and the Southern hognose snake. The only amphibian currently of concern is the Carolina crawfish frog which is listed as a Federal candidate species.

The shortnose sturgeon is the only endangered species of fish that occurs on or near SRS. Invertebrate species of concern include the brother spike mussel and American sand burrowing mayfly. The brother spike mussel is a South Carolina endangered species, and the burrowing mayfly is a Federal candidate species (Wike et al. 1994).

9.7.2 Plants

The SRS is populated by a diverse flora, including several unusual and rare species, eight of which are considered as federally endangered or possibly appropriate for proposed Federal listing as threatened or endangered. Federal candidate species include the North American sandalwood, awned meadow-beauty, bog spice bush, cypress knee sedge, Elliot's croton, loose water milfoil, and swamp lobelia. Smooth coneflower, a federally endangered species, has also been observed on Site (Wike et al. 1994).

9.8 Ecological Management Issues at SRS

Because the SRS provides refuge for a variety of wildlife species and habitats, management programs are maintained for wildlife, timber, and wetlands.

9.8.1 Wildlife Management

Since the closure of the SRS to the public in 1952, populations of white-tailed deer and feral hogs have steadily increased. A 1972 census of the deer population indicated that between 10,000 and 11,000 deer were living on the Site (Wike et al. 1992). Incidences of deer/vehicle collisions rose sharply, and habitat degradation became more evident. Feral hogs, the descendants of domestic pigs that were abandoned on the Site, also cause considerable habitat degradation and are detrimental to young tree seedlings and forest plantations. Regulated harvest of deer on SRS has been permitted since 1965, with an average of 1091 deer taken annually between 1965 and 1987 (SRFS 1988). Feral hogs are also harvested to reduce the population and control damage to vegetation.

9.8.2 Timber Management

Before the establishment of the SRS, approximately two-thirds of the Site was forestland, both pine forests and hardwood forests. Most of the forested areas on the Site are now actively managed by the Savannah River Forest Station. The timber management plan specifies requirements for 70,875 ha (175,000 acres) of commercial forest land and 6480 ha (16,000 acres) of nonforest land. The current management plan, developed in 1953, consists of planting and replanting of loblolly and longleaf pines, as well as several species of hardwoods.

9.8.3 Wetland Areas

The east coast of the United States is a major flyway for migrating waterfowl and other birds, which rely on wetland areas for food and cover during migration. Approximately 21% (18,000 ha, 45,000 acres) of the SRS is wetlands (Wike et al. 1992). The loss or damage of wetland areas all along the coast due to draining, disturbance, or contamination has made the wetland areas on the SRS much more important to migrating birds.

However, many wetland areas at SRS are affected by Site activities. Many areas, particularly areas near streams, were affected by thermal output from Site cooling water discharges. The temperature changes usually had drastic effects on species diversity and composition in aquatic and wetland environments. Some bottomland forest communities which were subjected to thermal releases suffered forest mortality. Cooling water discharges also changed the flow rates of some streams, increasing erosion and sedimentation in wetland areas. All of the SRS reactors have been shut down and recovery of the affected systems is occurring. However, the ecological restoration of these thermally impacted sites is an important on-going management issue.

10.0 Oak Ridge National Laboratory

This section discusses ecological resources managed by the DOE Oak Ridge Reservation (ORR) in Oak Ridge, Tennessee (Figure 10.1). Included is a brief description of the Site, its climate; the sources for ecological resources information, a discussion of the major vegetation types found on the Site and their associated wildlife and aquatic habitats and wildlife. Also included are descriptions of plant and animal species of concern, namely federal and state listed threatened or endangered species, and a discussion of ecological management issues on the Site.

10.1 Site Description

The ORR is located in Oak Ridge, Tennessee, approximately 28 km (17 mi) southwest of Knoxville. The ORR is the site of three separate DOE installations that are operated by Martin Marietta Energy Systems: the Oak Ridge National Laboratory (ORNL), the Oak Ridge Gaseous Diffusion Plant (ORGDP), and the Y-12 Plant. The 3563-ha (8800-acre) ORNL Site began operations in 1943 as a pilot plant for the development of plutonium-239 production and chemical separations processes. The present mission of ORNL includes large-scale research and development in the area of energy production and basic research in environment and health issues related to energy technologies (DOE 1988a). The 688-ha (1700-acre) ORGDP (K-25) Site was placed in a shutdown mode in 1987. Until that time, its primary operation was for uranium enrichment (DOE 1988a). The 328-ha (811-acre) Y-12 Plant was built in 1943 as part of the Manhattan Project. After World War II, the mission of the plant became manufacturing and developmental engineering (DOE 1993).

The ORR occupies a total of 14,440 ha (35,664 acres) in Roane and Anderson Counties, Tennessee. The Site is bordered on the west, south, and east by the Tennessee Valley Authority's Melton Hill and Watts Bar embayments on the Clinch River. The terrain on the reservation reflects its southern Appalachian location. The Site is characterized by rolling topography with subtle to exaggerated slopes with very few flat expanses of land. Ridges of sandstone, shale, and dolomite form the areas of highest elevation on the reservation, near 413 m (1350 ft), separated by valleys in places underlain by less resistant limestone (DOE 1988a). The areas of lowest elevation are found near the Clinch River, at approximately 230 m (740 ft). Groundwater under the reservation generally follows the topography and, in many places, the clay subsoil channels most of the hydrological input into surface flow. Several creeks that eventually empty into the Clinch River drain the Site.

10.2 Climate

The ORR is near the boundary between a humid subtropic climate and humid continental warm summer climate (Critchfield 1974). Meteorological data are available from on-site measurements and from measurements in the city of Oak Ridge, Tennessee. On average, the maximum daily temperature exceeds 32°C (90°F) 30 days per year and is below 0°C (32°F) 6 days per year; the minimum daily temperature is below 0°C (32°F) 87 days per year and is below -18°C (0°F) about once every two years (DOC 1987b). July is the warmest month, with daily maximum and minimum temperatures averaging 31°C (87°F) and 19°C (66°F), respectively. January is the coolest month, with daily

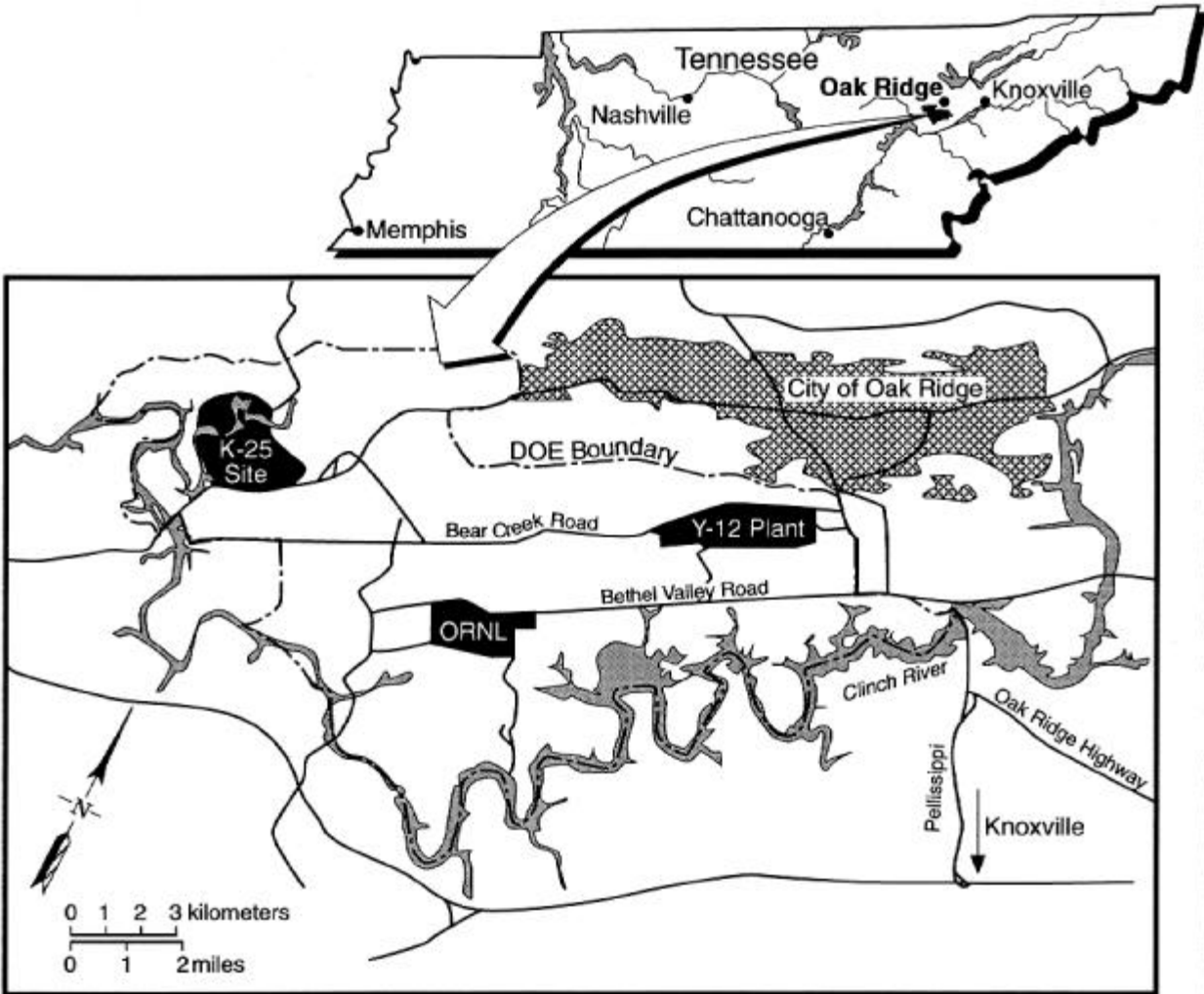


Figure 10.1. Oak Ridge Reservation, Tennessee

maximum and minimum temperatures averaging 8°C (46°F) and -2°C (28°F), respectively (DOC 1987b). Annual precipitation is approximately 140 cm (55 in.). Measurable precipitation (defined as 0.025 cm [0.01 in.] or greater) is recorded on an average of 128 days per year, and the area experiences an average of 51 thunderstorm days per year. The average annual snowfall is 33 cm (13 in.) and daily snowfall accumulations of 2.5 cm (1 in.) or greater occur an average of 4 days per year (DOC 1987b). Additional climatological information is summarized in Holdren et al. (1994).

10.3 Sources for Ecological Resource Information

Ecological resources at ORR have been monitored over the past 13 years since the establishment of the 5008-ha (12,374-acre) National Environmental Research Park (NERP) on the ORR in 1980. The Park maintains several research sites and state-registered natural areas for environmental and ecological

monitoring. In the previous five years, the ORR's Environmental Sciences Division has developed an extensive resource management program for ORR, ranging from threatened and endangered species management to wetland surveys.

10.4 Terrestrial Vegetation Types

Plant communities found on the ORR are characteristic of the ridge and valley regions of Appalachia, that range from the Allegheny Mountains in Pennsylvania to the Cumberland Range in northern Alabama (Kitchings and Mann 1976). Approximately 80% of ORR acreage is forested, with the remainder of the Site being grassland, wetlands, aquatic areas, or disturbed or developed areas. The riparian plant communities on the ORR are those of forests, grasslands and old fields, and wetlands. Table 13.1 identifies the major vegetation types found on the ORR and on all other sites discussed in this document.

10.4.1 Forest Communities

Several different types of forest communities occur on the ORR (Cunningham et al. 1993):

- **Oak-hickory forests** - This forest type is the most extensive and is the climax community of the forested areas of the region surrounding the ORR. Important species include chestnut oak, white oak, black oak, northern red oak, scarlet oak, and post oak, in association with various hickories (bitternut hickory, pignut hickory, and shagbark hickory) and ash. Other common species are tulip poplar, red maple, black gum, dogwood, and beech.
- **Northern hardwood forests** - This forest type consists of mixtures of beech, sugar maple, hemlock, and buckeye. Northern hardwood forests are small but fairly common in sheltered coves along stream drainages and sheltered north facing slopes on the ORR. Understory in this forest type usually includes maple leaf viburnum, pawpaw, rhododendron, and a variety of fern species. In other areas, wild ginger, blue cohosh, doll's eyes, and other herbaceous species occur that are rare to the ORR (Kitchings and Mann 1976).
- **Bottomland hardwood forests** - This forest type is characterized by cottonwoods, sycamore, American elm, ash, willow, silver maple, and river birch. Bottomland hardwood forests are restricted to floodplains along creek bottoms and are rare isolated areas on the ORR. Cane and dogwood form thickets in some floodplain areas. Groundcover in these areas includes primarily grasses.
- **Pine and pine hardwood forests** - Most natural areas of this type are dominated by shortleaf and Virginia pines. Oaks, hickories, and tulip poplar are often a part of these successional stages. This type of forest is also found in association with monocultures (e.g., plantations) of loblolly pine.
- **Hemlock/white pine/hardwood forests** - This forest type represents the southern boundary of a forest community that occurs in northern locations and at higher elevations. Dominant species are hemlock and white pine and associated hardwoods. This forest type occurs on the ORR only in very restricted areas (Parr and Pounds 1987).

- **Cedar, cedar-pine, and cedar-hardwood forests** - Small cedar barrens are common on the ORR, and are generally found in openings in the more extensive forest types. Cedar barrens are usually best developed on areas that are underlain by limestone or dolomite. They can appear quickly after disturbances. The present distribution of cedar forests on the ORR is indicative of both underlying geology and of past land use. The dominant species are eastern red cedar and a variety of drought-tolerant grasses and forbs. Prairie species, such as little bluestem and dropseed, that are more common in the midwestern United States, are characteristic of cedar barrens (Cunningham et al. 1993).

The original forests on the ORR were extensively cleared and have historically been cultivated or used for pasture. Cultivation on the ORR ended in 1942, and several areas developed into forest through natural succession or plantings. Many areas of the Site were planted with loblolly, shortleaf, and white pines between 1948 and 1954, and have experienced little or no invasion by hardwoods. Other pine plantations have been established in areas that were previously harvested (Cunningham et al. 1993).

10.4.2 Grassland and Old Field Communities

Except for those found in cedar barrens, all grassland or old field areas on the ORR are either areas that are maintained as such by ORR, such as powerline and pipeline rights-of-way or lawn areas, or are successional areas that are reverting to forest after a disturbance.

Old field communities on the ORR that are in early stages of succession are typically dominated by crabgrass or other grasses and ragweed. Depending on soil fertility, degree of erosion, availability of seed sources, and moisture, this stage of succession can persist for 20 years. Other species that are common to areas in early successional stages are biennial and perennial forbs such as horseweed, primrose, and many species of aster. Other old field areas on the ORR are dominated by broomsedge and other perennial grasses. Other species common to this successional stage include honeysuckle, brambles, fescue, and pine seedlings.

Older grassland areas on the ORR have entered a shrub phase when the grassland is invaded by shrubs, tree seedlings, and woody vines. Dominant species include honeysuckle, trumpet creeper, sumac, persimmon, sassafras, red cedar, and pine. Various hardwood seedlings become established at this stage of succession as well (Kitchings and Mann 1976).

10.4.3 Wetlands

Wetland areas occur in over 90 known locations on the ORR (Cunningham and Pounds 1991). Wetland types present on-site include emergent communities near reservoirs, emergent and aquatic communities in shallow ponds (usually former farm ponds), wet meadows and marshes near streams or seeps, and forested wetlands along East Fork Poplar Creek, Poplar Creek, Bear Creek, and their tributaries. Approximately 37 species of vascular plants are associated with these wetland areas on the ORR. The most common herbaceous emergent species are sedges and rushes. Also common are cattails, lizard's tail, and sweet flag. Alder, indigobush, buttonbush, and silky dogwood are common wetland shrub species on-site. Trees that have been documented near wetland areas include boxelder, green ash, sycamore, and black willow. Also observed in the wetland areas were floating aquatic plants, such as *Wolffia* spp. and *Lemna* spp., and submerged aquatic plants, such as *Elodia* spp., *Myriophyllum* spp., *Potamogeton* spp. (Cunningham and Pounds 1991).

10.5 Terrestrial Wildlife

Approximately 270 species of terrestrial vertebrates have been identified on the ORR, including 26 species of amphibians, 33 species of reptiles, 170 species of birds, and 40 species of mammals (Parr and Evans 1992). The following sections discuss wildlife found in some primary habitats on the ORR Site: hardwood forests, pine plantations, grasslands, wetlands, and caves.

10.5.1 Hardwood Forest Wildlife

The hardwood and mixed conifer/hardwood forests on the ORR provide valuable habitat for wildlife. Most animal species found in these forest types prefer the diversity of tree species and the relatively closed canopy that develops in these mature forest communities.

The most common amphibians in these areas include dusky salamanders and American toads. Reptiles typically found in the hardwood forests are the eastern box turtle, ground skink, worm snake, black racer, black rat snake, common kingsnake (aka black kingsnake), milk snake, and copperhead (Parr and Evans 1992).

Several species of birds use the hardwood forests for nesting and cover, including the yellow-shafted flicker, red-bellied woodpecker, hairy woodpecker, and downy woodpecker. Also found in these communities are blue jays, Kentucky warblers, pine warblers, ovenbirds, Carolina chickadees, and scarlet tanagers. Wild turkey have been re-introduced to the ORR and are often observed in the hardwood forest areas. Raptors use these forest types for nesting and hunting, the most commonly observed species being red-tailed and broad-winged hawks (Parr and Evans 1992).

Small mammals are abundant in the mixed hardwood forest areas of the ORR. Eastern gray squirrels and southern flying squirrels inhabit the areas, as do southeastern shrews, eastern moles, short-tailed shrews, and eastern chipmunks. White-tailed deer use the mixed forest areas primarily for cover in extreme weather. The most common predators in these areas are the long-tailed weasel and the bobcat (Parr and Evans 1992). Red and gray fox are observed occasionally, and muskrat are observed on the stream beds in the hardwood forest communities (Kitchings and Mann 1976).

10.5.2 Pine Plantation Wildlife

Pine plantations grow more quickly than other forest types, and form a dense canopy that shades out understory growth. Species diversity is much lower in these communities:

- The pine plantations are little utilized by reptiles and amphibians. Eastern fence lizards, six-lined racerunners, northern copperheads, and black rat snakes are the most common species (Kitchings and Mann 1976).
- Pine warblers and white-throated sparrows are found in pine plantations, but few other passerine birds are observed there. Raptors such as American kestrels (aka sparrow hawks), red-tailed hawks, red-shouldered hawks, turkey vultures, and an occasional bald eagle, have been observed hunting near the pine plantations (Kitchings and Mann 1976).
- White-footed mice, golden mice, and short-tail shrews are the most common mammal species found in the pine areas. Larger mammals occasionally use this habitat for shelter.

10.5.3 Grasslands Wildlife

Numerous amphibian and reptile species are found in the successional grasslands and old field habitats on the ORR. The northern cricket frog, the spring peeper, spotted salamander, red salamander, eastern box turtle, yellowbelly slider, eastern hognose snake, rough green snake, eastern fence lizards, and garter snakes have been observed in these areas (Kitchings and Mann 1976).

Bird species commonly found in grassland areas include bobwhite quail, red-tailed hawk, field sparrow, rufous-sided towhee, blue grosbeak, meadowlark, and red-winged blackbird. Eastern bluebirds have become more common with the establishment of nesting boxes on the ORR (Parr and Evans 1992). Cooper's hawks, sharp-shinned hawks, great horned owls, and barred owls hunt over the grassland and old field areas. Other birds that use the open areas are grasshopper sparrows, purple finches, horned larks, Swainson's warbler, and brown thrashers.

The principal mammal species that occur in these successional grasslands are the southeastern shrew, least shrew, short-tailed shrew, eastern harvest mouse, hispid cotton rat, pine vole, eastern cottontail rabbit, and the eastern mole. Groundhogs are common in areas that are mowed or grazed. Striped skunk, coyote, red fox, white-tailed deer, and opossum can be found in these areas at night (Parr and Evans 1992).

10.5.4 Wetland Wildlife

A large number of amphibians and reptiles have been identified in or near ORR wetland areas. Common species include the northern cricket frog, the upland chorus frog, eastern spadefoot toad, hellbender, mudpuppy, spiny softshell turtle, and snapping turtle. Frequently observed reptile species include the northern water snake, the southeastern crowned snake, and the eastern garter snake (Kitchings and Mann 1976).

Common waterfowl that use the wetland areas on-site include wood ducks, pintails, canvasbacks, Canada geese, hooded mergansers, and American widgeons. Shorebirds, such as great blue herons, cattle egrets, and green herons, are frequently observed. Other bird species common to the wetland areas on-site are spotted sandpipers, killdeer, loggerhead shrikes, Swainson's warblers, whistling swans, blue-gray gnatcatchers, and purple martins. Several raptor species hunt over the wetland areas on the ORR, including Cooper's hawks, marsh hawks, black vultures, American kestrels, bald eagles, and ospreys (Kitchings and Mann 1976).

Marsh rice rats, muskrats, and beaver are common mammals associated with ORR wetland areas. Other mammals that use these areas include raccoons, gray and red fox, white tailed deer, and bobcats (Kitchings and Mann 1976).

10.5.5 Cave Wildlife

Caves are very common in the limestone on the ORR. Although no sampling has been done to determine the extent of the use of caves by ORR wildlife, certain species have been observed in ORR caves. The caves are the only known on-site habitat of the green salamander on-site. The tracks of numerous small mammals, such as white-footed mice, short-tailed shrews, and weasels, have been observed in the light areas in cave openings. Raccoon, bobcat, mink, and foxes have also been observed in and around caves on the ORR. Several species of bats are the only animals that live deep in the caves and several more species, including the red bat, hoary bat, and silver-haired bat, roost in the light zones at the mouth of the caves (Parr and Evans 1992).

10.6 Aquatic Resources

Aquatic habitats on the ORR include the Clinch River, on the southern border of the Site, several small to medium-sized streams that drain the Site, wetland areas, and lakes and impoundments created by dams on the river. Over 60 species of fish occur in ORR aquatic habitats. Predominant fish species in the Clinch River and impoundments are gizzard shad, threadfin shad, skipjack herring, carp, smallmouth buffalo, white bass, smallmouth bass, largemouth bass, white crappie, sauger, and freshwater drum. Species found in smaller streams include stonerollers, golden shiners, striped shiners, fathead minnows, creek chubs, stripetail darters, and snubnose darters (Parr and Evans 1992).

Several species of turtles, salamanders, and frogs occur in ORR aquatic habitats. A few reptile species are common as well, such as the queen snake and the northern water snake. Muskrat and beaver are common in the aquatic habitats. Bald eagles and ospreys frequently hunt in aquatic areas. Osprey nesting platforms near Watts Bar Lake have been used successfully over the past few years (Parr and Evans 1992).

10.7 Wildlife and Plant Species of Concern

According to the U.S. Department of the Interior, Fish and Wildlife Service, several endangered or threatened plant and animal species either do occur or have the potential to occur on the ORR. Included are 18 federally endangered mollusc species, 3 threatened fish, 3 endangered birds, and 3 endangered mammals (DOE 1991a). There are also several plant and animal species that have been listed as threatened, endangered, or sensitive in the state.

10.7.1 Wildlife

Although 18 federally endangered species of molluscs potentially occur on or near the ORR (DOE 1991a), no populations of these species have been found in the Clinch River or its reservoirs south of the ORR. All of the mollusc species require large, free-flowing streams or rivers, making the reservoirs and embayments near the ORR unsuitable habitat (Kroodsma 1987).

The three threatened species of fish that potentially occur on or near the ORR, are the spotfin chub, the yellowfin madtom, and the slender chub (DOE 1991a). All three species have been historically present in the Clinch River and the nearby Emory River. It is unlikely that these species occur in the Clinch River or in streams on the ORR due to their preference for larger, free-flowing streams and rivers. These species generally require clear streams with considerable current and large size gravel substrate (Kroodsma 1987).

Three endangered bird species also either occur or potentially occur on the ORR:

- Bald eagles are observed fairly regularly in the area around the ORR. Some have attempted to nest on the ORR, but the success of the nesting is unknown (Parr and Evans 1992).
- Potential habitat also exists for the peregrine falcon, although none have been recorded breeding around the ORR during the last 30 years.
- Red-cockaded woodpeckers also may find suitable habitat on the ORR. This species nests in mature to old-age pines that have been infected with fungal diseases. While mature stands of pine are currently lacking on the ORR, red-cockaded woodpeckers have been reported in several areas around the ORR, making it more likely that the species includes the reservation in its range (Kroodsma 1987).

Two of the three federally endangered mammals that may be found on the ORR are bats. The gray bat hibernates and raises its young in caves, and has been observed on the ORR.^(a) Although Indiana bats have been observed in many areas in Tennessee, no surveys have been conducted to determine if any are present on the ORR, where suitable habitat exists for this species as well. Indiana bats hibernate in caves, but require floodplain hardwood forests along streams in order to raise their young. The third endangered species of mammal is the eastern cougar, believed to be either an accidental or intentional release from captivity (Parr and Evans 1992). Eastern cougars were once common in Tennessee, but have not been observed in the state for decades. Recent possible cougar sightings have prompted a search for signs of cougar populations. The ORR may provide suitable habitat for the cougars, with relatively little human disturbance and a growing population of white-tailed deer.

Potential habitat for both the Tennessee cave salamander and the northern pine snake, both state threatened species, exists on the ORR. Tennessee cave salamanders may occur in ORR caves; there is no record of northern pine snakes occurring on the reservation.

The osprey (a state-listed threatened species) has made a strong comeback on the ORR. Osprey populations in the state were down to two breeding pairs in 1978 due to DDT poisoning. Currently, several nesting platforms near the Clinch River are used by ospreys. The northern harrier, Cooper's hawk, sharp-shinned hawk, Bewick's wren, and grasshopper sparrow, all threatened in Tennessee, have also been recorded on the ORR (Kroodsma 1987).

One state threatened mammal, the river otter, occurs near the ORR, but would probably not find suitable habitat on the Site (Kroodsma 1987).

Extensive surveys for threatened and endangered species are currently underway.^(b)

(a) Personal communication, December 1994, Jason Mitchell, ORNL, Oak Ridge, Tennessee.

(b) Personal communication, December 1994, Jason Mitchell, ORNL, Oak Ridge, Tennessee.

10.7.2 Plants

Several sensitive plant species are found on the ORR. Approximately half of these rare or sensitive plants are found in wetland areas of the Site. Four federal candidate species of plants occur on the ORR: spreading false-foxglove, Appalachian bugbane, butternut, and tall larkspur (Cunningham et al. 1993). Ten state threatened species have been observed, including purple fringeless orchid, tubercled rein-orchid, ginseng, canada lily, golden seal, mountain witch-alder, northern bush-honeysuckle, and appalachian bugbane. Three state endangered species have also been found: tall larkspur, fen orchid, and pink lady-slipper (Cunningham et al. 1993). Surveys for rare and sensitive plants are currently underway.

10.8 Ecological Management Issues at Oak Ridge

The primary management issues involve the spawning of game fish in polluted streams on the Site and the management and protection of wetlands for water quality and natural areas and wetlands for species diversity.

10.8.1 Aquatic Ecology

The Clinch River, from the Watts Bar Reservoir to the Melton Hill Dam, supports a popular sport fishery for smallmouth bass and largemouth bass, among others. Several species of fish, including sauger, striped bass, and white bass, migrate seasonally up the river, through the reservoirs, and into the mouths of the creeks and embayments on the ORR in order to spawn. Poplar Creek, on the ORR, is a particularly important spawning site for gizzard shad and white bass. High levels of mercury have been found in the sediment of Poplar Creek, which has been traced to releases from the ORR's Y-12 plant that took place between 1950 and 1963. High concentrations of mercury and polychlorinated biphenyls (PCBs) have been found in several species of game fish taken from both Poplar Creek and from the Clinch River and its reservoirs (DOE 1991a).

10.8.2 Wetlands

Most wetland areas on the ORR are found along the embayments of the reservoirs that form the southern border of the Site, as well as along the creeks that drain the Site. The embayments support well-developed shallow wetland communities that are protected from damage by motorboats, recreational use of the shore, and waves. However, much of the debris and surface contamination on the reservoirs tends to collect in the wetland areas of the embayments. Contamination from the ORR drains through the creeks, affecting the wetland communities as well. The wetland areas along the embayments may be playing an important role in the regulation of water quality by adsorbing or decomposing some contaminants. As the wetland areas grow in size and mature, this role could increase substantially as the size of the wetlands associated with reservoirs increases over time (Cunningham and Pounds 1991).

Many of the small former livestock ponds on the ORR are the site of fairly well-established wetland communities. Some of the ponds no longer contain water or are not suitable for wetland habitat, having either been filled in or converted for use as settling ponds for ORR activities. Many other ponds appear to be stable and are supporting well-established wetland species. The ponds closest to the river seem to be the richest in species diversity, perhaps because of seeds or other plant material carried to the Site by migrating birds (Cunningham and Pounds 1991).

The most unusual wetland communities on the ORR are found in utility rights-of-way throughout the Site. Typically, these wetlands occur in places where small streams or drainages cut across the open area, resulting in a wet meadow habitat. A wide variety of herbaceous wetland plant species thrives in these areas, including three orchid species that have been listed as threatened in Tennessee. As these species become better established, they trap more water near the surface, slowly but constantly enlarging the wetland community. These fragile communities are threatened by the use of herbicides or heavy truck or mower traffic through the rights-of-way.

11.0 Argonne National Laboratory

This section discusses ecological resources managed by DOE at the Argonne National Laboratory (ANL) Site in northern Illinois (Figure 11.1). Included is a brief description of the ANL Site, its location, its climate, the background of its ecological resource studies, and associated wildlife, and its aquatic resources. Also included are brief discussions of plant and animal species of concern, including any federal or state listed threatened or endangered species, and the key ecological management issues for the ANL Site.

11.1 Site Description

Argonne National Laboratory was established in 1948 as a multidisciplinary research and development laboratory for conducting basic and applied research in energy technology. Activities at ANL include nuclear reactor design, synchrotron radiation accelerator design, and environmental research programs.

The ANL Site includes 688 ha (1700 acres) of the Des Plaines River Valley of DuPage County, Illinois. The Site is located approximately 35 km (22 mi) southwest of Chicago and 40 km (25 mi) west of Lake Michigan. Laboratory facilities occupy 81 ha (200 acres) of the ANL Site. The Site is surrounded by Waterfall Glen Forest Preserve, a greenbelt forest preserve that occupies 826 ha (2040 acres) of the DuPage County Forest Preserve District. Argonne National Laboratory is 1 mile north of the Des Plaines River, the Chicago Sanitary and Ship Canal, and the Illinois Waterway (Illinois and Michigan Canal). Beyond the forest preserve, adjacent land has been developed for high-density residential use.

The majority of the ANL Site is situated on 34 to 37 m (113 to 123 ft) of clayey to silty-clayey glacial till. The till is overlain by 0.3 to 0.6 m (1 to 2 ft) of loess and modern soil. Surface water follows two main drainage on-site, Freund Brook and Sawmill Creek, and three intermittent creeks. The northwest portion of the Site is drained by an intermittent stream that flows to the north. The ANL Site maintains a network of ditches and culverts that direct surface runoff to these streams. Freund Brook runs to the east-northeast and enters Sawmill Creek, that flows south to the Des Plaines River. The remaining drainages are located on the south half of the Site and drain southeast to a marsh on the floodplain of the Des Plaines River. Groundwater is contained within two aquifers. The shallow aquifer occurs between 35 to 75 m (115 to 246 ft). A deeper aquifer occurs at 240 to 450 m (790 to 1500 ft). The two are separated by a 45-m (148-ft) thick aquitard.

11.2 Climate

The ANL has a humid continental warm summer climate (Critchfield 1974). Meteorological data are available from on-site measurements and from measurements at Chicago's O'Hare International Airport. On average, the maximum daily temperature exceeds 32°C (90°F) 16 days per year and is below 0°C (32°F) 51 days per year; the minimum daily temperature is below 0°C (32°F) 133 days per year and is below -18°C (0°F) 14 days per year (DOC 1987c). July is the warmest month, with daily maximum and minimum temperatures averaging 28°C (83°F) and 17°C (63°F), respectively. January

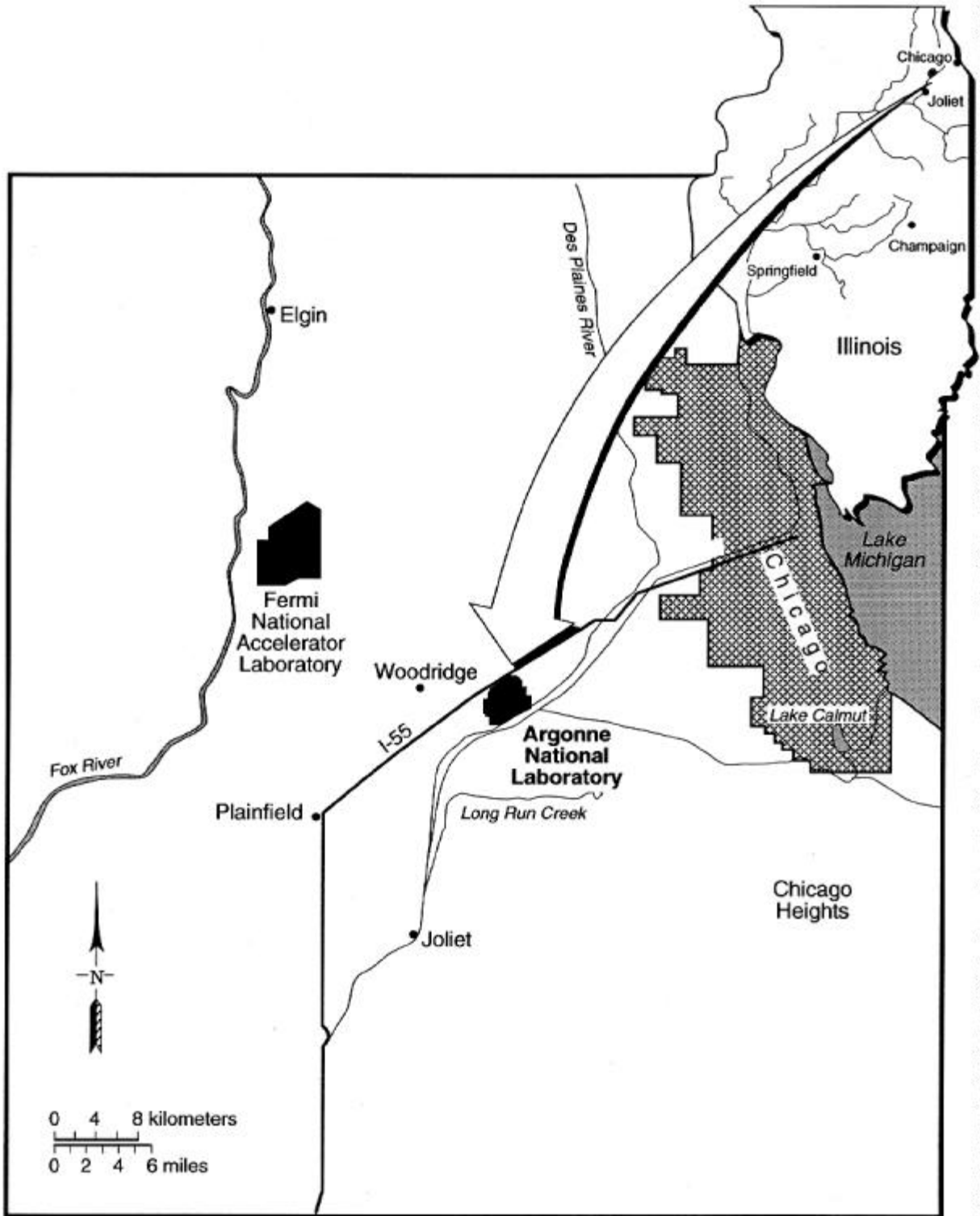


Figure 11.1. Argonne National Laboratory, Illinois

is the coolest month, with daily maximum and minimum temperatures averaging -2°C (29°F) and -10°C (14°F), respectively (DOC 1987c). Annual precipitation is on the order of 84 cm (33 in.), with about 65% falling from April through September. Measurable precipitation (defined as 0.025 cm [0.01 in.] or greater) is recorded an average of 127 days per year, and the area experiences an average of 38 thunderstorm days per year. The average annual snowfall is 99 cm (39 in.) and daily snowfall accumulations of 2.5 cm (1 in.) or greater occur an average of 12 days per year (DOC 1987c). Additional climatological information is summarized in Holdren et al. (1994).

11.3 Ecological Resource Background

Ecological resources at the ANL Site have been monitored over the past 20 years. The most complete survey of ANL Site biota was conducted by Messenger et al. (1969), who catalogued all plant and animal species on the Site. Other sources of information regarding ecological resources at the ANL Site include documents prepared in support of Site operations.

11.4 Terrestrial Vegetation Types

Argonne National Laboratory is located in a prairie peninsula that mixes oak-hickory forest and tall-grass prairie, which formerly covered glaciated areas of the northern midwest. The primary vegetation types on-site include open fields, mature and early succession woodlands (including forested areas that occur on slopes of shallow ravines), and wetlands (Messenger et al. 1969). Table 13.1 identifies the main vegetation types found on the ANL Site, as well as those found on all other sites discussed in this document.

11.4.1 Open Fields

Nearly 75% of the Site was farmed until the early 1950s (DOE 1982). Before farming, the area was vegetated by native tall-grass prairie species. Messenger et al. (1969) reported that old fields consisted primarily of weedy annual and perennial grasses and forbs, with some agricultural grasses and some native prairie grasses. A number of those fields were cleared of vegetation in 1986 in order to conduct archaeological surveys and currently are in mixed stages of succession. These fields are dominated by bluegrass and various forbs, including yarrow, goldenrod, aster, and cress (DOE 1990b).

11.4.2 Woodlands

Woodlands on ANL are characteristic of an oak-hickory forest type. Deciduous forests on-site are dominated by various species of oak including bur oak, white oak, red oak, and black oak. Species that occur in association with the oaks are hickory, hawthorn, cherry, and ash (DOE 1982). On steeper slopes, sugar maple and basswood occur. Silver maple, elm, cottonwood, box elder, and green ash, most of which are in an early successional stage, dominate lowland or poorly drained areas (DOE 1990b). The largest woodland, a mature oak-hickory stand, occurs in the northeast corner of the Site. Vegetation consists of mature white, bur, black oak, and shagbark hickory. Jack pine, white pine, and red pine also occur on-site. Pines were planted in old agricultural areas of the Site.

11.4.3 Wetlands

Several small ponds on the western portion of the Site occur in association with the south branch of Freund Brook. The ponds support cattail marshes and swampy low-lying woodlands. These areas are inundated year-round.

Several isolated wetlands that occur on-site range in size from 0.16 ha (0.4 acre) to approximately 5.5 ha (14 acres) (DOE 1990b). A majority of these wetlands occur in the 100-year floodplain of Freund Brook. Although they differ in size, species association, and functional importance, all wetlands on-site are classified as palustrine. Some wetland areas on-site, such as a 1 acre wetland known as Area C, occur in depressions surrounded by open fields. These areas do not usually have standing water, but retain enough soil moisture year-round to support hydrophytic vegetation, including one state endangered species, hairy marsh yellow cress (DOE 1990b).

Other wetlands on-site form complexes of open water, cattail marsh, and swampy woodlands. Area F, a 5.5-ha (13.6-acre) wetland complex, is typical of this type of palustrine wetland. Area F is an impoundment created by beaver and is one-fourth open water. Aquatic species found in Area F include common arrowhead, pondweed, duckweed, and bulrush (DOE 1990b).

11.5 Terrestrial Wildlife

The diversity of vegetation types at ANL Site affords habitat for a variety of vertebrate species. Terrestrial species include 5 amphibians, 7 reptiles, and 25 mammals. The Site also supports 40 species of birds that are summer residents and over 100 species that are seasonal migrants.

11.5.1 Open Fields Wildlife

The most frequently observed reptiles in the open fields of the ANL Site are fox snakes and garter snakes. Box turtles occur infrequently in wetter areas of the open fields. Amphibians do not frequently occur in the open fields, except near wet areas.

Several bird species occur in the fields and in the edge habitat near woodlands or pine plantations: Robins, grackles, starlings, and Canada geese are frequently observed in open areas; meadowlarks feed and nest in the fields, as do field sparrows; ring-necked pheasant forage in the fields as well; red-winged blackbirds occasionally use the fields and edge areas for forage; red-tailed hawks and American kestrels typically hunt over the fields.

Many small mammals occur in the open fields, including white-footed mice, deer mice, meadow jumping mice, house mice, meadow voles, eastern moles, and woodchucks. The eastern cottontail rabbit also occurs in the fields. Chipmunks and 13-lined ground squirrels are frequently observed in the fields and edge areas. Fallow deer, an introduced species, and white-tailed deer also use the open fields of the Site. Gray fox, red fox, and coyotes have also been observed hunting in open areas of the Site.

11.5.2 Woodland Wildlife

One reptile species that is common to the on-site wooded areas is the brown snake. Amphibian species that occur around forest ponds include tree frogs, the American toads, chorus frogs, and tiger salamanders.

Bird species common to the woodlands include the white-breasted nuthatch, bluejay, black-capped chickadee, American crow, cardinal, and broad-winged hawk. Wooded areas on-site also support the red-bellied woodpecker, red-headed woodpecker, hairy woodpecker, and downy woodpeckers throughout the year. Summer residents include the brown thrasher, the rose-breasted grosbeak, and the rufous-sided towhee.

Short-tailed shrews and opossums are common mammals in the woodlands. The wooded areas also support striped skunks and raccoons, as well as gray and fox squirrels. Brown bats also occur in the woodland areas and are most commonly found in association with the streams on-site.

11.5.3 Wetland Wildlife

The majority of reptiles and amphibians that occur on the ANL Site occur in wetlands. Water snakes and painted turtles are frequently observed around wetlands. Tiger salamanders are found near swampy woodland areas or wooded ponds. Bullfrogs, leopard frogs, green frogs, and chorus frogs are common to the on-site wetlands (DOE 1982).

Wetlands also support a number of birds and migrant waterfowl. Red-winged blackbirds and killdeer commonly occur in association with wetlands. Mallards, wood ducks, Canada geese, green-back herons, and great blue herons are frequently observed in spring and autumn months. Also observed are the black-crowned night heron and great egret, both state endangered species (DOE 1990b).

Deer mice are common in the wetland areas. Muskrats have been observed near the streams and open water areas on-site. Beaver not only live in the ANL Site wetlands, but are also responsible for creation of some of them (DOE 1982). White-tailed deer and fallow deer also use the wetlands. Foxes, raccoons, striped skunks, and mink are common predators that occur in wetlands.

11.6 Aquatic Resources

Aquatic resources on-site include streams, ponds, impoundments created by beaver, and drainage ditches. These aquatic habitats support many species of algae and invertebrates, as well as a number of hydrophytic plant species. In addition, nine species of fish have been observed in the aquatic habitats on-site, including black bullhead, bluegill, creek chub, golden shiner, goldfish, green sunfish, largemouth bass, northern creek chub, orange-spotted sunfish, and black crappie.

Freund Brook flows east, draining a large portion of the Site. Its stream gradient is comparatively steep, forming primarily riffle habitat. Aquatic vegetation found in the impounded areas of Freund Brook includes arrowhead, pondweed, bulrush, and roadside rush. Vegetation found in the stream bed includes cattails and clearweed. The brook supports few fish due to low summer flows and high temperatures (DOE 1990b). Freund Brook also has several impoundments varying in size, depth, and diversity of aquatic biota. Some upstream impoundments were created by beaver dams. The condition of those dams

controls the water level. Dominant vegetation in these areas includes horsetail, rice cut grass, fox sedge, and willow. Downstream impoundments range in size from 1000 m² (0.25 acre) to 7700 m² (1.9 acre). Dominant vegetation in these ponds includes nodding bur marigold, false nettle, swamp thistle, bald spikerush, and swamp rose mallow (Van Lonkhuyzen and LaGory 1994). Green sunfish and minnows are the dominant fish species (DOE 1982).

Sawmill Creek, a tributary of the Des Plaines River, also drains the eastern portion of the Site. Many parts of the creek are silt-laden and have a relatively steep gradient. Annual floodwaters form wetlands in several areas. These areas are characterized by reed canary grass, black willow, and American elm (Van Lonkhuyzen and LaGory 1994). Creek chubs, as well as minnows and green sunfish, have been observed in the creek.

11.7 Wildlife and Plant Species of Concern

11.7.1 Wildlife

The only federally listed threatened or endangered species likely to occur on-site is the Indiana bat (DOE 1982). There have been unconfirmed reports of the capture of Indiana bats in the Waterfall Glen Forest Preserve, directly south of the Site (DOE 1990b). However, the species has not been recorded on-site. Bald eagles, the American and arctic subspecies of the peregrine falcon, and Kirtland's warbler, all federally endangered species, migrate through northeastern Illinois and could occur on-site. Bald eagles have been observed nesting in adjacent counties (DOE 1982). The great egret and the black-crowned night heron, both state listed endangered species, have been documented in wetlands on the southern portion of the Site. Hine's emerald dragonfly, currently proposed for federal listing as endangered, is listed as potentially occurring on the Site.^(a)

11.7.2 Plants

One state endangered species, the hairy marsh yellow cress, has been found in the wetlands on the Site.

11.8 Ecological Management Issues on ANL Site

The key ecological management issues include the protection of wetlands, management of the herd of fallow deer living on-site, and the surveying and protection of native prairie species.

(a) Personal communication, January 1995, Kirk LaGory, ANL, Argonne, Illinois.

11.8.1 Wetlands

Several wetlands, including wet meadows, floodplain or riparian wetlands, cattail marshes, open water, and forested wetlands, occur on-site (USDA 1994). Some of the wetlands are relatively new, and have been formed by either human or beaver activities. Other wetland areas are relatively disturbed, particularly those located near construction sites. Those areas are undergoing changes in species composition as they become drier. Still other wetland areas are undisturbed and support unusual plant species. The wetland areas of the Site provide critical habitat for ANL Site wildlife. Most of the wetland areas occur in association with Freund Brook or Sawmill Creek, and are therefore affected by the quality and flow of water in those streams.

11.8.2 Wildlife Management

The Site provides habitat for a number of wildlife species that are causing damage, or have the potential to cause damage, to Site vegetation and/or structures. Most damage occurs as a result from overpopulation or overcrowding of these species. White-tailed and European fallow deer cause the majority of problems. Vehicle collisions with deer have increased 137% within a two-year period (1992 to 1994) (USDA 1994). The Site now supports a herd of over 130 fallow deer. During February and March of 1994, the USDA office responded to 20 incidents of dead or dying fallow deer, all of which were related to malnutrition caused by overpopulation. The large populations of both deer species have caused streambank erosion and damage to fences and managed plantings as well. Other problem species on the Site include opossums, European starlings, Canada geese, pigeons, and English house sparrows. ANL is currently working with the USDA to devise a wildlife damage management plan, and is investigating methods of thinning populations of certain species, either through live capture and relocation or culling (USDA 1994).

11.8.3 Prairie Fragmentation

Native prairies are one of the most rapidly disappearing ecosystems in the United States. In 1969, Messenger et al. (1969) reported that prairie plants were well represented on the ANL Site. Included in the 1969 catalogue of ecological resources at ANL Site were 28 species of prairie plants, some of which occurred in association with the less common wet prairie areas on-site. Messenger et al. (1969) described a prairie found in the flood plain of the Des Plaines River near the southern part of the Site that floods each spring and dries completely throughout the summer and fall months. More recent ecological surveys have not been as extensive as previous surveys and the condition or location of prairie fragments that may remain on-site is not well documented. Prairie vegetation is now limited to roadsides and scattered old field areas on the Site.^(a) Maintenance of native species diversity and the prevention of encroachment by woody species are major issues for prairie conservation.

(a) Personal communication, January 1995, Kirk LaGory, ANL, Argonne, Illinois.

12.0 Fernald Environmental Management Project

This section discusses ecological resources managed by DOE at the Fernald Environmental Management Project (FEMP) in southwestern Ohio (Figure 12.1). Included are brief descriptions of the FEMP Site, its climate, sources of information on its ecological resources, major plant and animal communities, its aquatic resources, and an overview of the Site's species of concern. Also included is a discussion of key ecological issues at the Site.

12.1 Site Description

The FEMP Site occupies 425 ha (1050 acres) in Butler and Hamilton counties in southwestern Ohio. The Site is located approximately 27 km (17 mi) northwest of Cincinnati. When the Site was established in 1951, its primary mission was the production of uranium metal in support of defense activities. In recent years, the mission has changed to one of environmental restoration and compliance (DOE 1992b). To reflect that change, DOE officially changed the name of the Fernald Site in 1991 from the Feed Materials Production Center to FEMP.

Local topography is characterized by gently rolling uplands and the wide, flat-bottomed Great Miami River Valley. The Site is located in the valley, bordered by limestone and shale bluffs that rise up to 91 m (300 ft) above the valley floor. The Site sits on a silty clay glacial till that overlies a sand and gravel aquifer. Surface drainage follows an east-to-west pattern, into Paddy's Run, an intermittent stream near the western boundary of FEMP property. The Fernald Site is located approximately 1 km (0.62 mi) west of the Great Miami River (DOE 1992b).

Production facilities occupy 81 ha (200 acres) in a centrally located fenced area. The remainder of the Site is primarily undeveloped, with several waste storage areas. Land use adjacent to the Site includes farming, residential housing, and sand and gravel pit operations (DOE 1992b).

12.2 Climate

The FEMP has a humid continental warm summer climate (Critchfield 1974). Meteorological data are available from on-site measurements and from measurements at the Greater Cincinnati Airport. On average, the maximum daily temperature exceeds 32°C (90°F) 19 days per year and is below 0°C (32°F) 30 days per year; the minimum daily temperature is below 0°C (32°F) 109 days per year and is below -18°C (0°F) 7 days per year (DOC 1987a). July is the warmest month, with daily maximum and minimum temperatures averaging 30°C (86°F) and 18°C (65°F), respectively. January is the coolest month, with daily maximum and minimum temperatures averaging 3°C (37°F) and -7°C (20°F), respectively (DOC 1987a). Annual precipitation is 100 cm (40 in.). Measurable precipitation (defined as 0.025 cm [0.01 in.] or greater) is recorded on an average of 129 days per year, and the area experiences an average of 43 thunderstorm days per year. The average annual snowfall is 58 cm (23 in.) and daily snowfall accumulations of 2.5 cm (1 in.) or greater occur an average of 7 days per year (DOC 1987a). Additional climatological information is summarized in Holdren et al. (1994).

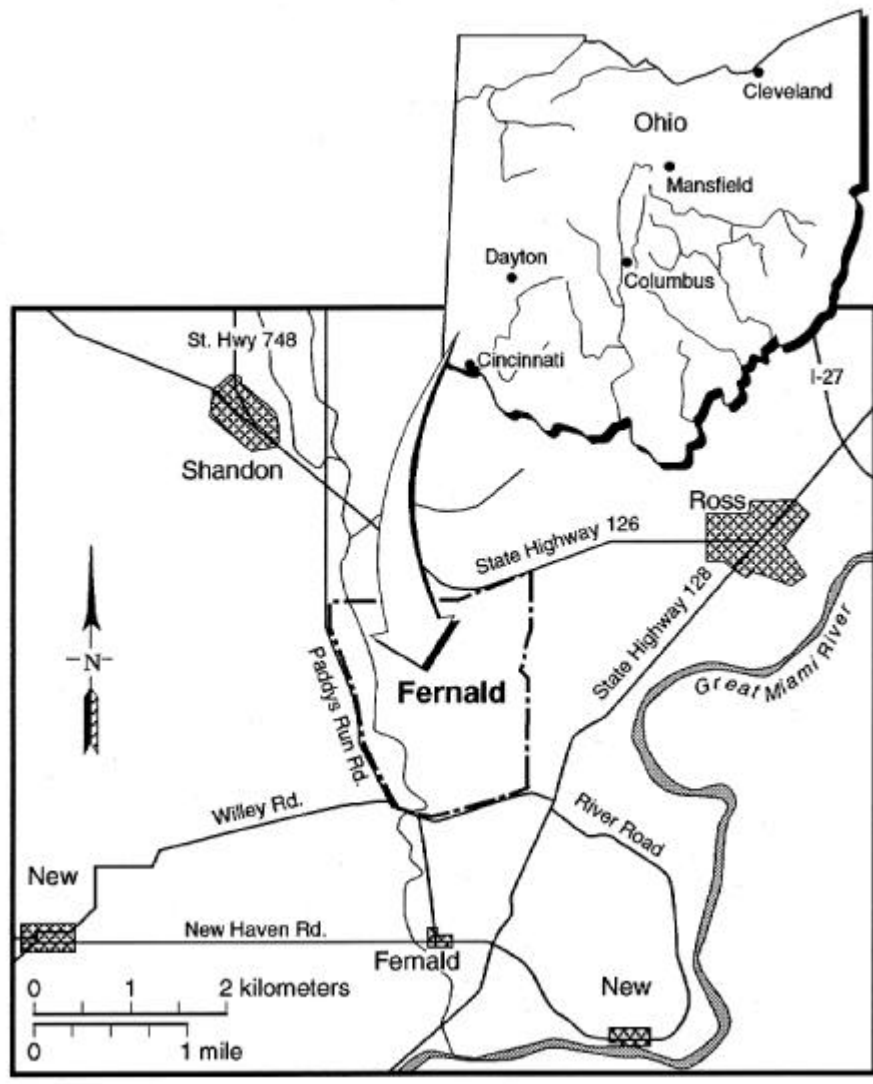


Figure 12.1. Fernald Environmental Management Project, Ohio

12.3 Sources for Ecological Resource Information

Biological monitoring activities, particularly the tracking of radionuclides through different biological contaminant pathways, has been an ongoing activity at FEMP. More detailed biological and ecological surveys have been completed only within the last 2 to 3 years, after the Site's primary mission changed in 1991. Sitewide characterization reports, environmental impact statements, and remedial investigation/feasibility studies provide the most current reference to ecological resource data.

12.4 Terrestrial Vegetation Types

The FEMP is located in the oak-hickory forest component of the eastern deciduous forest. Five different ecological communities and over 222 species of vascular plants have been identified on-site (DOE 1992c). Plant communities are found in FEMP grasslands, pine plantations, woodlots, an inactive fly ash disposal area, and wetlands. Table 13.1 identifies the main vegetation types found at the FEMP Site and at all other sites discussed in this document.

12.4.1 Grasslands

The majority of the FEMP Site is vegetated by introduced grass species. Several grassland areas are leased by local dairy farms for grazing. Both the grazed and ungrazed areas are dominated by upland grass species. Red fescue and Kentucky bluegrass are common to both types of grassland areas. In the spring, orchard grass appears as a codominant species on ungrazed areas (DOE 1992c).

12.4.2 Pine Plantations

Two pine plantations are located on the FEMP Site, one at the northern boundary and another southwest of the former production area. The dominant species in these areas are white pine and Austrian pine. Common understory tree and shrub species include dogwood, common elderberry, blackberry, multiflora rose, cherry, poison ivy, and Virginia creeper. Dominant ground cover species include goldenrod, Kentucky bluegrass, brome, and ragweed (DOE 1992c).

12.4.3 Woodlots

Some areas in the northern part of the Site support stands of mid-successional deciduous trees. Although most areas exhibit varying degrees of disturbance from grazing (the area is leased to local dairy farmers), some are undisturbed. Species composition in these wooded areas varies relative to soil moisture and type as well as to the level of disturbance. Some areas are dominated by northern red oak, shingle oak, hackberry, and American elm. Tree species dominant in other areas include sycamore, eastern cottonwood, and boxelder. Common shrub species include Ohio buckeye, roughleaf dogwood, and multiflora rose (DOE 1992c).

12.4.4 Reclaimed Fly Ash Pile Area

An inactive fly ash disposal area south of the former production area has been considered a separate habitat in most ecological surveys because of its distinct floral and faunal component. The species present are indicative of a highly disturbed area. Tree species include eastern cottonwood and black locust. The shrub layer includes poison ivy, honeysuckle, and prairie rose. Dominant ground cover includes Kentucky bluegrass, red fescue, and ragweed (DOE 1992c).

12.4.5 Wetlands

A total of 15 ha (36 acres) of freshwater wetlands were delineated at the FEMP. Delineated wetlands included 11 ha (27 acres) of palustrine forested wetlands, 3 ha (7 acres) of drainage ditches/swales, and 1 ha (2 acres) of isolated persistent emergent and scrub/shrub wetlands.

12.5 Terrestrial Wildlife

A total of 153 species of vertebrates have been recorded on the FEMP Site. Included are 22 species of fish, 13 amphibians and reptiles, 20 mammals, and 98 birds (DOE 1992c), living in grasslands, pine plantation, woodlot, or riparian/wetland habitat.

12.5.1 Grassland Wildlife

Two species of amphibians, the American toad and Fowler's toad, have been observed in the grasslands on the FEMP. No reptiles were observed in these areas.

Bobwhite quail and killdeer are observed in the grassland areas. Turkey vultures, red-tailed hawks, and American kestrels commonly hunt the grasslands. Other birds that include the grasslands in their range are common yellowthroats, eastern meadowlarks, eastern bluebirds, field sparrows, grasshopper sparrows, and savannah sparrows.

Short-tailed shrews, eastern moles, and eastern cottontail rabbits are among the small mammals that live in the grasslands and compose a significant component of the prey base. Woodchucks and meadow voles are also common. White-tailed deer are seen frequently in the grasslands. Coyotes and red foxes are the primary predators in the grassland areas (DOE 1992c).

12.5.2 Pine Plantation Wildlife

Box turtles and Butler's garter snakes are the only commonly observed reptile species in the pine plantations. The amphibians American toads and Fowler's toads are common as well.

Raptors common to the grassland areas are also found in the pine plantations, with the exception of the northern harrier. Great horned owls are observed in the pines occasionally. The downy woodpecker and the yellow-shafted flicker (aka northern or common flicker) use the pines to hunt for insects. Great crested flycatchers, purple martins, tufted titmice, golden-crowned kinglets, chipping sparrows, and eastern meadowlarks are other commonly observed birds in the pine plantations.

Virginia opossums, eastern cottontail rabbits, meadow voles, house mice, and raccoons are the most common small mammals in the plantations. White-tailed deer, coyotes, and red foxes are also observed (DOE 1992c).

12.5.3 Woodlot Wildlife

Black rat snakes and box turtles are the only reptiles commonly seen in the wooded areas. No amphibians have been recorded there.

Several species of raptors nest in the wooded areas, as do American woodcock and bobwhite quail. Ruby-throated hummingbirds, red-bellied woodpeckers, hairy woodpeckers, and pileated woodpeckers are seen in the deciduous woodlands. Other common species include eastern phoebes, barn swallows, white-breasted nuthatches, several species of vireos, blackpoll warblers, and swamp sparrows.

Fox squirrels are common in the woodlots, as are little brown bats and white-footed mice. Meadow jumping mice are also found there. Red foxes and white-tailed deer are common (DOE 1992c).

12.5.4 Riparian/Wetland Wildlife

Bullfrogs, green frogs, spring peepers, and northern cricket frogs are found in riparian and wetland areas of FEMP. Queen snakes, northern watersnakes, and smooth softshell turtles are also observed.

Green-backed herons, wood ducks, and mallards are frequent visitors to the FEMP Site. Spotted sandpipers are also common to the riparian areas on-site. Belted kingfishers use the riparian areas to hunt for insects. Brown creepers, mourning warblers, northern waterthrushes, and yellow-breasted chats also occur in the riparian and wetland area.

Northern short-tailed shrews frequent riparian and wetland areas of the FEMP, as do fox squirrels and muskrats. Big brown bats, silver-haired bats, red bats, and little brown bats also use these areas. Raccoon and red foxes hunt in the riparian/wetland areas (DOE 1992c).

12.6 Aquatic Resources

The primary drainage from the FEMP Site is Paddys Run, an intermittent stream that runs north to south on the western boundary of the Site. Paddys Run empties directly into the Great Miami River, south of the Site, and has historically received runoff from the waste storage areas of the Site. Other small drainage, many manmade, feed into Paddys Run. Stormwater control actions have greatly reduced the amount of drainage received by Paddys Run.

Approximately 22 species of fish have been identified on the FEMP, in Paddys Run, and in the other smaller drainage. The most common species include the bluntnose minnow, creek chub, and stoneroller minnow. Also observed are bluegill, largemouth bass, white suckers, and orange-spotted sunfish.

12.7 Wildlife and Plant Species of Concern

Populations of one state-listed threatened invertebrate exist on FEMP property. There is also habitat for a federally listed endangered mammal and a state-listed threatened amphibian.

12.7.1 Wildlife

One federally endangered mammal, the Indiana bat, occurs in parts of Butler County. Although surveys conducted in 1990 showed that no Indiana bats were located on the FEMP Site, a breeding population was found near Ross, Ohio, approximately 5 miles away. In 1994, a survey to update the status of the Indiana bat population on the property did not locate individuals of this species. Sections of Paddys Run on the FEMP Site were declared excellent habitat for the Indiana bat because of the amount of dead trees, the overhang of live trees, and relatively little disturbance (DOE 1992c; Witaker 1994).

The cave salamander, a state endangered species, has also been found in Butler and Hamilton Counties. Surveys conducted in 1993 indicate that no cave salamanders were found within the FEMP boundary, and only a few areas of the Site have been designated as marginal to moderate habitat for this salamander (DOE 1992c, Davis 1994). A known population exists north of the Fernald property in a wooded ravine.

The Sloan's crayfish, a state-listed threatened invertebrate, was found during 1993-1994 surveys in Paddys Run in rocky riffle habitat with moderate waterflow (St. John 1993, 1994). The results of the survey indicate that the population is limited to northern sections of Paddys Run and nearby Dry Fork Creek.

12.7.2 Plants

Surveys for sensitive plant species were conducted on the property in 1994 and no listed species were found (RUST Environment and Infrastructure 1994a, b, c, d).

12.8 Ecological Resource Groups and Issues

The most sensitive areas on the FEMP Site are the wetland areas in the deciduous forest, and the riparian areas near Paddy's Run. Both habitats provide vital resources to FEMP wildlife. The wooded riparian areas and wooded wetland areas occur infrequently on the FEMP Site. Within the FEMP boundary, most of Paddy's Run is cut deeply into the sediment, with steep banks on both sides. Because of this, the terraces that form on either side are dominated by dry, upland plant species. There are few areas along Paddy's Run where additional wetland types of vegetation occur. There are even fewer areas along Paddy's Run that have sufficient stream flow and tree overhang to support the bat species found on FEMP. This type of riparian habitat is rare throughout the midwest.

13.0 Conclusion

Although the sites described in this document are located in various parts of the United States, many of them support similar ecosystems. Table 13.1 depicts the types and locations of vegetation communities that occur on these sites; and although the size, health, and species composition of these communities vary from site to site, there are common resource management issues related to each community type.

13.1 Sensitive Habitats

Many sites discussed in this document contain areas of relatively undisturbed native plant communities. These sensitive areas generally represent habitat types that are either rare or declining on a regional basis or are easily disturbed. These areas include wetlands, native grasslands, shrub-steppe, and riparian areas.

As presented in Table 13.1, wetlands occur at six of the sites. Wetlands function in the same capacity at each of these sites; however, the ecological significance of each varies from a regional standpoint. The sites are located within different migratory flyways (i.e., Atlantic, Mississippi, Central, Pacific). In these flyways, wetland areas provide critical habitat for migratory birds and wetland areas. In addition, these areas support a large percentage of wildlife species that occur at each site and provide habitat for many federally listed sensitive plant species. Wetlands at each of the sites have been affected by past contamination, construction activity, and agriculture/grazing.

Eight of the 10 sites support native grasslands. In some cases, native grasslands are locally or regionally limited and have been protected, to some degree, on the sites. For example, native California pine bluegrass communities, which are rapidly disappearing throughout the state, can be found in some areas of the LLNL Site 300. Native grassland communities at each of the eight sites are threatened by invasion of non-native vegetation species; in some cases, such as at the Hanford Site, native species have become completely overrun by non-native cheatgrass. Native grasslands are fragile communities and most have been impacted to some degree by grazing or other physical disturbances, such as off-road vehicle travel, construction activities, etc.

While shrub-steppe communities occur at only 2 of 10 sites, this vegetation represents a unique assemblage that has declined throughout the western United States. Shrub-steppe vegetation occurs on the Hanford and INEL Sites. In the past, these areas have been impacted by agriculture, grazing, burning, and physical disturbances. The integrity of mature stands of sagebrush, the primary species comprising shrub-steppe vegetation communities, has been affected by disturbance. Once disturbed, these areas require relatively long periods for recovery and consequently are rapidly invaded by aggressive non-native species.

Riparian areas are important at many of the sites because these areas provide vital habitat for wildlife, particularly in semi-arid climates typical of SNL or the Hanford Site. These areas also provide travel corridors for wildlife moving between habitats. Riparian areas are easily disturbed by contamination or construction activities. Many of these areas support threatened and endangered

Table 13.1. Distribution of Plant Communities Across the U.S. Department of Energy Complex

U.S. Department of Energy Site										
Habitat	Hanford Site	Idaho National Engineering Laboratory	Lawrence Livermore National Laboratory	Sandia National Laboratory	Rocky Flats Plant	Los Alamos National Laboratory	Savannah River Site	Oak Ridge Reservation	Argonne National Laboratory	Fernald Environmental Management Project
Native Grasslands	X	X	X	X	X			X	X	
Shrub-steppe	X	X								
Riparian/Riverine	X	X		X	X		X		X	X
Coastal Sage Scrub			X							
Wetlands			X	X	X		X	X	X	X
Palustrine emergent			X	X	X		X	X	X	
Palustrine shrub			X		X		X	X	X	
Palustrine forest			X		X		X	X	X	X
Woodlands										
Coniferous				X	X	X	X	X	X	X
Deciduous			X				X	X	X	X
Juniper		X				X				
Mixed				X			X	X	X	
Managed habitats					X		X	X	X	X

13.2

species, such as the prime Indiana bat habitat in the wooded riparian areas of the FEMP or the streams in the canyon bottoms of the LANL Site that provide habitat for migrating whooping cranes.

13.2 Federal Threatened, Endangered, or Candidate Plant and Animal Species

Data on federal threatened, endangered, or candidate plant and animal species have been compiled from site biological surveys, environmental impact documents, and other site-specific studies. Although the majority of the species occur on one site only, several species of birds occur on many of the sites; the bald eagle, for example, occurs on eight of the sites. Other species that occur at multiple sites include the ferruginous hawk, the peregrine falcon, and the loggerhead shrike. Many others, such as the whooping crane and long-billed curlew, are migratory, and appear at sites along their migratory route. Most bird species on this list depend on the sensitive plant communities discussed above, for foraging habitat, nesting habitat, and other special needs.

13.3 Management of Big Game or Feral Species

Several sites have one or more big-game or feral species, such as the elk on the Hanford Site or white-tailed deer and feral pigs on the SRS, whose populations have grown to the extent that damage to other important ecological resources has occurred. Elk, for example, can damage native sagebrush and are responsible for crop depredation on adjacent agricultural lands at the Hanford and INEL Sites. Fallow deer on the ANL Site have damaged sensitive wetland and forest habitat. On many sites, the culling of herds or special hunts have been recommended to manage species capable of large-scale or irreversible damage.

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Appendix A

Listing of Species Discussed in Text

Appendix A

Appendix A consists of a list of all plant and animal species (alphabetically by common name) mentioned in the text of the document, together with each species' scientific name. The list also indicates, in the special status column, whether the species is a federally endangered, threatened, or category species, or whether the species is categorized under a special state listing.⁽¹⁾ Definitions for the abbreviations used are as follows:

Federal Listings

- Federal Endangered (FE) - Any species in danger of extinction throughout all or a significant portion of its range.
- Federal Threatened (FT) - Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.
- Federal Proposed Endangered (FPE) - Taxa already proposed to be listed as endangered.
- Federal Proposed Threatened (FPT) - Taxa already proposed to be listed as threatened.
- Federal Category 1 (FC1) - Taxa for which the U.S. Fish and Wildlife Service has on file enough information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened species. Proposed rules have not yet been issued because this action is precluded at present by other listing activity.
- Federal Category 2 (FC2) - Taxa for which the U.S. Fish and Wildlife Service has information indicating that their listing as endangered or threatened might be appropriate, but for which sufficient data on biological vulnerability and threats are not currently available.

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- (a) Each state has unique terminology for designating state listed threatened and endangered species. The categories used in this appendix are a generic representation of this terminology. It is possible for a species to be listed as sensitive in one state and endangered in another. The intent here is to notify the reader that a species has received a special state designation.

State Listings

- State Endangered (SE)
- State Threatened (ST)
- State Candidate (SC) - or other special state listing.

Table A.1. Listing of Species Discussed in Text

Common Name	Scientific Name	Special Status
PLANTS		
Alder	<i>Alnus serrulata</i>	
Alkali ryegrass	<i>Elymus triticoides</i>	
Alkali sacaton	<i>Sporobolus airoides</i>	
Alligator juniper	<i>Juniperus deppeana</i>	
Alligatorweed	<i>Alternanthera philoxeroides</i>	
American elm	<i>Ulmus americana</i>	
American wintercress	<i>Barbarea orthoceras</i>	
Apache plume	<i>Fallugia paradoxa</i>	
Appalachian bugbane	<i>Cimicifuga rubifolia</i>	FC2, ST
Ash	<i>Fraxinus spp.</i>	
Awnead-meadow beauty	<i>Rhexia aristosa</i>	FC2
Bald cypress	<i>Taxodium distichum</i>	
Bald spikerush	<i>Eleocharis calsa</i>	
Baltic rush	<i>Juncus balticus</i>	
Banana yucca	<i>Yucca baccata</i>	
Bearberry	<i>Arctostaphylos uva-ursi</i>	
Beech	<i>Fagus grandiflora</i>	
Bell's twinpod	<i>Physaria bellii</i>	FC2
Bentgrass	<i>Agrostis spp.</i>	
Big bluestem	<i>Andropogon gerardii</i>	

Common Name	Scientific Name	Special Status
Big sagebrush	<i>Artemisia tridentata</i>	
Bitternut hickory	<i>Carya cordiformis</i>	
Black cherry	<i>Prunus serotina</i>	
Black grama	<i>Bouteloua eriopoda</i>	
Black gum	<i>Nyssa sylvatica</i>	
Black-jack oak	<i>Quercus marilandica</i>	
Black locust	<i>Robinia pseudoacacia</i>	
Black oak	<i>Quercus velutina</i>	
Black sage	<i>Salvia mellifera</i>	
Black willow	<i>Salix nigra</i>	
Blackberry	<i>Rubus alleghensis</i>	
Blue cohosh	<i>Caulophyllum thalictroides</i>	
Blue grama	<i>Bouteloua gracilis</i>	
Blue oak	<i>Quercus douglassii</i>	
Bluebunch wheatgrass	<i>Agropyron spicatum</i>	
Bluejack oak	<i>Quercus incana</i>	
Bog spice bush	<i>Lindera subcoiacea</i>	FC2
Bottlebrush squirreltail	<i>Sitanion hystrix</i>	
Boxelder	<i>Acer negundo</i>	
Brambles	<i>Rubus spp.</i>	
Brome	<i>Bromus diandrus</i>	
Broomsedge	<i>Andropogon virginicus</i>	
Buckeye	<i>Aesculus octandra</i>	
Buckwheat	<i>Erigonum spp.</i>	
Buffalo grass	<i>Buchloe dactyloides</i>	
Bulrush	<i>Scirpus spp.</i>	
Bur oak	<i>Quercus macrocarpa</i>	
Bush muhly	<i>Muhlenbergia porteri</i>	
Butternut	<i>Juglans cinerea</i>	FC2

Common Name	Scientific Name	Special Status
Buttonbush	<i>Cephalanthus occidentalis</i>	
California buckwheat	<i>Erigeron fasciculatum</i>	
California sagebrush	<i>Artemisia californica</i>	
Canada lily	<i>Lilium canadense</i>	ST
Canadian bluegrass	<i>Poa compressa</i>	
Cane	<i>Arundinaria gigantea</i>	
Carey saxifrage	<i>Saxifraga careyana</i>	
Cattail	<i>Typha latifolia</i>	
Cheatgrass	<i>Bromus tectorum</i>	
Chestnut oak	<i>Quercus prinus</i>	
Chokecherry	<i>Prunus virginiana</i>	
Cliff fendlerbush	<i>Fendlera rupicola</i>	
Club cholla	<i>Opuntia clavata</i>	SC
Colorado butterfly plant	<i>Gaura neomexicana</i>	FC1
Columbia milk-vetch	<i>Astragalus columbianus</i>	FC1, ST
Common arrowhead	<i>Sagittaria latifolia</i>	
Cottonwood	<i>Populus trichocarpa</i>	
Coyote willow	<i>Salix exigua</i>	
Crabgrass	<i>Digitaria spp.</i>	
Creeping barberry	<i>Berberis repens</i>	
Crested wheatgrass	<i>Agropyron cristatum</i>	
Currant	<i>Ribes divaricata</i>	
Cypress knee sedge	<i>Carex decomposita</i>	FC
Dense sedge	<i>Carex densa</i>	SC
Doll's eyes	<i>Actaea pachypoda</i>	
Douglas fir	<i>Pseudotsuga menziesii</i>	
Duckweed	<i>Lemna spp.</i>	
Dwarf evening primrose	<i>Camissonia pygmaea</i>	SC
Eastern red cedar	<i>Juniperus virginiana</i>	

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Elderberry	<i>Sambucus mexicana</i>	
Elliott's croton	<i>Croton elliotii</i>	FC
Elm	<i>Ulmus spp.</i>	
Engelmann spruce	<i>Picea englemannii</i>	
False nettle	<i>Boehmeria cylindrica</i>	
False pimpernel	<i>Lindernia anagallidea</i>	SC
Fen orchid	<i>Liparis loeselii</i>	SE
Fescue	<i>Festuca elatior</i>	
Flowering Dogwood	<i>Cornus florida</i>	
Fluffgrass	<i>Tridens puchellus</i>	
Forktip three-awn grass	<i>Aristida spp.</i>	SC
Four o'clock	<i>Mirabilis multiflora</i>	
Fox sedge	<i>Carex vulpinoidea</i>	
Fremont cottonwood	<i>Populus fremontii</i>	
Galleta	<i>Hilaria jamesii</i>	
Gambel oak	<i>Quercus gambelii</i>	
Giant wildrye	<i>Elymus cinereus</i>	
Ginseng	<i>Panax quinquefolium</i>	ST
Golden seal	<i>Hydrastis canadense</i>	ST
Grama grass cactus	<i>Pediocactus papyracanthus</i>	FC2, SE
Gray cryptantha	<i>Cryptantha leucophaea</i>	SC
Gray horsebrush	<i>Tetradymia canescens</i>	
Gray oak	<i>Quercus grisea</i>	
Grayish white giant hyssop	<i>Agastache cana</i>	SC
Greasewood	<i>Sarcobatus vermiculatus</i>	
Green ash	<i>Fraxinus pennsylvanica</i>	
Hackberry	<i>Celtis laevigata</i>	
Hawthorn	<i>Crataegus erythropoda</i>	

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Hairgrass	<i>Deschampsia danthonioides</i>	
Hairy marsh yellow cress	<i>Rorippa islandica var. hispida</i>	SE
Hemlock	<i>Tsuga canadensis</i>	
Honeysuckle	<i>Lonicera japonica</i>	
Hoover's desert-parsely	<i>Lomatium tuberosum</i>	FC2, ST
Hopsage	<i>Grayia spinosa</i>	
Hornwort	<i>Anthocerotae spp.</i>	
Horsetail	<i>Equisetum arvense</i>	
Horseweed	<i>Conyza canadensis</i>	
Hydrolea	<i>Hydrolea quadrivalvis</i>	
Indian ricegrass	<i>Oryzopsis hymenoides</i>	
Indigobush	<i>Amorpha fruticosa</i>	
Ironwood	<i>Carpinus caroliniana</i>	
Jack pine	<i>Pinus banksiana</i>	
Japanese brome	<i>Bromus japonicus</i>	
Junegrass	<i>Koeleria cristata</i>	
King's bladderpod	<i>Lesquerella kingii var cobrensis</i>	
Knotweed	<i>Scirpus cyperinus</i>	
La Jolla prairie clover	<i>Dalea scarisoa</i>	SC
Large-flowered fiddleneck	<i>Amsinckia grandiflora</i>	FE, SE
Large-flowered gymnosteris	<i>Gymnosteris nudicaulis</i>	
Laurel oak	<i>Quercus laurifolia</i>	
Lemhi milkvetch	<i>Astragalus aquilonius</i>	
Lesser ladies' tresses	<i>Spiranthes ovalis</i>	
Limber pine	<i>Pinus flexilis</i>	
Little bluestem	<i>Andropogon scoparius</i>	
Lizard's tail	<i>Saururus cernuus</i>	
Loblolly pine	<i>Pinus taeda</i>	

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Longleaf pine	<i>Pinus palustris</i>	
Loose water milfoil	<i>Myriophyllum laxum</i>	FC2
Lovegrass	<i>Eragrostis spp.</i>	
Low sage	<i>Artemisia arbuscula</i>	
Maple leaf viburnum	<i>Viburnum acerifolium</i>	
Meadow foxtail	<i>Alopecurus aequalis</i>	
Mesa dropseed	<i>Sporobolus flexosus</i>	
Mock-orange	<i>Pholadelphus microphyllus</i>	
Mountain mahogany	<i>Cercocarpus montanus</i>	
Mountain muhly	<i>Muhlenbergia montana</i>	
Mountain witch-alder	<i>Fothergilla major</i>	ST
Mulberry	<i>Morus alba</i>	
Multiflora rose	<i>Rosa multiflora</i>	
Nebraska sedge	<i>Carex nebraskensis</i>	
Needle-and-thread grass	<i>Stipa comata</i>	
New Mexico locust	<i>Robinia neomexicana</i>	
New Mexico olive	<i>Forestiera neomexicana</i>	
Nipple cactus	<i>Coryphantha missouriensis</i>	
Nodding bur marigold	<i>Bidens cernua</i>	
North American sandalwood	<i>Nestronia umellula</i>	FC
Northern bush-honeysuckle	<i>Diervilla lonicera</i>	ST
Northern red oak	<i>Quercus rubra</i>	
Northern wormwood	<i>Artemisia campestris borealis</i>	FC, SE
Norwegian spruce	<i>Picea excelsa</i>	
Oatgrass	<i>Danthonia intermedia</i>	
One-seed juniper	<i>Juniperus monosperma</i>	
Painted milkvetch	<i>Astragalus ceramicus var apus</i>	
Pawpaw	<i>Asimina triloba</i>	

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Persimmon	<i>Diospyros virginiana</i>	
Persistent sepal yellowcress	<i>Rorippa columbiae</i>	FC2, SE
Pignut hickory	<i>Carya glabra</i>	
Pine bluegrass	<i>Poa scabrella</i>	
Pine dropseed	<i>Blepharoneuron tricholepis</i>	
Pink lady-slipper	<i>Cypripedium acuale</i>	SE
Pinyon pine	<i>Pinus edulis</i>	
Piper's daisy	<i>Erigeron piperianus</i>	SC
Plains milkvetch	<i>Astragalus gilviflorus</i>	
Poison ivy	<i>Rhus radicans</i>	
Ponderosa pine	<i>Pinus ponderosa</i>	
Pondweed	<i>Potamogeton spp.</i>	
Poplar	<i>Populus spp.</i>	
Post oak	<i>Quercus stellata</i>	
Poverty weed	<i>Iva axillaris</i>	
Prickly pear	<i>Opuntia polycantha</i>	
Primrose	<i>Oenothera spp.</i>	
Purple fringeless orchid	<i>Platanthera peramoena</i>	ST
Rabbitbrush	<i>Chrysothamnus viscidiflorus</i>	
Ragweed	<i>Ambrosia artemisiifolia</i>	
Red ash	<i>Fraxinus pennsylvanica</i>	
Red maple	<i>Acer rubrum</i>	
Red pine	<i>Pinus resinosa</i>	
Redbud	<i>Cercis canadensis</i>	
Reed canarygrass	<i>Phalaris arundinacea</i>	
Rhododendron	<i>Rhododendron maximum</i>	
Rice cut grass	<i>Leersia oryzoides</i>	
Ring muhly	<i>Muhlenbergia torreyi</i>	

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
River birch	<i>Betula nigra</i>	
Rocky Mountain juniper	<i>Juniperus scopulorum</i>	
Roughleaf dogwood	<i>Cornus drummondii</i>	
Rush	<i>Juncus spp.</i>	
Russian olive	<i>Elaeagnus angustifolia</i>	
Saltsage	<i>Atriplex nuttallii</i>	
Sand dropseed	<i>Sporobolus cryptandrus</i>	
Sand sagebrush	<i>Artemisia filifolia</i>	
Sandberg's bluegrass	<i>Poa sandbergii</i>	
Santa Fe milkvetch	<i>Astragalus feensis</i>	SC
Sassafras	<i>Sassafras albidum</i>	
Scarlet oak	<i>Quercus coccinea</i>	
Shadscale	<i>Atriplex confertifolia</i>	
Shagbark hickory	<i>Carya ovata</i>	
Shingle oak	<i>Quercus imbricaria</i>	
Shining flatsedge	<i>Cyperus rivularis</i>	SC
Shortleaf pine	<i>Pinus echinata</i>	
Shrub live oak	<i>Quercus turbinella</i>	
Siberian elm	<i>Ulmus pumila</i>	
Side-oats grama	<i>Bouteloua curtipendula</i>	
Silky dogwood	<i>Cornus amomum</i>	
Silver maple	<i>Acer saccharinum</i>	
Skunkbush sumac	<i>Rhus trilobata</i>	
Slash pine	<i>Pinus elliotti</i>	
Smooth coneflower	<i>Echinacea laevigata</i>	FE
Snakeweed	<i>Gutierrezia bracteata</i>	
Snowberry	<i>Symphoricarpos spp.</i>	
Soapweed yucca	<i>Yucca glauca</i>	

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Southern mudwort	<i>Limosella aquatica</i>	SC
Spreading false-foxglove	<i>Aureolaria patula</i>	FC1
Spreading gilia	<i>Ipomopsis polycladon</i>	
Subalpine fir	<i>Abies lasiocarpa</i>	
Sugar maple	<i>Acer saccharum</i>	
Sumac	<i>Rhus typhina</i>	
Swamp lobelia	<i>Lobelia boykinii</i>	FC2
Swamp rose mallow	<i>Hibiscus palustris</i>	
Swamp thistle	<i>Cirsium muticum</i>	
Sweet flag	<i>Acorus calamus</i>	
Sweet gum	<i>Liquidambar styraciflua</i>	
Sycamore	<i>Plantanus occidentalis</i>	
Tall larkspur	<i>Delphinium exaltatum</i>	FC2, SE
Tamarisk	<i>Tamarix pentandra</i>	
Thick-spike wheatgrass	<i>Agropyron dasystachyum</i>	
Thistle milkvetch	<i>Astragalus kentrophyta</i> var. <i>Jessiae</i>	
Thread-leaved sedge	<i>Carex filifolia</i>	
Three-awn grass	<i>Aristida purpurea</i>	
Threetip sagebrush	<i>Artemisia tripartita</i>	
Tree-like oxytheca	<i>Oxytheca dendroidea</i>	
Tree-of-heaven	<i>Ailanthus altissima</i>	
Trumpet creeper	<i>Campsis radicans</i>	
Tuberclad rein-orchid	<i>Plantathera flava</i> var. <i>herbiola</i>	ST
Tulip tree	<i>Liriodendron tulipifera</i>	
Turkey oak	<i>Quercus laevis</i>	
Utah juniper	<i>Juniperus osteosperma</i>	
Ute ladys' tresses	<i>Spiranthes diluvialis</i>	FT
Valley oak	<i>Quercus lobata</i>	

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Virginia creeper	<i>Parthenocissus quinquefolia</i>	
Virginia pine	<i>Pinus virginiana</i>	
Water ash	<i>Fraxinus caroliniana</i>	
Water milfoil	<i>Myriophyllum spp.</i>	
Water oak	<i>Quercus nigra</i>	
Water smartweed	<i>Polygonum amphibium</i>	
Water tupelo	<i>Nyssa aquatica</i>	
Watercress	<i>Rorippa nasturium aquatica</i>	
Waterweed	<i>Elodea spp.</i>	
Wavy leaf oak	<i>Quercus undulata</i>	
Western wheatgrass	<i>Agropyron smithii</i>	
Wheatgrass	<i>Agropyron spp.</i>	
White fir	<i>Abies concolor</i>	
White heart hickory	<i>Carya tomentosa</i>	
White oak	<i>Quercus alba</i>	
White visnagita	<i>Neolloydia intertexta</i>	SE
Wild ginger	<i>Asarum canadense</i>	
Wild oat	<i>Avena barbata</i>	
Wild plum	<i>Prunus americana</i>	
Willow	<i>Salix spp.</i>	
Winged-seed evening primrose	<i>Camissonia pterosperma</i>	
Winterfat	<i>Ceratoides lanata</i>	
Wright's fishhook cactus	<i>Mammillaria wrightii</i>	FE, SE
Wright's pincushion		SE
MOLLUSKS		
Alabama lamp pearly mussel	<i>Lampsilis virescens</i>	FE
Appalachian monkeyface pearly mussel	<i>Quadrula sparsa</i>	FE

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Brother spike mussel	<i>Elliption fraterna</i>	SE
California floater	<i>Anodonta Californiensis</i>	FC2
Chittenanago ovate amber snail	<i>Succinea chittenangoensis</i>	FT
Columbia pebblesnail	<i>Fulminicola columbiana</i>	FC2
Cumberland bean pearly mussel	<i>Villosa trabalis</i>	FE
Cumberland monkeyface pearly mussel	<i>Quadrula intermedia</i>	FE
Fine-rayed pigtoe pearly mussel	<i>Fusconaia cuneolus</i>	FE
Orange-footed pearly mussel	<i>Plethobasus cooperianus</i>	FE
Painted snake coiled forest snail	<i>Anguispira picta</i>	FT
Pale lilliput pearly mussel	<i>Taxolasma cylindrellus</i>	FE
Pink mucket pearly mussel	<i>Lampsilis orbiculata</i>	FE
Rough pigtoe pearly mussel	<i>Pleurobema plenum</i>	FE
Shiny pigtoe pearly mussel	<i>Fusconaia edgariana</i>	FE
Tan riffle shell pearly mussel	<i>Epioblasma walkeri</i>	FE
Tubercled-blossom or green-blossom pearly mussel	<i>Epioblasma torulosa</i>	FE
Turgid-blossom pearly mussel	<i>Epioblasma turgidula</i>	FE
White warty back pearly mussel	<i>Plethobasus cicatricosus</i>	FE
Yellow-blossom pearly mussel	<i>Epioblasma florentina</i>	FE
INSECTS		
American sand burrowing mayfly	<i>Dolania americana</i>	FC2
Hine's emerald dragonfly	<i>Somatochlora hineana</i>	FT
Valley elderberry longhorn beetle	<i>Desmocerus californicus dimorphus</i>	FT
CRUSTACEANS		
Fairy shrimp	<i>Branchinecta sp.</i>	FC1
FISH		

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
American shad	<i>Alosa sapidissima</i>	
Atlantic sturgeon	<i>Acipenser oxyrhincus</i>	
Black bullhead	<i>Ictalurus melas</i>	
Bluegill	<i>Lepomis macrochirus</i>	
Bluntnose shiner	<i>Notropis simus</i>	FT
Bluntnose minnow	<i>Pimephales notatus</i>	
Bowfin	<i>Amia calva</i>	
Brook trout	<i>Salvelinus fontinalis</i>	
Brown trout	<i>Salmo trutta</i>	
Bull (Dolly varden) trout	<i>Salvelinus confluentis</i>	FC1
Carp	<i>Cyprinus carpio</i>	
Cave salamander	<i>Eurycea lucifuga</i>	
Central stoneroller minnow	<i>Campostoma anomalum</i>	
Channel catfish	<i>Ictalurus punctatus</i>	
Creek chub	<i>Semotilus atromaculatus</i>	
Fathead minnow	<i>Pimephales promelas</i>	
Freshwater drum	<i>Aplodinotus grunniens</i>	
Gar	<i>Lepisosteus spp.</i>	
Gizzard shad	<i>Dorosoma cepedianum</i>	
Golden shiner	<i>Notemigonus crysoleucas</i>	
Goldfish	<i>Carassius auratus</i>	
Green sunfish	<i>Lepomis cyanellus</i>	
Hickory shad	<i>Alosa mediocris</i>	
Kokanee salmon	<i>Oncorhynchus nerka</i>	
Lake chub	<i>Couesius plumbeus</i>	
Largemouth bass	<i>Micropterus salmoides</i>	
Mountain whitefish	<i>Prosopium williamsoni</i>	
Orange-spotted sunfish	<i>Lepomis humilis</i>	

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Rainbow trout	<i>Oncorhynchus mykiss</i>	
Rio Grande silvery minnow	<i>Hybognathus amarus</i>	FC1
River lamprey	<i>Lamprera ayresi</i>	FC2
River carpsucker	<i>Carpionodes carpio</i>	
Sauger	<i>Stizostedion canadense</i>	
Shorthead sculpin	<i>Cottus confusus</i>	
Shortnose sturgeon	<i>Acipenser brevirostrum</i>	FE, SE
Skipjack herring	<i>Alosa chrysochloris</i>	
Slender chub	<i>Hybopsis cahnii</i>	FT
Smallmouth bass	<i>Micropterus dolomieu</i>	
Smallmouth buffalo	<i>Ictiobus bubalus</i>	
Snubnose darter	<i>Etheostoma simoterum</i>	
Speckled dace	<i>Rhinichthys osculus</i>	
Spotfin chub	<i>Hybopsis monacha</i>	FT
Striped shiner	<i>Luxilus chrysocephalus</i>	
Striped bass	<i>Morone saxatilis</i>	
Stripetail darter	<i>Etheostoma kennicotti</i>	
Threadfin shad	<i>Dorosoma petenense</i>	
Walleye	<i>Stizostedion vitreum</i>	
White sucker	<i>Catostomus commersoni</i>	
White crappie	<i>Pomoxis annularis</i>	
White bass	<i>Morone chrysops</i>	
Yellowfin madtom	<i>Noturus flavipinnis</i>	FT
REPTILES AND AMPHIBIANS		
Alameda striped racer	<i>Masticophis lateralis euryxanthus</i>	FC1
American alligator	<i>Alligator mississippiensis</i>	FT, ST
American crocodile	<i>Crocodylus acutus</i>	FE

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
American toad	<i>Bufo americanus</i>	
Common kingsnake	<i>Lampropeltis getulus</i>	
Blackneck garter snake	<i>Thamnophis cyrtopsis</i>	
Brown snake	<i>Storeria dekayi</i>	
Bullfrog	<i>Rana catesbeiana</i>	
Butler's garter snake	<i>Thamnophis butleri</i>	
California horned lizard	<i>Phrynosoma coronatum frontale</i>	FC2
California red-legged frog	<i>Rana aurora draytoni</i>	FPE
California slender salamander	<i>Batrachoseps attenuatus</i>	
California tiger salamander	<i>Ambystoma californiense</i>	FC1
Carolina crawfish (= gopher) frog	<i>Rana areolata capito</i> (= <i>capito capito</i>)	FC2
Chorus frog	<i>Pseudacris triseriata</i>	
Coachwhip	<i>Masticophis flagellum</i>	
Collared lizard	<i>Crotaphytus collaris</i>	
Copperhead	<i>Agkistrodon contortrix</i>	
Cottonmouth snake	<i>Agkistrodon piscivorus</i>	
Dusky salamander	<i>Desmognathus fuscus</i>	
Eastern box turtle	<i>Terrapene carolina</i>	
Eastern fence lizard	<i>Sceloporus undulatus</i>	
Eastern hognose snake	<i>Heterodon platyrhinos</i>	
Fowler's toad	<i>Bufo woodhousii fowleri</i>	
Fox snake	<i>Elaphe vulpina</i>	
Gopher snake	<i>Pituophis melanoleucus</i>	
Gopher tortoise	<i>Gopherus polyphemus</i>	FC2
Great Plains skink	<i>Eumeces obsoletus</i>	
Great Plains toad	<i>Bufo cognatus</i>	
Green frog	<i>Rana clamitans</i>	

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Green salamander	<i>Aneides aeneus</i>	FC2
Green toad	<i>Bufo debilis</i>	
Ground skink	<i>Scincella lateralis</i>	
Hellbender	<i>Cryptobranchus alleganiensis</i>	FC2
Jemez Mountain salamander	<i>Plethodon neomexicanus</i>	FC2
Lesser earless lizard	<i>Holbrookia maculata</i>	
Longnose snake	<i>Rhinocheilus lecontei</i>	
Longnose leopard lizard	<i>Gambelia wislizenii</i>	
Many-lined skink	<i>Eumeces multivirgatus</i>	
Milk snake	<i>Lampropeltis triangulum</i>	
Mountain patchnose snake	<i>Salvadora grahamiae</i>	
Mudpuppy	<i>Necturus maculosus</i>	
Night snake	<i>Hypsiglena torquata</i>	
Northern alligator lizard	<i>Elgaria (= Gerrhonotus) coeruleus</i>	
Northern cricket frog	<i>Acris crepitans</i>	
Northern leopard frog	<i>Rana pipiens</i>	
Northern pine snake	<i>Pituophis melanoleuous melanoleucus</i>	FC2, ST
Northern sagebrush lizard	<i>Sceloporus graciosus graciosus</i>	FC2
Northern water snake	<i>Nerodia sipedon</i>	
Painted turtle	<i>Chrysemys picta</i>	
Plains blackhead snake	<i>Tantilla nigriceps</i>	
Plains garter snake	<i>Thamnophis radix</i>	
Plains spadefoot toad	<i>Scaphiopus bombifrons</i>	
Queen snake	<i>Regina septemvittata</i>	
Racer	<i>Coluber constrictor</i>	
Rat snake	<i>Elaphe obsoleta</i>	
Red salamander	<i>Pseudotriton ruber</i>	

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Red-spotted toad	<i>Bufo punctatus</i>	
Regal ringneck snake	<i>Diadophis punctatus regalis</i>	
Rough green snake	<i>Opheodrys aestivus</i>	
Sagebrush lizard	<i>Sceloporus graciosus</i>	
Short-horned lizard	<i>Phrynosoma douglassi</i>	
Side-blotched lizard	<i>Uta stansburiana</i>	
Six-lined racerunner	<i>Cnemidophorus sexlineatus</i>	
Smooth softshell turtle	<i>Apalone (= Trionyx) mutica</i>	
Snapping turtle	<i>Chelydra serpentina</i>	
Southeastern crowned snake	<i>Tantilla coronata</i>	
Southern toad	<i>Bufo terrestris</i>	
Southern hognose snake	<i>Heterodon simus</i>	
Spiny softshell turtle	<i>Apalone (= Trionyx) spinifera</i>	
Spotted salamander	<i>Ambystoma maculatum</i>	
Spring peeper	<i>Hyla (= Pseudacris) crucifer</i>	
Striped whipsnake	<i>Masticophis taeniatus</i>	
Tennessee cave salamander	<i>Gyrinophilus palleucus</i>	FC2, ST
Tiger salamander	<i>Ambystoma tigrinum</i>	
Tree frog	<i>Hyla spp.</i>	
Tree lizard	<i>Urosaurus ornatus</i>	
Upland chorus frog	<i>Pseudacris feriarum</i>	
Western box turtle	<i>Terrapene ornata</i>	
Western diamondback rattlesnake	<i>Crotalus atrox</i>	
Western fence lizard	<i>Sceloporus occidentalis</i>	
Western hognose snake	<i>Heterodon nasicus</i>	
Western painted turtle	<i>Chrysemys picta belli</i>	
Western rattlesnake	<i>Crotalus viridis</i>	
Western spadefoot toad	<i>Scaphiopus hammondi</i>	FC2

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Western terrestrial garter snake	<i>Thamnophis elegans</i>	
Whiptail lizard	<i>Cnemidophorus spp.</i>	
Woodhouse's toad	<i>Bufo woodhousei</i>	
Worm snake	<i>Carphophis amoenus</i>	
Yellowbelly slider	<i>Trachemys scripta</i>	
BIRDS		
Aleutian Canada goose	<i>Branta canadensis leucopareia</i>	FT, SE
American crow	<i>Corvus brachyrhynchos</i>	
American goldfinch	<i>Carduelis tristis</i>	
American kestrel	<i>Falco sparverius</i>	
American peregrine falcon	<i>Falco peregrinus anatum</i>	FE
American robin	<i>Turdus migratorius</i>	
American white pelican	<i>Pelecanus erythrorhynchos</i>	SE
American widgeon	<i>Mareca americana</i>	
Anna's hummingbird	<i>Clypte anna</i>	
Appalachian Bewick's wren	<i>Thryomanes bewickii altus</i>	FC2
Artic peregrine falcon	<i>Falco peregrinus tundricus</i>	FE
Ash-throated flycatcher	<i>Myiarchus cinerascens</i>	
Bachman's sparrow	<i>Aimophia aestivalis</i>	FC2
Baird's sparrow	<i>Ammodramus airdii</i>	
Bald eagle	<i>Haliaeetus leucocephalus</i>	FT, FE
Bank swallow	<i>Riparia riparia</i>	
Barn swallow	<i>Hirundo rustica</i>	
Belted kingfisher	<i>Ceryle alcyon</i>	
Bewick's wren	<i>Thryomanes bewickii</i>	ST
Black phoebe	<i>Sayornis nigricans</i>	
Black tern	<i>Chilidonias niger</i>	FC2

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Black vulture	<i>Coragyps atratus</i>	
Black-billed magpie	<i>Pica pica</i>	
Black-capped chickadee	<i>Parus atricapillus</i>	
Black-chinned hummingbird	<i>Archilochus alexandris</i>	
Black-crowned night heron	<i>Nycticorax nycticorax</i>	SE
Black-headed grosbeak	<i>Pheuctucus melanocephalus</i>	
Black-shouldered kite	<i>Elanus caeruleus</i>	
Black-throated gray warbler	<i>Dendroica nigrescens</i>	
Black-throated sparrow	<i>Amphispiza bilineata</i>	
Blackpoll warbler	<i>Dendroica striata</i>	
Blue grosbeak	<i>Guiraca caerulea</i>	
Blue grouse	<i>Dendragapus obscurus</i>	
Bluejay	<i>Cyanocitta cristata</i>	
Blue-gray gnatcatcher	<i>Polioptila caerulea</i>	
Bobwhite quail	<i>Colinus virginianus</i>	
Brewer's blackbird	<i>Euphagus cyanocephalus</i>	
Brewer's sparrow	<i>Spizella breweri</i>	
Broad-billed hummingbird	<i>Cynanthus latirostris</i>	
Broad-tailed hummingbird	<i>Selasphorus platycercus</i>	
Broad-winged hawk	<i>Buteo platypterus</i>	
Brown creeper	<i>Certhis americana</i>	
Brown thrasher	<i>Toxostoma rufum</i>	
Brown-headed cowbird	<i>Molothrus ater</i>	
Bufflehead	<i>Cucephala albeola</i>	
Burrowing owl	<i>Speotyto cunicularia</i>	
Bushtit	<i>Psaltriparus minimus</i>	
California quail	<i>Callipepla californica</i>	
Canada goose	<i>Branta canadensis</i>	

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Canvasback	<i>Aythya valisineria</i>	
Canyon wren	<i>Catherpes mexicanus</i>	
Cardinal	<i>Richmondia cardinalis</i>	
Carolina chickadee	<i>Parus carolinensis</i>	
Cassin's kingbird	<i>Tyrannus vociferans</i>	
Cattle egret	<i>Bubulcus ibis</i>	
Chinese ring-necked pheasant	<i>Phasianus colchicus</i>	
Chipping sparrow	<i>Spizella passerina</i>	
Chukar partridge	<i>Alectoris chukar</i>	
Cinnamon teal	<i>Anas cyanoptera</i>	
Clark's nutcracker	<i>Nucifraga colubiana</i>	
Cliff swallow	<i>Hirundo phyrhronota</i>	
Common barn owl	<i>Tyto alba</i>	
Common loon	<i>Gavia immer</i>	SC
Common nighthawk	<i>Chordeiles minor</i>	
Common poor-will	<i>Phalaenoptilus nuttallii</i>	
Common raven	<i>Corvus corax</i>	
Common yellowthroat	<i>Geothlypis trichas</i>	
Cooper's hawk	<i>Accipiter cooperii</i>	ST, SE
Cordilleran flycatcher	<i>Empidonax occidntalis</i>	
Crissal thrasher	<i>Toxostoma dorsale</i>	
Dark-eyed junco	<i>Junco hymalis</i>	
Downy woodpecker	<i>Picoides pubescens</i>	
Dusky flycatchers	<i>Empidonax oberhoiseri</i>	
Eastern bluebird	<i>Sialia sialis</i>	
Eastern kingbird	<i>Tyrannus tyrannus</i>	
Eastern phoebe	<i>Sayornis phoebe</i>	
Evening grosbeak	<i>Coccothraustes vespertina</i>	

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Ferruginous hawk	<i>Buteo regalis</i>	FC2, ST
Field sparrow	<i>Spizella pusilla</i>	
Flammulated owl	<i>Otus flammeolus</i>	SC
Golden eagle	<i>Aquila chrysaetos</i>	FE, SC
Grace's warbler	<i>Dendroica graciae</i>	
Grackle	<i>Quiscalus quiscula versicolor</i>	
Grasshopper sparrow	<i>Ammodramus savannarum</i>	ST
Gray flycatcher	<i>Empidonax writghtii</i>	
Gray partridge	<i>Perdix perdix</i>	
Great blue heron	<i>Ardea herodias</i>	
Great egret	<i>Casmerodius albus</i>	SE
Great horned owl	<i>Bubo virginianus</i>	
Greater roadrunner	<i>Geococcyx californianus</i>	
Green heron	<i>Butorides virescens</i>	
Green towhee	<i>Pipilo chlorurus</i>	
Green-backed heron	<i>Butorides striatus</i>	
Green-tailed towhee	<i>Pipilo chlorurus</i>	
Gyr Falcon	<i>Falco rusticolus</i>	
Hairy woodpecker	<i>Picoides villosus</i>	
Hammond's flycatcher	<i>Empidonax hammondii</i>	
Hooded merganser	<i>Lophodytes cucullatus</i>	
Horned lark	<i>Eremophila alpestris</i>	FC2
House finch	<i>Carpodacus mexicanus</i>	
House sparrow	<i>Passer domesticus</i>	
House wren	<i>Troglodytes aedon</i>	
Indigo bunting	<i>Passerina cyanea</i>	
Kentucky warbler	<i>Oporornis formosus</i>	
Killdeer	<i>Charadrius vociferus</i>	

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Kirtland's warbler	<i>Dendroica kirtlandii</i>	FE
Lark sparrow	<i>Chandestes grammacus</i>	
Lazuli bunting	<i>Passerina amoena</i>	
Lesser goldfinch	<i>Spinus psaltria</i>	
Lewis' woodpecker	<i>Melanerpes lewis</i>	SC
Loggerhead shrike	<i>Lanius ludovicianus</i>	FC2, SE
Long-billed curlew	<i>Numenius americanus</i>	FC2
Long-eared owl	<i>Asio otus</i>	
MacGillivray's warbler	<i>Oporonis tolmiei</i>	
Mallard	<i>Anas platyrhynchos</i>	
Marsh wren	<i>Cistothorus palustris</i>	
Merlin	<i>Falco columbarius</i>	
Mexican spotted owl	<i>Strix occidentalis lucida</i>	FT, SE
Mississippi kite	<i>Ictinia mississippiensis</i>	
Mountain bluebird	<i>Sialia currucoides</i>	
Mountain chickadee	<i>Parus gambeli</i>	
Mountain plover	<i>Charadrius montanus</i>	FC2
Mourning dove	<i>Zenaida macroura</i>	
Mourning warbler	<i>Oporonis philadelphia</i>	
Mute swan	<i>Cignus olor</i>	
Northern goshawk	<i>Accipiter gentilis</i>	FC2
Northern harrier	<i>Circus cyaneus</i>	ST
Northern mockingbird	<i>Mimus polyglottos</i>	
Northern oriole	<i>Icterus galbula</i>	
Northern pintail	<i>Anas acuta</i>	
Northern pygmy owl	<i>Glaucidium gnoma</i>	
Northern rough-winged swallow	<i>Stelgidopteryx serripennis</i>	
Northern saw-whet owl	<i>Aegolius acadicus</i>	

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Northern shoveler	<i>Anas clypeata</i>	
Northern waterthrush	<i>Seiurus noveboracensis</i>	
Orange-crowned warbler	<i>Vermivora celata</i>	
Osprey	<i>Pandion haliaetus</i>	SE
Ovenbirds	<i>Seirus aurocapillus</i>	
Peregrine falcon	<i>Falco peregrinus</i>	FE, SE
Pine siskin	<i>Carduelis pinus</i>	
Pine warblers	<i>Dendroica pinus</i>	
Pintail	<i>Anas acuta</i>	
Pinyon jay	<i>Gymnorhinus cyanocephalus</i>	
Plain titmouse	<i>Parus inornatus</i>	
Prairie falcon	<i>Falco mexicanus</i>	
Purle finch	<i>Carpodacus purpureus</i>	
Purple martin	<i>Progne subis</i>	
Rad-naped sapsucker	<i>Sphyrapicus nuchalis</i>	
Red-bellied woodpecker	<i>Melanerpes carolinus</i>	
Red-cockaded woodpecker	<i>Picoides borealis</i>	FE
Red-shouldered hawk	<i>Buteo lineatus</i>	
Red-tailed hawk	<i>Buteo jamaicensis</i>	
Red-winged blackbird	<i>Aegelaius phoeniceus</i>	
Rock dove	<i>Columba livia</i>	
Rock wren	<i>Salpinctes obsoletus</i>	
Rose-breasted grosbeak	<i>Pheucticus ludovicianus</i>	
Rough-legged hawk	<i>Buteo lagopus</i>	
Ruby-crowned kinglet	<i>Regulus calendula</i>	
Ruby-throated hummingbirds	<i>Archilochus colubris</i>	
Rufous-crowned sparrow	<i>Aimophila ruficeps</i>	
Rufous-sided towhee	<i>Pipilo erythrophthalmus</i>	

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Sage grouse	<i>Centrocercus urophasianus</i>	
Sage sparrow	<i>Amphispiza belli</i>	SC
Sage thrasher	<i>Oreoscoptes montanus</i>	SC
Sandhill crane	<i>Grus canadensis</i>	SE
Savannah sparrow	<i>Passerculus sandwichensis</i>	FE, SE
Say's phoebe	<i>Sayornis saya</i>	
Scaled quail	<i>Callipepla squamata</i>	
Scarlet tanager	<i>Piranga olivacea</i>	
Scott's oriole	<i>Icterus parisorum</i>	
Scrub jay	<i>Aphelocoma coerulescens</i>	
Sharp-shinned hawk	<i>Accipiter striatus</i>	ST
Short-eared owl	<i>Asio flammeus</i>	
Snipe	<i>Gallinago gallinago</i>	
Snow goose	<i>Chen caerulescens</i>	
Song sparrow	<i>Melospiza melodia</i>	
Southwestern willow flycatcher	<i>Empidonax traillii extimus</i>	FE, SE
Spotted owl	<i>Strix occidentalis</i>	
Spotted sandpiper	<i>Actitis macularia</i>	
Starling	<i>Sturnus vulgaris</i>	
Stellar's jay	<i>Cyanocitta stelleri</i>	
Summer tanager	<i>Piranga rubra</i>	
Swainson's hawk	<i>Buteo swainsoni</i>	SC
Swainson's warbler	<i>Lomnothlypis swainsonii</i>	
Swallow-tailed kite	<i>Elanoides forficatus</i>	FE, SE
Swamp sparrow	<i>Melospiza georgiana</i>	
Townsend's solitaire	<i>Myadestes townsendi</i>	
Tree sparrow	<i>Spizella arborea</i>	
Tree swallow	<i>Tachycineta bicolor</i>	

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Tri-colored blackbird	<i>Aegelaius tricolor</i>	FC2
Turkey	<i>Meleagris gallopavo</i>	
Turkey vulture	<i>Cathartes aura</i>	
Vesper sparrows	<i>Pooecetes gramineus</i>	
Violet-green swallow	<i>Tachycineta thalassina</i>	
Virginia warbler	<i>Vermivora virginiae</i>	
Warbling vireo	<i>Vireo gilvus</i>	
Western bluebird	<i>Sialia mexicana</i>	
Western burrowing owl	<i>Athene cunicularia</i>	FC
Western flycatcher	<i>Empidonax difficilis</i>	
Western kingbird	<i>Tyrannus verticalis</i>	
Western meadowlark	<i>Sturnella neglecta</i>	
Western sage grouse	<i>Centrocercus urophasianus phaios</i>	FC2
Western screech owl	<i>Otus kennicottii</i>	
Western snowy plover	<i>Charadrius alexandrinus nivosus</i>	FC2
Western tanager	<i>Piranga ludoviciana</i>	
Western wood-pewee	<i>Contopus sordidulus</i>	
Whip-poor-will	<i>Caprimulgus vociferus</i>	
Whistling swan	<i>Olor columbianus</i>	
White-breasted nuthatch	<i>Sitta carolinensis</i>	
White-crowned sparrow	<i>Zonotrichia leucophrys</i>	
White-faced ibis	<i>Plegadis chihi</i>	FC2
White-tailed kite	<i>Elanus leucurus</i>	
White-throated sparrow	<i>Zonotrichia albicollis</i>	
White-throated swift	<i>Aeronautes saxatalis</i>	
Whooping crane	<i>Grus americana</i>	FE
Williamson's sapsucker	<i>Sphyrapicus thyoideus</i>	
Willow flycatcher	<i>Empidonax traillii</i>	SE

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Wilson's warbler	<i>Wilsonia pusilla</i>	
Wood duck	<i>Aix sponsa</i>	
Wood stork	<i>Mycteria americana</i>	FE
Yellow warbler	<i>Dendroica petechia</i>	
Yellow-breasted chat	<i>Icteria virens</i>	
Yellow-rumped warbler	<i>Dendroica coronata</i>	
Yellow-shafted flicker	<i>Colaptes auratus</i>	
Zone-tailed hawk	<i>Buteo albonotatus</i>	
MAMMALS		
Badger	<i>Taxidea taxus</i>	
Banner-tailed kangaroo rat	<i>Dipodomys spectabilis</i>	
Beaver	<i>Castor canadensis</i>	
Big brown bat	<i>Eptesicus fuscus</i>	
Black bear	<i>Ursus americanus</i>	
Black-footed ferret	<i>Mustela nigripes</i>	FE
Black-tailed deer	<i>Odocoileus hemionus columbianus</i>	
Black-tailed jack rabbit	<i>Lepus californicus</i>	
Black-tailed prairie dog	<i>Cynomys ludovicianus</i>	
Bobcat	<i>Lynx rufus</i>	
Brazilian free-tailed bat	<i>Tadarida brasiliensis</i>	
Brush mouse	<i>Peromyscus boylii</i>	
California ground squirrel	<i>Spermophilus beecheyi</i>	
California myotis (bat)	<i>Myotis californicus</i>	
California pocket mouse	<i>Perognathus californicus</i>	
California vole	<i>Microtus californicus</i>	
Chipmunk	<i>Tamias striatus griseus</i>	
Colorado chipmunk	<i>Eutamias quadrivittatus</i>	

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Cougar	<i>Felis concolor</i>	
Coyote	<i>Canis latrans</i>	
Deer mouse	<i>Peromyscus maniculatus</i>	
Desert cottontail rabbit	<i>Sylvilagus audubonii</i>	
Desert shrew	<i>Notiosorex crawfordi</i>	
Desert woodrat	<i>Neotoma lepida</i>	
Eastern chipmunk	<i>Tamias striatus</i>	
Eastern cottontail rabbit	<i>Sylvilagus floridanus</i>	
Eastern cougar	<i>Felis concolor couguar</i>	FE
Eastern gray squirrel	<i>Sciurus carolinensis</i>	
Eastern mole	<i>Scalopus aquaticus</i>	
Elk	<i>Cervus elaphus</i>	
Fallow deer	<i>Dama dama</i>	
Feral hog	<i>Sus scrofa</i>	
Fox squirrel	<i>Sciurus niger rufiventer</i>	
Fringed myotis (bat)	<i>Myotis thysanodes</i>	FC2
Gapper's red-backed mouse	<i>Clethrionomys gapperi</i>	
Goat Peak pika	<i>Ochotona princeps nigrescens</i>	FC2
Golden mouse	<i>Ochrotomys nuttallii</i>	
Gray bat	<i>Myotis grisescens</i>	FE
Gray fox	<i>Urocyon cinereoargenteus</i>	
Gray squirrel	<i>Sciurus carolinensis leucotis</i>	
Great Basin pocket mouse	<i>Perognathus parvus</i>	
Ground squirrel	<i>Citellus spp.</i>	
Gunnison's prairie dog	<i>Cynomys gunnisoni</i>	
Hermann's kangaroo rat	<i>Dipodomys herrmanni</i>	
Hispid cotton rat	<i>Sigmodon hispidus</i>	
Hispid pocket mouse	<i>Perognathus hispidus</i>	

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Hoary bat	<i>Lasiurus cinereus</i>	
House mouse	<i>Mus musculus</i>	
Indiana bat	<i>Myotis sodalis</i>	FE
Least chipmunk	<i>Eutamias minimus</i>	
Least shrew	<i>Cryptotis parva</i>	
Little brown myotis (bat)	<i>Myotis lucifugus</i>	
Long-eared myotis (bat)	<i>Myotis evotis</i>	FC2
Long-legged myotis (bat)	<i>Myotis volans</i>	FC2
Long-tailed weasel	<i>Mustela frenata</i>	
Marsh rice rat	<i>Oryzomys palustris</i>	
Meadow jumping mouse	<i>Zapus hudsonius</i>	
Meadow vole	<i>Microtus pennsylvanicus</i>	
Merriam's kangaroo rat	<i>Dipodomys merriami</i>	
Mink	<i>Mustela vison</i>	
Moose	<i>Alces alces</i>	
Mountain cottontail rabbit	<i>Sylvilagus nuttalli</i>	
Mountain sheep	<i>Ovis canadensis</i>	
Mule deer	<i>Odocoileus hemionus</i>	
Muskrat	<i>Ondatra zibethicus</i>	
New Mexican jumping mouse	<i>Zapus hudsonius luteus</i>	FC2
Northern grasshopper mouse	<i>Onychomys leucogaster</i>	
Norway rat	<i>Rattus norvegicus</i>	
Occult little brown bat	<i>Myotis lucifugus occultus</i>	FC2
Opossum	<i>Didelphis virginiana</i>	
Ord's kangaroo rat	<i>Dipodomys ordii</i>	
Pale Townsend's big-eared bat	<i>Plecotus townsendio pallescens</i>	FC2
Pallid bat	<i>Antrozous pallidus</i>	
Pine vole	<i>Microtus pinetorum</i>	

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Pinyon mouse	<i>Peromyscus truei</i>	
Pocket gopher	<i>Thomomys bottae</i>	
Porcupine	<i>Erethizon dorsatum</i>	
Preble's meadow jumping mouse	<i>Zapus hudsonius preblei</i>	FC2
Pronghorn antelope	<i>Antilocapra americana</i>	
Pygmy rabbit	<i>Sylvilagus idahoensis</i>	FC2, SE
Rabbit	<i>Sylvilagus spp.</i>	
Raccoon	<i>Procyon lotor</i>	
Rafinesque's big-eared bat	<i>Plecotus rafinesquii</i>	FC2
Red bat	<i>Lasiurus borealis</i>	
Red fox	<i>Vulpes vulpes</i>	
Ringtail	<i>Bassariscus astutus</i>	
River otter	<i>Lutra canadensis</i>	ST
Rock mouse	<i>Peromyscus difficilis</i>	
Rock pocket mouse	<i>Perognathus intermedius</i>	
Rock squirrel	<i>Spermophilus variegatus</i>	
San Joaquin kit fox	<i>Vulpes macrota mutica</i>	FE
Short-tailed shrew	<i>Blarina brevicauda</i>	
Silky pocket mouse	<i>Perognathus flavus</i>	
Silver-haired bat	<i>Lasionycteris noctivagans</i>	
Small-footed myotis	<i>Myotis leibii</i>	FC2
Southeastern shrew	<i>Sorex longirostris</i>	
Southern flying squirrel	<i>Glaucomys volans</i>	
Southern plains woodrat	<i>Neotoma micropus</i>	
Southwestern myotis	<i>Myotis auriculus</i>	
Spotted bat	<i>Euderma maculatum</i>	FC2, SE
Spotted ground squirrel	<i>Spermophilus spilosoma</i>	
Star-nose mole	<i>Condylura cristata</i>	

Table A.1. (cont'd)

Common Name	Scientific Name	Special Status
Striped skunk	<i>Mephitis mephitis</i>	
Swift fox	<i>Vulpes velox</i>	FC2
Texas antelope squirrel	<i>Ammospermophilus interpres</i>	
Thirteen-lined ground squirrel	<i>Citellus tridecimlineatus</i>	
Townsend's big-eared bat	<i>Plecotus townsendii</i>	SC
Vole	<i>Microtus spp.</i>	
Water shrew	<i>Sorex mirriami</i>	
Washington ground squirrel	<i>Spermophilus washingtoni</i>	FC2
Western harvest mouse	<i>Reithrodontomys megalotis</i>	
Western jumping mouse	<i>Zapus princeps</i>	
Western spotted skunk	<i>Spilogale gracilis</i>	
White-footed mouse	<i>Peromyscus leucopus</i>	
White-tailed antelope squirrel	<i>Ammospermophilus leucurus</i>	
White-tailed deer	<i>Odocoileus virginianus</i>	
White-throated woodrat	<i>Neotoma albigula</i>	
Woodchuck (groundhog)	<i>Marmota monax</i>	
Yuma myotis (bat)	<i>Myotis yumanensis</i>	FC2