



OAK RIDGE RESERVATION

Physical Characteristics and Natural Resources

October 2006

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**OAK RIDGE RESERVATION PHYSICAL CHARACTERISTICS
AND NATURAL RESOURCES**

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ACRONYMS

BSR	biological significance ranking
DOE	Department of Energy
EPA	Environmental Protection Agency
ETTP	East Tennessee Technology Park
MAB	Man and the Biosphere (Program)
MSL	mean sea level
NAAQS	National Ambient Air Quality Standards
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
ppm	parts per million
TDEC	Tennessee Department of Environment and Conservation
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency

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This reference document pulls together basic information about physical characteristics and natural resources of the Oak Ridge Reservation (ORR) from many individuals and sources. Although it is not possible to mention everyone who has played a role in characterization of the ORR natural resources over the past 60 years, we thank and gratefully acknowledge those who have directly contributed to the preparation of this document.

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1. OAK RIDGE RESERVATION PHYSICAL CHARACTERISTICS AND NATURAL RESOURCES

The topography, geology, hydrology, vegetation, and wildlife of the Oak Ridge Reservation (ORR) provide a complex and intricate array of resources that directly impact land stewardship and use decisions (Fig. 1). The purpose of this document is to consolidate general information regarding the natural resources and physical characteristics of the ORR.

The ORR, encompassing 33,114 acres (13,401 ha) of federally owned land and three Department of Energy (DOE) installations, is located in Roane and Anderson Counties in east Tennessee, mostly within the corporate limits of the city of Oak Ridge and southwest of the population center of Oak Ridge.

The ORR is bordered on the north and east by the population center of the city of Oak Ridge and on the south and west by the Clinch River/Melton Hill Lake impoundment.

All areas of the ORR are relatively pristine when compared with the surrounding region, especially in the Valley and Ridge Physiographic Province (Fig. 2). From the air, the ORR is clearly a large and nearly continuous island of forest within a landscape that is fragmented by urban development and agriculture. Satellite imagery from 2006 was used to develop a land-use/land-cover map of the ORR and surrounding lands (Fig. 3).

Following the acquisition of the land comprising the ORR in the early 1940s, much of the Reservation served as a buffer for the three primary facilities: the X-10 nuclear research facility (now known as the Oak Ridge National Laboratory [ORNL]), the first uranium enrichment facility or Y-12 (now known as the Y-12 National Security Complex [Y-12 Complex]), and a gaseous diffusion enrichment facility (now known as the East Tennessee Technology Park [ETTP]). Over the past 60 years, this relatively undisturbed area has evolved into a rich and diverse eastern deciduous forest ecosystem of streams and reservoirs, hardwood forests, and extensive upland mixed forests.

The combination of a large land area with complex physical characteristics and diverse natural resources has provided a critical foundation for supporting DOE's environmental research mission, as well as the area in which to build leading-edge facilities.

2. CLIMATE

The climate of the Oak Ridge region may be broadly classified as humid subtropical. The term *humid* indicates that the region receives a surplus of precipitation compared to the level of evapotranspiration that is normally experienced throughout the year. The subtropical nature of the local climate indicates that the region experiences warm to hot summers and cool to cold winters. Such areas typically experience significant changes in temperatures between summer and winter.

Local winters are characterized by synoptic weather systems that often produce significant precipitation events every 3 to 5 days. Although infrequent, these wet periods may be followed by arctic air outbreaks. While snow and ice are not usually associated with these systems, there is occasional snowfall each winter. Winter cloud cover tends to be enhanced by the region's terrain.

Severe thunderstorms are most frequent during spring, although the Cumberland Mountains and the Cumberland Plateau (Fig. 3) usually inhibit the intensity of severe systems that traverse the region. Summers are characterized by warm, humid conditions. Occasional frontal systems can produce organized lines of thunderstorms (and rare damaging tornados). More frequently, however, summer precipitation is due to air-mass thundershowers that result from daytime heating and rising humid air. Although ample precipitation usually occurs during the fall, October tends to be the driest month of the year. The occurrence of precipitation during the fall tends to be less cyclic than during other seasons, although it is occasionally enhanced by decaying tropical systems moving north from the Gulf of Mexico. During November, winter-type cyclones again begin to dominate the weather. The terrain often exhibits a significant influence on local climate. Primarily, these effects result in

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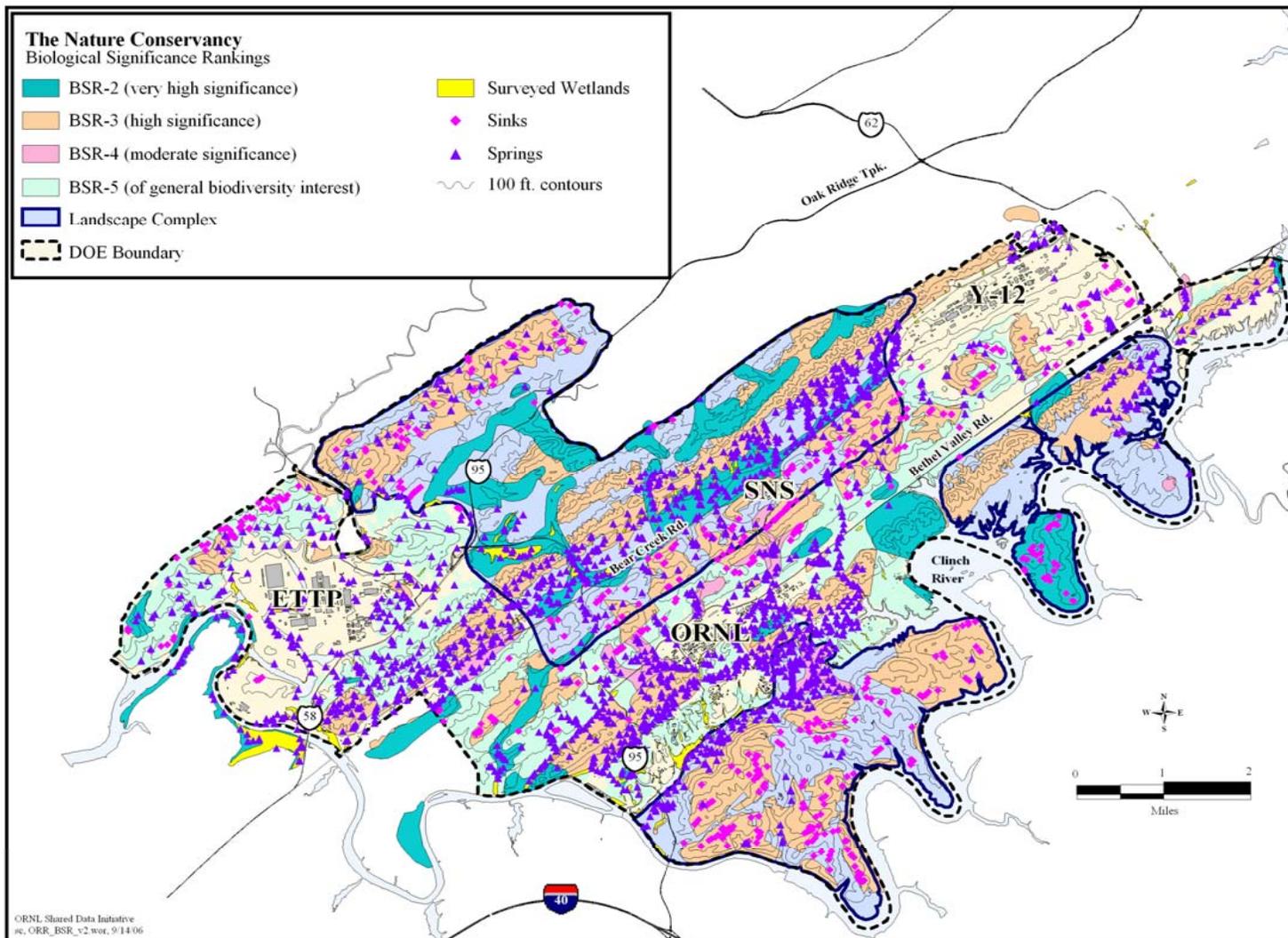


Fig. 1. ORR biologically significant areas, sinks, and springs.

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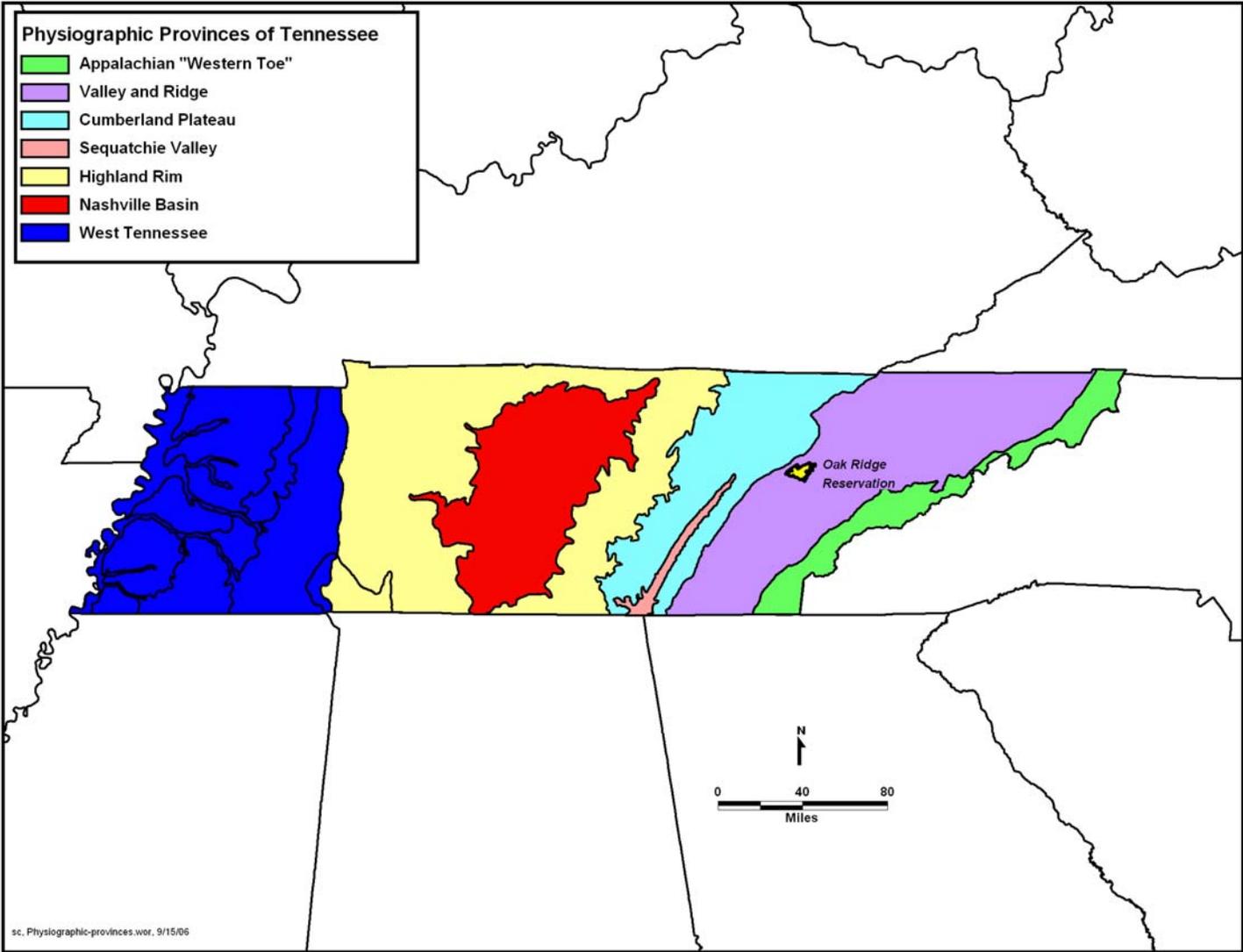
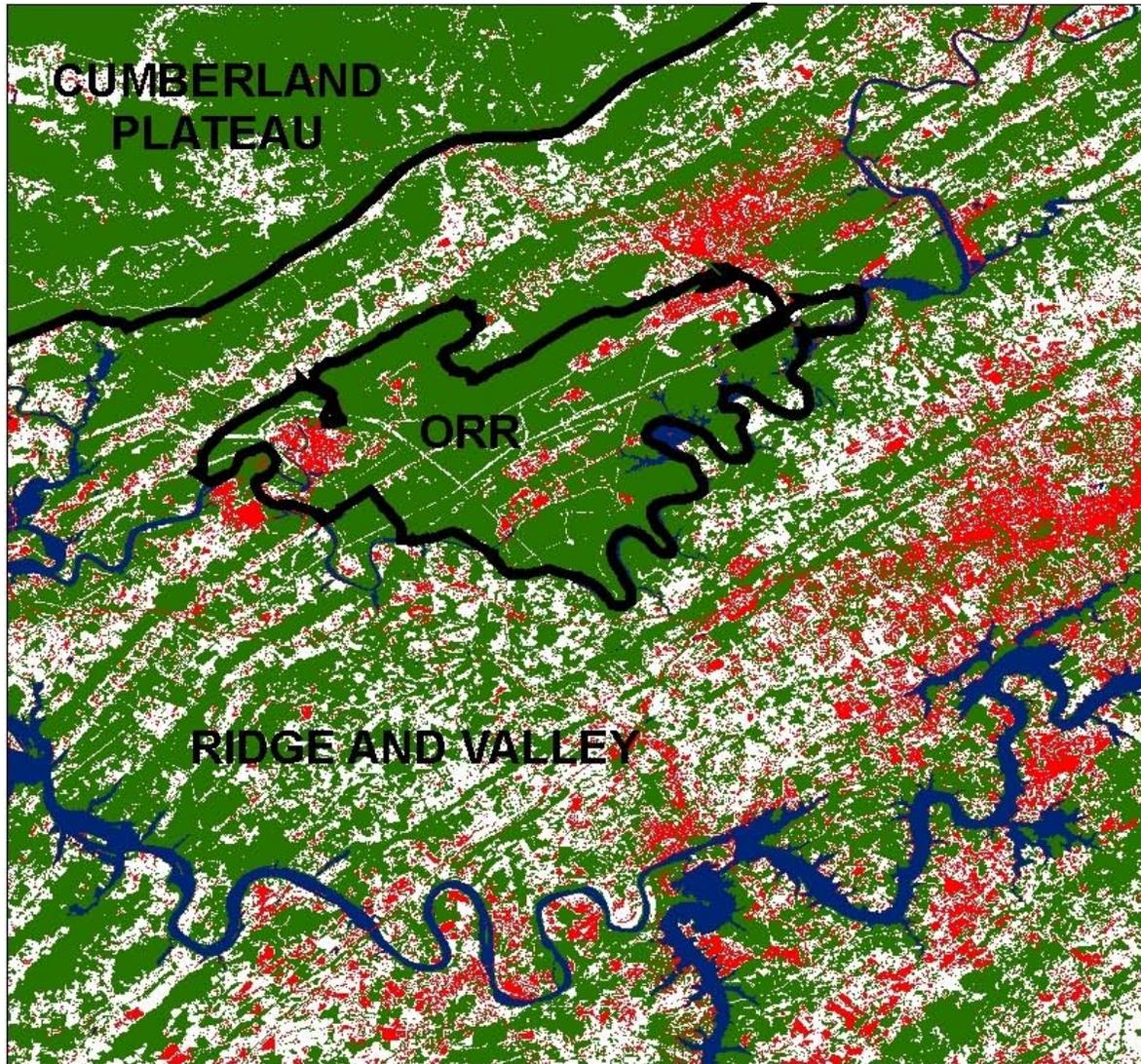


Fig. 2. ORR's position within the physiographic provinces of Tennessee.



Class Names

-  Water
-  Agricultural Land
-  Urban Land
-  Forest Land

Scale

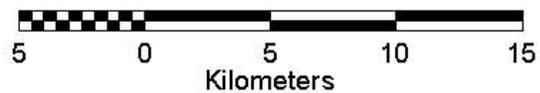


Fig. 3. Regional land-cover map prepared from a July 3, 2006, Landsat Thematic Mapper image.

seasonal changes to cloud cover, precipitation, air mass, and wind-flow regimes.

2.1 TEMPERATURE

The mean 30-year annual temperature (1976–2005) for the Oak Ridge area was 58°F (14.4°C). The coldest month is typically January, with temperatures averaging about 36°F (2.3°C). However, in 1985 the minimum temperature dipped to –24°F (–31°C). July tends to be the warmest month of the year, with temperatures averaging 78°F (25.3°C) and on rare occasions peaking as high as 99°F (37°C).

Although average daily temperatures across the ORR are not significantly affected by the local terrain, noticeable differences do occur with respect to maximum and minimum temperatures. Such differences can result in significant temperature variations with changes in elevation as small as 33 to 67 ft (10 to 20 m). This type of phenomenon occurs most frequently during nighttime hours (especially near sunrise) but can also occur during the approach of large-scale low-pressure areas as warm air advection interacts with the local ridge-and-valley terrain.

2.2 WINDS

The complex terrain significantly affects wind patterns in the Oak Ridge area. These factors primarily result from the presence of the Cumberland Plateau, the Cumberland Mountains, the Great Smoky Mountains, the orientation axis of the Great Valley (which includes most of the Valley and Ridge Physiographic Province), and the local ridge-and-valley terrain structure. Although surface winds tend to follow the axes of the valleys, winds above the ridge-and-valley terrain (altitudes of 328 ft [100 m] or more) often blow from significantly different directions than the surface winds as a result of several wind-forcing mechanisms created by regional terrain. The presence of the ridge-and-valley terrain reduces average wind speeds at local valley-bottoms sites, resulting in frequent periods of near calm conditions (particularly during clear, early-morning hours).

Five major terrain-related wind regimes regularly affect the Great Valley of eastern Tennessee: (1) pressure-driven channeling, (2) downward-momentum transport or vertically coupled flow, (3) forced channeling, (4) along-valley thermal circulations, and (5) mountain–valley circulations. Pressure-driven channeling and vertically coupled flow (unstably stratified conditions) affect wind flow on scales comparable to that of the Great Valley (i.e., hundreds of miles). Forced channeling occurs on similar scales but is also quite important at smaller spatial scales, such as that of the local ridge-and-valley terrain (Birdwell 1996). Along-valley and mountain–valley circulations are thermally-driven and occur within a large range of spatial scales. Thermal flows are more prevalent under conditions of clear skies and low humidity. Pressure-driven channeling, in its simplest form, is the redirection of synoptically induced wind flow through a valley channel. The direction of wind flow through the valley is determined by the pressure gradient superimposed on the valley’s axis (Whiteman 2000). The process is affected by Coriolis forces, a leftward deflection of winds (in the Northern Hemisphere). Eckman (1998) suggested that pressure-driven channeling plays a significant role in the Great Valley. Winds driven purely by such a process shift from up-valley to down-valley flow or conversely as weather-induced flow shifts across the axis of the Great Valley. Because the processes involved in pressure-driven flow primarily affect the horizontal motion of air, the presence of a temperature inversion significantly enhances flow. Weak vertical air motion and momentum associated with such inversions allow different layers of air to slide over each other (Monti et al. 2002). Forced channeling is the direct deflection of wind by terrain. This form of channeling necessitates some degree of vertical-motion transfer, implying that the mechanism is less pronounced during temperature-inversion conditions. Although forced channeling can result from interactions between large valleys and mountain ranges (such as the Great Valley and the surrounding mountains), the mechanism is especially important in small, narrow valleys such as those on the ORR (Kossmann and Sturman 2002). Large-scale forced channeling regularly occurs within the Great Valley when

northwest to north winds (i.e., perpendicular to the axis of the central Great Valley) coincide with vertically coupled flow. The phenomenon sometimes results in a split flow pattern (i.e., winds to the southwest of Knoxville moving down-valley and those to the east of Knoxville moving up-valley). The causes of such a flow pattern could include the shape characteristics of the Great Valley (Kossmann and Sturman 2002) but also might be related to the specific location of the Cumberland and Great Smoky Mountains relative to upper-level wind flow (Eckman 1998). The convex shape of the Great Valley with respect to a northwest wind flow can lead to a divergent wind-flow pattern in the Knoxville area, resulting in downward air motion. Additionally, horizontal flow is reduced by the windward mountain range (the Cumberland Mountains), which increases buoyancy and Coriolis effects (Froude and Rossby ratios in the meteorological field). Consequently, the leeward mountain range (the Great Smoky Mountains) becomes more effective at blocking or redirecting the winds.

Vertically coupled winds occur when the atmosphere is unstable, a state characterized by cooler temperatures aloft. When a strong horizontal wind component is also present (as in conditions behind a winter cold front), winds ignore the terrain, flowing over it in roughly in the same direction as the winds aloft. This phenomenon is a consequence of the horizontal transport and momentum aloft being transferred to the surface. However, Coriolis effects can turn the winds by up to 25° to the left (Birdwell 1996).

Thermally driven winds are common in areas of significantly complex terrain. These winds occur as a result of pressure and temperature differences caused by varied surface–air energy exchange at similar altitudes along a valley’s axis, sidewalls, and/or slopes. Thermal flows operate most effectively when synoptic winds are light and thermal differences are exacerbated by clear skies and low humidity (Whiteman 2000). The ridge-and-valley terrain can be responsible for enhancing or inhibiting such airflow, depending on the ambient weather conditions. Eckman (1998) suggested that the presence of daytime up-valley winds and nighttime down-valley (drainage) flows between the ridge-and-valley terrain of the Oak Ridge area tended to reverse at about 9:00 to 11:00 a.m. and at about 5:00 to 7:00 p.m. local time. The terrain-following nature of drainage winds suggests that they would be more directly impacted by the presence of the ridge-and-valley terrain than daytime flows, which tend to be accompanied by significant vertical motions.

2.3 PRECIPITATION

The 30-year annual average precipitation for 1976–2005 was 54 in. (137 cm), including about 11 in. (27.4 cm) of snowfall (NOAA 2006).

2.4 EVAPOTRANSPIRATION

Evapotranspiration is defined as the total amount of water that is transferred from the earth’s surface to the atmosphere from surface water and ice by evapotranspiration and from the transpiration of plants. (*Transpiration* refers to the process through which water vapor is released by plants to the atmosphere.) Regionally, annual evapotranspiration has been estimated to range from 32 to 35 in. (81 to 89 cm), or 60 to 65% of rainfall (Farnsworth, Thompson, and Peck 1982). More specifically, evapotranspiration in the Oak Ridge area has been estimated at 29 to 30 in. (74 to 76 cm), or 55 to 56% of annual precipitation (TVA 1972; Moore 1988; and Hatcher et al. 1989).

Evapotranspiration is greatest during the growing season, which in the vicinity of the ORR encompasses about 220 days, from late March through mid-October. During the growing season, evapotranspiration can exceed the rate of precipitation, resulting in soil-moisture deficits.

2.5 MIXING HEIGHTS

The mixing height (i.e., the atmospheric layer nearest the earth’s surface where active diffusion and mixing occur) varies significantly with respect to time of day, synoptic weather, season, and

proximity to terrain. The depth of the surface mixing layer is usually correlated to atmospheric stability, which is the tendency of the atmosphere to mix vertically. The local ridge-and-valley terrain primarily affects stability through the reduction of surface winds, which tends to allow for the development of very stable surface layers (i.e., strong temperature inversions) at night, particularly under clear skies and light background winds.

2.6 STABILITY

Stability describes the tendency of the atmosphere to mix or overturn. Consequently, dispersion parameters are influenced by the stability characteristics of the atmosphere. Stability classes range from “A” (very unstable) to “G” (very stable). The “D” stability class represents a neutral state. The local ridge-and-valley terrain plays a role in the development of stable surface air under certain conditions and influences the dynamics of airflow.

The suppression of vertical motions during stable conditions increases the frequency with which air motion is impacted by the local terrain. Conversely, stable conditions isolate wind flows within the ridge-and-valley terrain from the effects of more distant terrain features and from winds aloft. These effects are particularly true with respect to mountain waves. Deep stable layers of air tend to reduce the vertical space available for oscillating vertical air motions caused by local mountain ranges (Smith et al. 2002). This effect on mountain-wave formation could be important with regard the impact that the nearby Cumberland Mountains might have on local airflow.

A second factor that could decouple large-scale wind-flow effects from local ones (and thereby produce stable surface layers) occurs with overcast-sky conditions. Clouds overlying the Great Valley can warm as a result of direct insulation on the cloud tops. Warming can also occur within the clouds as latent energy is released because of the condensation of moisture. Surface air underlying the clouds can remain relatively cool (because it is cut off from direct exposure to the sun). Consequently, the vertical temperature gradient associated with the air mass can become more stable (Lewellen and Lewellen 2002). Long wave cooling of a fog deck has also been observed to help modify stability in the surface layer (Whiteman et al. 2001). Stable boundary layers typically form as a result of radiational cooling processes near the ground (Van de Weil et al. 2002); however, they are also influenced by the mechanical energy supplied by horizontal wind motion (which is in turn influenced by the large-scale weather-related pressure gradient). The ridge-and-valley terrain can have a significant ability to block such winds and their associated mechanical energy (Carlson and Stull 1986). Consequently, enhanced radiational cooling at the surface results because less wind energy is available to remove chilled air.

Stable boundary layers also exhibit intermittent turbulence that has been associated with a number of the above factors. The process results from give-and-take between the effects of friction and radiational cooling. As a stable surface layer intensifies through a radiation cooling process, it tends to decouple from air aloft, thereby reducing the effects of surface friction. The upper air layer responds with an acceleration in wind speed. Increased wind speed aloft results in an increase in mechanical turbulence and wind shear at the boundary with the stable surface layer. Eventually, the turbulence works into the surface layer and weakens it. As the inversion weakens, friction again increases, reducing winds aloft. The reduced wind speeds aloft allow enhanced radiation cooling at the surface, which re-intensifies the inversion and allows the process to start again. Van de Weil et al. (2002) have shown that cyclical temperature oscillations up to 39°F can result from these processes. Because these intermittent processes are primarily driven by large-scale horizontal wind flow and radiational cooling of the surface, the ridge-and-valley terrain significantly affects these oscillations.

3. REGIONAL AIR QUALITY

The Environmental Protection Agency (EPA) Office of Air Quality Planning and Standards has set National Ambient Air Quality Standards (NAAQS) for key principal pollutants, which are called criteria pollutants. These pollutants are sulfur dioxide (SO₂), carbon monoxide (CO), carbon dioxide (CO₂), nitrogen dioxide (NO₂), lead (Pb), ozone (O₃), particulate matter with aerodynamic diameter less than or equal to 2.5 μm (PM_{2.5}), and particles with an aerodynamic diameter less than or equal to 10 μm in diameter (PM₁₀). EPA evaluates NAAQS based on ambient (outdoor) levels of the criteria pollutants. Areas that satisfy NAAQS are classified as attainment areas, while areas that exceed NAAQS for a particular pollutant are classified as nonattainment areas for that pollutant.

The ORR is located in Anderson and Roane Counties in Air Quality Control Region 207 (East Tennessee–Southeastern Virginia). EPA has designated Anderson County as a basic nonattainment area for the 8-h O₃ standard, as part of the larger Knoxville 8-h basic O₃ nonattainment area that encompasses several counties, and for PM_{2.5}. For all other criteria pollutants for which EPA has made attainment designations, existing air quality in the greater Knoxville and Oak Ridge area is in attainment as defined by NAAQS.

4. TOPOGRAPHY AND GEOLOGY

The ORR is located in the Valley and Ridge Physiographic Province, which is characterized by a series of parallel narrow, elongated ridges and valleys that follow a northeast-to-southwest trend (Hatcher et al. 1992). The Valley and Ridge Physiographic Province has developed on thick, folded beds of sedimentary rock deposited during the Paleozoic era. The long axes of the folded beds control the shapes and orientations of a series of long, narrow parallel ridges and intervening valleys. These axes of the ridge-and-valley terrain within the ORR lie approximately along an east-northeast–west-southwest axis (60–240°). The differing degrees of resistance to erosion of the shales, sandstones, and carbonate rocks comprised in the lithology determine local relief.

The topography and slope of the ORR are shown in Fig. 4, bedrock geology is shown in Fig. 5, and watershed information is shown in Fig. 6. The elevation within the ORR ranges from a low of 750 ft (229 m) mean sea level (MSL) along the Clinch River to a high of 1260 ft (384 m) MSL along Pine Ridge. The topographic relief between valley floors and ridge crests is generally about 300 to 350 ft (91.5 to 107 m). Weathering and erosion processes, coupled with the generally southern-dipping attitude of bedrock underlying the area, result in rather steep (commonly steeper than 45°) northwest-facing slopes, while southeast-facing slopes are commonly gentler (Fig. 4). Terrain at the ORR is hilly, with slopes that average about 7.5% and that range from less than 3% to more than 50%.

The bedrock on the ORR ranges in age from 350 to 550 million years old (Fig. 5). The valleys are typically underlain by bedrock formations predominated by siltstones and limestones, including the Conasauga Group and the Chickamauga Group. The Conasauga Group consists primarily of shale interbedded with shaley to silty limestone. The Chickamauga Group consists primarily of limestone, with layers of siltstone. Ridges are underlain by two different types of erosion-resistant bedrock: (1) formations predominated by sandstones, siliceous shales, and siltstones (Rome Formation and Post-Chickamauga rocks) and (2) siliceous dolostones of the Knox Group (Hatcher et al. 1992). The Rome Formation and Post-Chickamauga rocks are typified by steep slopes and shallow depths to bedrock. The Knox Group consists of silica-rich carbonate rocks that can deeply weather to form a thick mantle of silty clay soils rich in chert.

The Rome Formation and the Conasauga, Chickamauga, and Post-Chickamauga Groups generally have limited capacity to transmit or store groundwater (aquitards). The Knox Group and the adjacent Maynardville Limestone in the Conasauga Group are the principal groundwater-bearing rock units (aquifers) on the ORR. A combination of fractures and solution conduits in this aquifer control

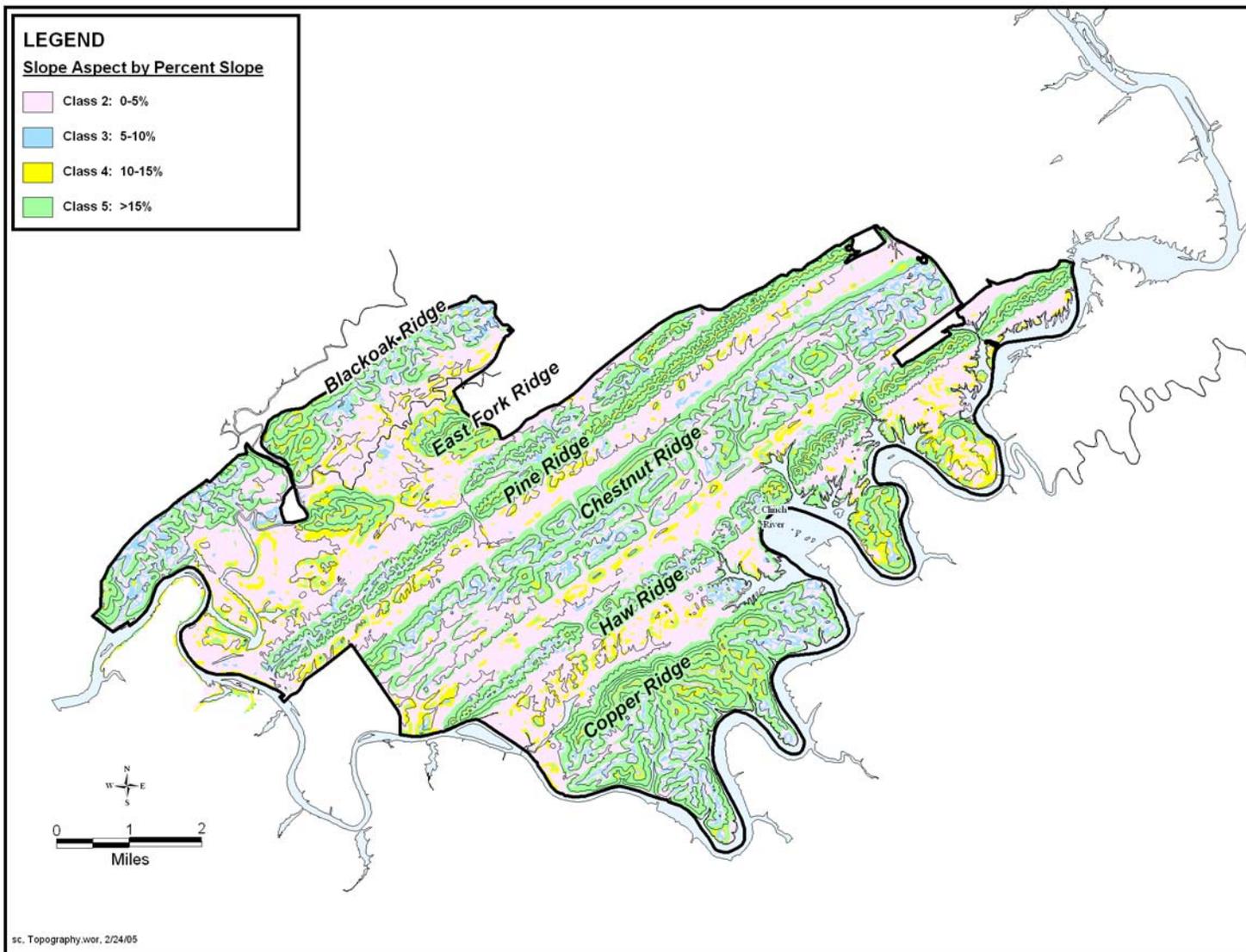


Fig. 4. ORR topography with slope.

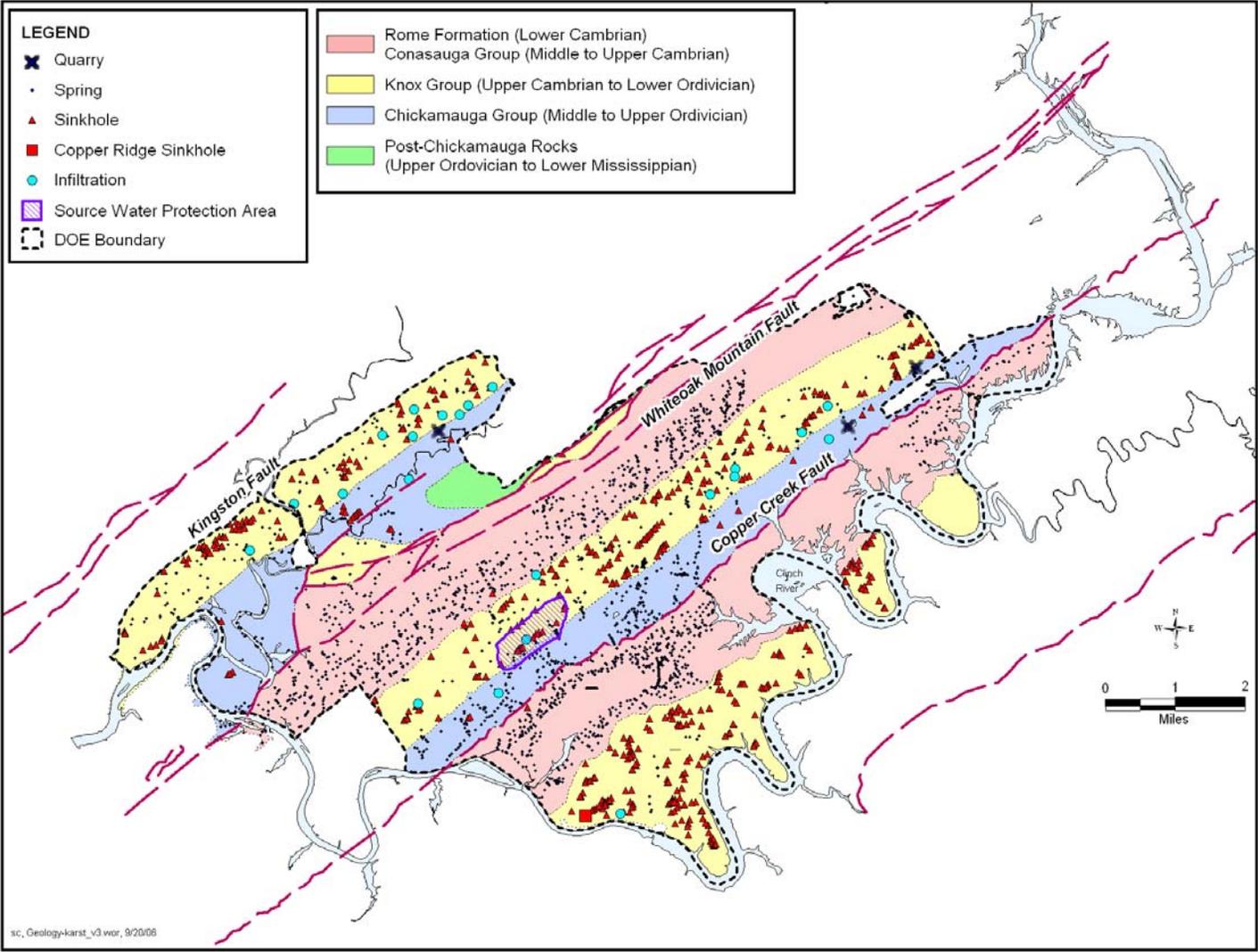


Fig. 5. ORR geology with karst features.

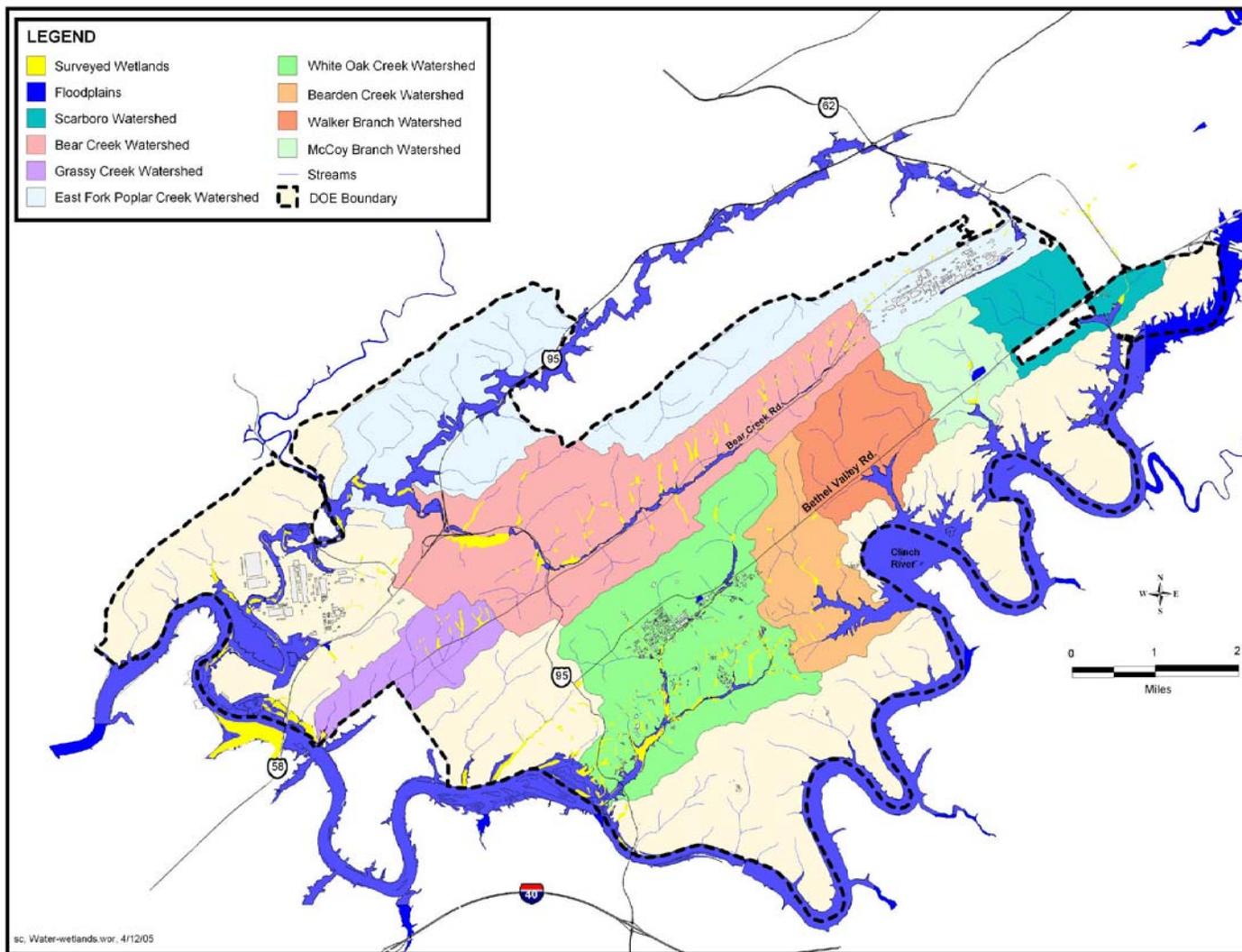


Fig. 6. Water, wetlands, floodplains, and watersheds on the ORR.

flow over substantial areas, and large quantities of water can move long distances. Active groundwater flow can occur at substantial depths in the Knox Aquifer (300 to 400 ft [91.5 to 122 m] deep). The Knox Aquifer is the primary source of groundwater to many streams (i.e., base flow), and most large springs on the ORR receive discharge from the Knox Aquifer.

The remaining geologic units on the ORR (the Rome Formation, the Conasauga Group [below the Maynardville Limestone], and the Chickamauga Group) constitute the ORR Aquitards, which consist mainly of siltstone, shale, sandstone, and thinly bedded limestone of low to very low permeability. Nearly all groundwater flow in the ORR Aquitards occurs through fractures. The typical yield of a well in the ORR Aquitards is less than 1 gal/min (3.8 L/min), and the base flows of streams draining areas underlain by the ORR Aquitards are poorly sustained because of such low flow rates.

While topography and underlying geology typically control surface water and groundwater flow, widespread fracturing and faulting can also impact flow. In addition, carbonate rock units display dissolutional features and landforms, collectively referred to as *karst*. Karst features observed on the ORR range from minor solutional enlargement of fractures, to larger conduit flow paths, to enterable caves (Fig. 5). All three ORR facilities are situated on carbonate bedrock to some extent, so groundwater flow and contaminant transport are at least partially controlled by solution conduits.

Karst appears to be most developed in association with the Knox Group and adjacent Maynardville Limestone carbonate units. The highest density of sinkholes occurs in the Knox Group, and drilling data suggest that the largest solution cavities are associated with these formations. Large karst-related springs typically occur along the base of the ridges underlain by the Knox Group and Maynardville Limestone. Property damage in recent years to residential homes on neighboring properties as a result of settlement has highlighted the potential for collapse in areas underlain by cavernous limestone. Because karst features are best developed in the Knox Group carbonates, the potential for collapse is greatest in areas underlain by this formation.

5. SURFACE WATER

Waters drained from the ORR eventually reach the Tennessee River via the Clinch River, which forms the southern and western boundaries of the ORR. The ORR lies within the Valley and Ridge Physiographic Province, which is composed of a series of drainage basins or troughs containing many small streams feeding the Clinch River. Surface-water hydrology on the ORR is characterized by a network of small streams that are tributaries of the Clinch River (Fig. 6). Surface water at each of the major facilities of the ORR drains into a tributary or series of tributaries, streams, or creeks within different watersheds. Each of these watersheds drains into the Clinch River, affecting different sub-basins (Fig. 6). The largest of the drainage basins is that of Poplar Creek, which receives drainage from a 136 mile² (352-km²) area, including the northwestern sector of the ORR. It flows from northeast to southwest, approximately through the center of ETTP, and discharges directly into the Clinch River.

East Fork Poplar Creek, which discharges into Poplar Creek east of ETTP, originates within the Y-12 Complex near the former S-3 Ponds and flows northeast along the south side of the Y-12 Complex. Various Y-12 Complex wastewater discharges to the upper reaches of East Fork Poplar Creek from the late 1940s to the early 1980s left a legacy of contamination (e.g., mercury, polychlorinated biphenyls, uranium) that has been the subject of water-quality improvement initiatives over the past 12 to 15 years. Bear Creek also originates within the Y-12 Complex, with its headwaters near the former S-3 Ponds where the creek flows southwest. Bear Creek is mostly affected by stormwater runoff, groundwater infiltration, and tributaries that drain former waste disposal sites in the Bear Creek Valley Burial Grounds Waste Management Area and the current Environmental Management Waste Management Facility.

Both the Bethel Valley and Melton Valley portions of ORNL are in the White Oak Creek drainage basin, which has an area of 6.4 mile² (16.5 km²). White Oak Creek headwaters originate on

Chestnut Ridge, north of ORNL, near the Spallation Neutron Source site. At the ORNL site, the creek flows east along the southern boundary of the developed area and then southwesterly through a gap in Haw Ridge to the western portion of Melton Valley, where it forms a confluence with Melton Branch. The waters of White Oak Creek enter White Oak Lake, which is an impoundment formed by White Oak Dam. Water flowing over White Oak Dam enters the Clinch River after passing through the White Oak Creek embayment area.

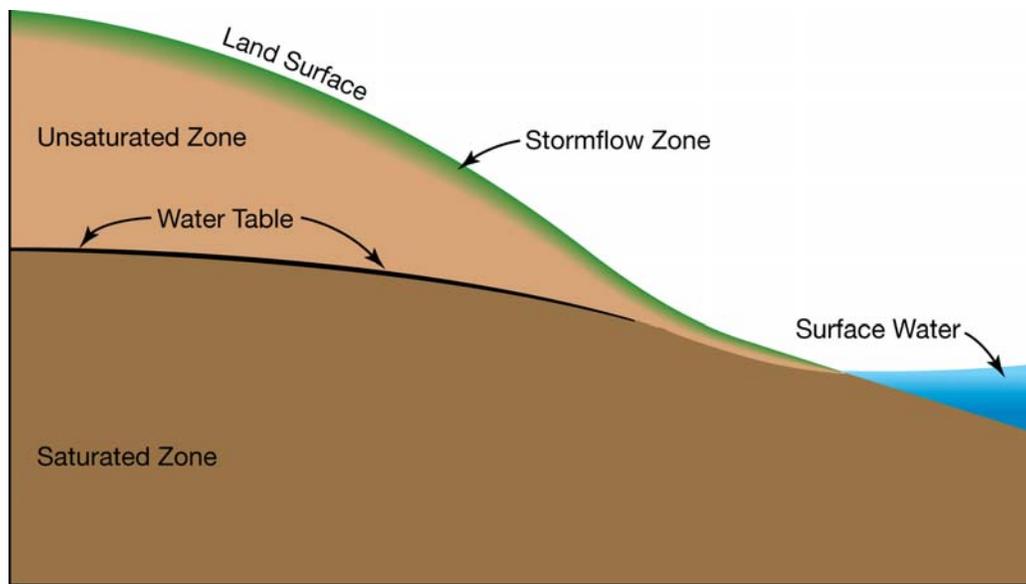
Water levels in the Clinch River are regulated by the Tennessee Valley Authority (TVA), and fluctuations in the river can have an effect on streams draining the ORR. Most of the ORR is located above the probable maximum flood elevation along the Clinch River.

6. SUBSURFACE HYDROLOGY

6.1 GROUNDWATER HYDROLOGY

A portion of the rainwater that falls on the land surface accumulates as groundwater by infiltrating into the subsurface. The accumulation of groundwater in pore spaces of sediments and bedrock creates sources of usable water; the water flows in response to external forces. Groundwater eventually reappears at the surface in springs, swamps, stream and river beds, and pumped wells. Thus, groundwater is a reservoir for which the primary input is recharge from infiltrating rainwater, and the output is discharged to springs, swamps, rivers, streams, and wells.

Groundwater on the ORR occurs both in the unsaturated zone as transient, shallow subsurface storm flow and within the deeper saturated zone. An unsaturated zone of variable thickness separates the storm-flow zone and water table. Adjacent to surface water features or in valley floors, the water table is found at shallow depths, and the unsaturated zone is thin. Along the ridge tops or near other high topographic areas, the unsaturated zone is thick, and the water table often lies at considerable depth (49 to 164 ft [15 to 50 m] deep). In low-lying areas in which the water table occurs near the surface, the storm-flow and saturated zones are indistinguishable. Figure 7 is a generalized schematic showing the relationship between the streamflow zone, water table, and unsaturated (vadose) and saturated (phreatic) zones.



ORNL 06-G01442/lmh

Fig. 7. Relationship between stormflow zone, water table, and unsaturated and saturated zones.

Two broad hydrologic units have been identified on the ORR: (1) the Knox Aquifer, which includes the Maynardville Limestone and is highly permeable, and (2) the ORR Aquitards, which consist of less permeable geologic units. The geologic regime referred to as the ORR Aquitards comprises bedrock and residuum of the Cambrian-age Rome Formation and Conasauga Group (excluding the Maynardville Limestone) and the Chickamauga Group. Bedrock included in these formations is predominantly clastic sediment (shales, siltstones, well-cemented sandstones, and clayey to silty limestones). The ORR Aquitards include local zones in which groundwater occurs in quantities sufficient to provide a potential resource of limited use. These zones typically occur within karstic carbonate members of the clastic bedrock formations. Although marginal localized groundwater resources occur within the ORR Aquitards, these formations are far less important to regional water resources—including being a source of potable water for private and public water supply and a source of baseflow to regional surface water bodies—than is the Knox Aquifer.

Portions of the ORR underlain by carbonate bedrock commonly exhibit karst geomorphic features. About 60% of the ORR is underlain by carbonate-dominated bedrock. Karst geomorphic features form in carbonate-rich bedrock and are evident as sinkholes, solution caverns, and sinking creeks. In addition to creation of subsurface voids in bedrock, the weathering process leaves behind the insoluble mineral components of the rock that combine with organic residues of decaying plant materials to form a soil mantle over most of the ORR. The soil mantle forms a physical and geochemical filter that reduces the direct infiltration of rainfall and contaminants into the groundwater system. Geochemical retardation of contaminants in the soil mantle reduces the mobility of many types of contaminants. Groundwater flow in most of the carbonates is quite different from flow in porous media, in which advective flow conditions largely govern flow and solute transport. Groundwater flow in karst terranes manifests itself in multiple scales of porosity, such as diffusion in intergranular pores of weathered or inherently porous bedrock, flow by seepage in rock fractures with water and rock matrix interaction on fracture surfaces, or flow in conduits in which rapid velocities limit the interaction between the water and bedrock. Groundwater discharge from springs and seeps is abundant on the ORR and accounts for the normal baseflow of natural stream systems in the area. Most recharge to the groundwater system occurs through dispersed percolation of rainwater through the soil mantle and through capture in surface dolines (i.e., sinkholes) during the winter and early spring months, when evapotranspiration losses of soil moisture are negligible. Groundwater storage in thick soil profiles and in the weathered bedrock zone of the Knox Group outcrop areas such as Blackoak, Chestnut, and Copper Ridges provides most of the dry-season baseflow and feeds the area's largest springs. Most groundwater flow in the carbonate bedrock groundwater basins on the ORR originates as intergranular or fracture seepage through the soil mantle, and flow progresses through coalescing networks of conduits that culminate at spring discharges. Baseflow springs often occur near major geologic outcrop boundaries, where semiconfining bedrock lithologies tend to limit the orientation of conduit development and promote upward flow of groundwater to discharge at the land surface. In portions of the ORR underlain by shale-rich bedrock, such as the Conasauga Group bedrock of Bear Creek Valley and Melton Valley, groundwater seepage is typically through fractures in weathered bedrock with discharge to nearby streams. Discrete baseflow springs are not common in the shale-dominated outcrop areas; however, small seeps are abundant.

6.2 UNSATURATED ZONE HYDROLOGY

Because ORR landforms consist almost entirely of sloping land surfaces, the concepts of hillslope hydrology may be used to describe the active hydrologic process. Based on soil percolation capacity and soil structure, as well as direct measurement of water transmission in soil test areas, it is estimated that in undisturbed, naturally vegetated areas on the ORR, about 90% of the infiltrating precipitation does not reach the water table but travels through the 3- to 6.5-ft (1- to 2-m) storm-flow zone, which approximately corresponds to the root zone. This condition exists because of the permeability contrast between the shallow storm-flow zone and the underlying unsaturated zone.

Recharge of the groundwater system is strongly seasonal at the ORR, and percolation processes in the shallow soil are moderated by the amount of soil moisture present. During the active growing season (April through October) evapotranspiration by plants removes moisture from the soil within the root zone. When soil moisture levels are low, any percolating rainwater is absorbed in the root zone to replenish the soil moisture deficit. During that phase little or no water reaches the water table.

When rainfall amounts exceed any existing soil moisture deficits and saturation of the shallow soils begins to occur, seepage of water begins. When saturation of the shallow soils occurs on sloping land, the downslope gradient allows lateral drainage of water through macropores (e.g., holes left by decay of dead plant roots, animal burrows) as well as vertical seepage to the water table through pervious zones. During the nongrowing season (November through March), there is little evapotranspiration to remove water from the root zone, and saturation of the shallow soils occurs more rapidly than during the summer months. Typical evapotranspiration losses from the root zone range from a low of about 0.01 in./d (0.025 cm/d) rainfall equivalent during January and February to a high of about 0.16 in./d (0.41 cm/d) rainfall equivalent during July. Thus, development of a 1-in. (2.5-cm) water deficit would require only 1 week without rainfall during July but more than 2 months without rainfall during the winter.

The amount of water that actually recharges the groundwater zone is highly variable across the ORR, depending on the shallow soil characteristics, permeability and degree of fracturing of regolith (rocky, weathered in place) beneath the surface soils, presence of dolines that capture storm flow and focus recharge in small areas, and presence of paved or covered areas in which little or no rainfall infiltration occurs. Higher recharge is expected in areas of karst hydrogeology such as the Knox Aquifer because of internal drainage through dolines than in areas underlain by the clastic bedrock formations.

6.3 SATURATED ZONE HYDROLOGY

The saturated zone on the ORR can be conceptually divided into four flow zones in a vertical cross section: (1) an uppermost water-table interval, (2) an intermediate interval, (3) a deep interval, and (4) an aquiclude (i.e., a zone of extremely low permeability). The presence and thickness of any zone can vary across the ORR. Available evidence indicates that most water in the saturated zone (i.e., the water table to the intermediate interface) in the ORR Aquitards is transmitted through a 3- to 20-ft (1- to 6-m) layer of closely spaced, well-connected fractures. The water table is a surface that defines the upper limit of saturation.

As in the storm-flow zone, the bulk of groundwater in the saturated zone resides within the pore spaces of the rock matrix. The rock matrix typically forms blocks that are bounded by fractures. Contaminants migrating from sources by way of the fractures typically occur in higher concentrations than in the matrix; thus, the contaminants tend to move (diffuse) into the matrix. This process, termed *diffusive exchange* or *matrix diffusion*, between water in matrix pores and water in adjacent fractures reduces the overall contaminant migration rates relative to groundwater-flow velocities. For example, the leading edge of a geochemically nonreactive contaminant mass such as tritium might migrate along fractures at a typical rate of 3 ft/d (1 m/d); however, the center of mass of a contaminant plume typically migrates at a rate less than 2 ft/d (0.66 m/d).

In the ORR Aquitards, chemical characteristics of groundwater change from a mixed-cation- HCO_3 water type at shallow depth to an Na- HCO_3 water type at deeper levels (100 ft [30.5 m]). This transition, not marked by a distinct change in rock properties, serves as a useful marker and can be used to distinguish the more active water table and intermediate groundwater intervals from the sluggish flow of the deep interval. There is no evidence of similar change with depth in the chemical characteristics of water in the Knox Aquifer; virtually all wells are within the monitoring regime of Ca-Mg- HCO_3 -type water. Although the mechanism responsible for this change in water types is poorly understood, it most likely is related to the amount of time the water is in contact with a specific type of rock.

Most groundwater flow in the saturated zone occurs within the water-table interval. Most flow is through weathered, permeable fractures and matrix rock and within solution conduits in the Knox Aquifer. The range of seasonal fluctuations of water-table depth and rates of groundwater flow vary significantly across the reservation. In areas underlain by the Knox Aquifer, seasonal fluctuations in water levels average 17 ft (5.3 m), and mean discharge from the active groundwater zone is typically 85 gal/min (322 L/min) per 1 mile² (2.6 km²). In the ORR Aquitards of Bear Creek Valley, Melton Valley, East Fork Valley, and Bethel Valley, seasonal fluctuations in water levels average 5 ft (1.5 m), and typical mean discharge is 26 gal/min (98 L/min) per 1 mile² (2.6 km²).

In the intermediate interval, groundwater flow paths are products of fracture density and orientation. Groundwater movement primarily occurs in fractures that are poorly connected. In the Knox Aquifer, a few cavity systems and fractures control groundwater movement in this zone, but in the ORR Aquitards, the bulk of flow is through fractures, along which permeability can be increased by weathering.

The deep interval of the saturated zone is delineated by a change to an Na-Cl water type. Hydrologically active fractures in the deep interval are significantly fewer and shorter than in the other intervals, and the spacing is greater. Wells in the deep interval of the ORR Aquitards typically yield less than 0.3 gal/min (1.1 L/min.) and thus are barely adequate for water supply.

In the ORR Aquitards, saline water characterized by total dissolved solids ranging up to 275,000 parts per million (275,000 mg/L) and chlorides generally in excess of 50,000 ppm (50,000 mg/L) (ranging up to 163,000 ppm [163,000 mg/L]) lies beneath the deep interval of the groundwater zone, delineating an aquiclude. Chemically, this water resembles brines typical of major sedimentary basins, which originated from evaporating water bodies. The brines are thought to have been pushed westward and trapped by overthrusting rock during the formation of the Appalachian Mountains (about 250 million years ago). The chemistry suggests extremely long residence times (i.e., very low flow rates); however, some mixing with shallow groundwater has been observed (Nativ, Halleran, and Hunley 1997).

The aquiclude has been encountered at depths of 400 and 800 ft (122 and 244 m) in Melton and Bethel Valleys, respectively, (near ORNL), and it is believed to approach 1000 ft (305 m) in portions of Bear Creek Valley (near the Y-12 Complex) underlain by aquitard formations. The depth to the aquiclude in areas of the Knox Aquifer is not known but is believed to be greater than 1200 ft (366 m). The depth to the aquiclude has not been established in the vicinity of ETTP.

6.4 GROUNDWATER FLOW

Many factors influence groundwater flow on the ORR. Topography, surface cover, geologic structure, karst features, and rock type exhibit especially strong influences on the hydrogeology. Variations in these features result in variations in the total amount of groundwater moving through the system (flux). As an example, the overall decrease in open fracture density with depth results in a decreased groundwater flux with depth.

Topographic relief on the ORR is such that most active subsurface groundwater flow occurs at shallow depths. U.S. Geological Survey modeling (Tucci 1992) has suggested that 95% of all groundwater flow occurs in the upper 49 to 98 ft (15 to 30 m) of the saturated zone in the ORR Aquitards. As a result, flow paths in the active-flow zones (particularly in the aquitards) are relatively short, and nearly all groundwater discharges to local surface water drainages on the ORR. Conversely, in the Knox Aquifer it is believed that solution conduit flow paths could be considerably longer, perhaps as much as 1 mile (1.6 km) long in the along-strike direction. No evidence at this time substantiates the existence of any deep, regional flow off the ORR or between basins within the ORR in either the Knox Aquifer or the ORR Aquitards. Data collected in 1994 and 1995, however, have demonstrated that groundwater flow occurs off the ORR in the intermediate interval of the Knox Aquifer, near the east end of the Y-12 Complex.

7. CAVES, OPEN SINKHOLES, AND QUARRIES

In addition to providing important habitat for some plants and animals, including sensitive species, the caves, sinkholes, and quarries on the ORR are often attractive to people, yet can be hazardous. The numerous caves on the reservation are not open to the public; access is restricted to research and monitoring uses. A large, open sinkhole is located near the Highway 95 entrance to the Tower Shielding Facility, in an area maintained by periodic mowing. The sinkhole is fenced, and access is restricted. The area is not open to the public. The three inactive quarries (Lambert, Kerr Hollow, and Rogers) are all in restricted areas and not open to the public.

8. VEGETATION AND WILDLIFE

Most of the ORR is relatively pristine when compared with the surrounding region, especially in the Valley and Ridge Physiographic Province (Mann et al. 1996). Viewed from the air, the ORR is clearly a large and nearly continuous island of forest within a landscape fragmented by urban development and agriculture. Many ecological communities (e.g., cedar barrens, river bluffs, and wetlands) with unique biota, often including rare species, are known to exist within the larger framework of mixed hardwood and pine forest on the ORR (Pounds, Parr, and Ryon 1993).

The ORR is mostly contiguous native eastern deciduous forest. Prior to their government acquisition as a security buffer for military activities, the approximately 1000 individual farmsteads in the area now included in the ORR consisted of forest, woodlots, open grazed woodlands, and fields. Results of remote-sensing analyses show that in 1994 about 70% of the ORR was in forest cover and about 20% was transitional, consisting of old fields, agricultural areas, cutover forestlands, roadsides, and utility corridors (Washington-Allen et al. 1995). Forested areas (hardwood and pine, with many areas in blocks greater than 100 acres [40 ha]) are found throughout the reservation. Less than 2% of the reservation remains as open agricultural fields (Mann et al. 1996). Pine-beetle outbreaks during 1993 to 1994 and 1999 to 2000 impacted more than half the approximately 9500 acres (3840 ha) of planted and natural ORR pine stands. These areas have now naturally regenerated (only a few were replanted) as pine or hardwood stands. ORR forests are mostly oak-hickory, pine-hardwood, or pine. Minor areas of other hardwood-forest cover types are found throughout the ORR, including northern hardwoods, a few small natural stands of hemlock or white pine, and floodplain forests. Figure 8 shows ORR forests by forest groupings based on forestry compartment maps from the 1980s.

Over 1100 vascular plant species are found on the ORR (compared to the approximately 1650 species of the Great Smoky Mountains National Park, the most biologically diverse with respect to vascular plants of all the national parks in the contiguous United States). A list of vascular plants found on the ORR is found in Table A in Appendix A. This list, with additional detail, is also available at www.esd.ornl.gov/facilities/nerp. Twenty-one plants listed by the state as rare (endangered, threatened, or special concern) are found on the ORR (Awl et al. 1996; DOE 2005). The population of tall larkspur on the ORR is one of the largest populations known to occur anywhere in the world. The species is listed as globally rare by the Nature Conservancy and endangered by the state of Tennessee (Table 1).

This large, relatively unfragmented area of mature eastern deciduous hardwood forest provides habitat for numerous wildlife species. Such blocks of forested area are increasingly uncommon in the Valley and Ridge Physiographic Province and nationwide. In addition to the forested habitats and pine plantations, the ORR contains seminatural grasslands (e.g., hay) and forest edge (e.g., transmission line corridors through forest) that provide the diversity of habitats suitable for a great variety of wildlife. Other wildlife habitats on the ORR include old-field successional areas; unique or important vegetational communities such as cedar barrens and old-growth forests; seminatural



Fig. 8. ORR forests by forest groupings.

Table 1. Vascular plant species on the ORR listed by state or federal agencies in 2006

Species	Common name	Habitat on the ORR	Status code ^a
Currently known or previously reported from the ORR			
<i>Aureolaria patula</i>	Spreading false-foxglove	River bluff	FSC, T
<i>Carex gravida</i>	Heavy sedge	Varied	S
<i>Carex oxylepis</i> var. <i>pubescens</i> ^b	Hairy sharp-scaled sedge	Shaded wetlands	S
<i>Cimicifuga rubifolia</i>	Appalachian bugbane	River slope	FSC, T
<i>Cypripedium acaule</i>	Pink lady's-slipper	Dry to rich woods	E, CE
<i>Delphinium exaltatum</i>	Tall larkspur	Barrens and woods	FSC, E
<i>Diervilla lonicera</i>	Northern bush-honeysuckle	River bluff	T
<i>Draba ramosissima</i>	Branching whitlow-grass	Limestone cliff	S
<i>Elodea nuttallii</i>	Nuttall waterweed	Pond, embayment	S
<i>Fothergilla major</i>	Mountain witch-alder	Woods	T
<i>Hydrastis canadensis</i>	Golden seal	Rich woods	S, CE
<i>Juglans cinerea</i>	Butternut	Slope near stream	FSC, T
<i>Juncus brachycephalus</i>	Small-head rush	Open wetland	S
<i>Lilium canadense</i>	Canada lily	Moist woods	T
<i>Lilium michiganense</i> ^c	Michigan lily	Moist woods	T
<i>Liparis loeselii</i>	Fen orchid	Forested wetland	E
<i>Panax quinquefolius</i>	Ginseng	Rich woods	S, CE
<i>Platanthera flava</i> var. <i>herbiola</i>	Tuberculed rein-orchid	Forested wetland	T
<i>Populus grandidentata</i> ^d	Large-tooth aspen	Dry, woodlands	S
<i>Ruellia purshiana</i>	Pursh's wild-petunia	Dry, open woods	S
<i>Scirpus fluviatilis</i>	River bulrush	Wetland	S
<i>Spiranthes lucida</i>	Shining ladies-tresses	Boggy wetland	T
<i>Thuja occidentalis</i>	Northern white cedar	Rocky river bluffs	S
<i>Viola tripartita</i> var. <i>tripartita</i>	Three-parted violet	Rocky woods	S
Rare plants that occur near and could be present on the ORR			
<i>Agalinis auriculata</i>	Earleaf false foxglove	Calcareous barren	FSC, E
<i>Allium burdickii</i> or <i>A. tricoccom</i> ^e	Ramps	Moist woods	S, CE
<i>Berberis canadensis</i>	American barberry	Rocky bluff, creek bank	S
<i>Gnaphalium helleri</i>	Catfoot	Dry woodland edge	S
<i>Lathyrus palustris</i>	A vetch	Moist meadows	S
<i>Liatris cylindracea</i>	Slender blazing star	Calcareous barren	E
<i>Lonicera dioica</i>	Mountain honeysuckle	Rocky river bluff	S
<i>Meehania cordata</i>	Heartleaf meehania	Moist calcareous woods	T
<i>Pedicularis lanceolata</i>	Swamp lousewort	Calcareous wet meadow	T
<i>Pycnanthemum torrei</i>	Torrey's mountain-mint	Calcareous barren edge	S
<i>Solidago ptarmicoides</i>	Prairie goldenrod	Calcareous barren	E

^aStatus codes:

- CE Status due to commercial exploitation.
- E Endangered in Tennessee.
- FSC Federal special concern; formerly designated as C2. See *Federal Register*, February 28, 1996.
- S Special concern in Tennessee.
- T Threatened in Tennessee.

^b*Carex oxylepis* var. *pubescens* has not been observed during recent surveys.

^c*Lilium michiganense* is believed to have been extirpated from the ORR by the impoundment at Melton Hill.

^d*Populus grandidentata* was reported in two ORR locations in 2003. One of the reports was confirmed, but the tree died during the year. In 2004 additional trees were found in the vicinity of the dead tree.

^eRamps have been reported near the ORR, but there is not sufficient information to determine which of the two species is present or if the occurrence might have been introduced by planting. Both species of ramps have the same state status.

corridors; planted hardwoods and pines; bottomlands and wetlands, including an increasing number of beaver ponds; caves; and developed and semideveloped areas and roads.

The resulting diversity of wildlife species ranges from common species found in urban and suburban areas of eastern Tennessee to species with more restrictive requirements, such as interior forest bird species. The ORR hosts more than 70 species of fish; about 45 species of reptiles and amphibians; more than 200 species of migratory, transient, and resident birds; and more than 30 species of mammals, as well as innumerable invertebrate species. Tables B.1, B.2, and B.3 list the fish; reptiles, amphibians, and mammals; and birds found on the ORR. Among these, 17 species of federally or state-listed (endangered, threatened, or in need of management) vertebrate species have been confirmed in recent surveys (Mitchell et al. 1996). Furthermore, appropriate habitat for approximately 20 additional species has been identified. In addition, 13 of the recorded bird species are listed by Partners in Flight as species of concern. Monitoring by Partners in Flight has also determined that 11 of the 16 species that are of top conservation priority in the region are present on the reservation during the breeding season. Table 2 lists the animals of special concern on the ORR. Updated information on ORR wildlife is maintained online at the Research Park's Web site, www.esd.ornl.gov/facilities/nerp.

The Tennessee dace (listed by the state as in need of management) is found in numerous streams and tributaries on the reservation, in contrast to declining or absent populations in streams outside the ORR.

Listed rare species (plants and wildlife) occur across the ORR in more than 50 different locations, which are protected as Research Park Natural Areas. As a result of urbanization, many of these Research Park Natural Areas contain plants or animals now absent from or uncommon in areas surrounding the ORR.

9. INTERIOR FOREST RESOURCES

The ORR's extensive forest area, amounting to approximately 24,000 acres (9,712 ha), is valuable not only for its size, but also because of its many patches of forest larger than 50 contiguous acres (20 ha) (Fig. 9). Contiguous forest provides habitat for several plant and animal species not associated with smaller patches of forest. This is especially true for certain increasingly rare bird species. Deep forest habitat is located away from large openings and typically has more than 70% canopy cover. A minimum of 50 contiguous acres (20 ha) of forest habitat can be used as a benchmark as the required acreage for the presence of many deep forest wildlife species.

As human populations continue to increase and expand, large tracts of contiguous forest are becoming smaller and are broken into a greater number of pieces. Forest area is lost to clearing of land for industry, agriculture, and residential development, and the remaining forest is further fragmented by associated roads and utility corridors. Fragmentation creates an "edge effect" that alters habitat conditions such as moisture regime, microclimate, and light penetration and can result in the introduction and spread of predators harmful to forest-dependent species. Nesting forest birds increasingly fall prey to predators associated with edge habitat such as feral cats, raccoons, and certain snake species. The creation of cleared areas throughout forests also opens the area to the brown-headed cowbird, a common nest parasite that uses edge habitat and parasitizes nests of forest birds. Cowbirds fly in from the edges to lay their eggs in the nests of forest birds, where the larger more aggressive cowbird young out-compete the fledglings of the forest-bird species. As more edges are created through the forest, cowbird penetration and associated nest predation on forest species such as wood thrush increase.

Table 2. Animal species of concern reported on the ORR^{a, b}

Scientific name	Common name	Status ^c		
		Federal	State	PIF ^d
Fish				
<i>Phoxinus tennesseensis</i>	Tennessee dace		NM	
Amphibians and reptiles				
<i>Hemidactylium scutatum</i>	Four-toed salamander		NM	
Birds				
<i>Accipiter striatus</i>	Sharp-shinned hawk		NM	
<i>Anhinga anhinga</i>	Anhinga		NM	
<i>Caprimulgus carolinensis</i>	Chuck-will's widow			C
<i>Ardea alba</i>	Great egret		NM	
<i>Circus cyaneus</i>	Northern harrier		NM	
<i>Contopus cooperi</i>	Olive-sided flycatcher		NM	
<i>Dendroica caerulescens</i>	Black-throated blue warbler			C
<i>Dendroica cerulea</i>	Cerulean warbler		NM	C
<i>Dendroica discolor</i>	Prairie warbler			C
<i>Egretta caerulea</i>	Little blue heron		NM	
<i>Egretta thula</i>	Snowy egret		NM	
<i>Falco peregrinus</i>	Peregrine falcon	^e	E	
<i>Haliaeetus leucocephalus</i>	Bald eagle	^f	NM	
<i>Helmitheros vermivorus</i>	Worm-eating warbler			C
<i>Hylocichla mustelina</i>	Wood thrush			C
<i>Lanius ludovicianus</i>	Loggerhead shrike		NM	
<i>Oporornis formosus</i>	Kentucky warbler			C
<i>Poocetes gramineus</i>	Vesper sparrow		NM	
<i>Protonotaria citrea</i>	Prothonotary warbler			C
<i>Seiurus motacilla</i>	Louisiana waterthrush			C
<i>Sitta pusilla</i>	Brown-headed nuthatch			C
<i>Sphyrapicus varius</i>	Yellow-bellied sapsucker		NM	
<i>Spizella pusilla</i>	Field sparrow			C
<i>Tyto alba</i>	Barn owl		NM	
<i>Vermivora chrysoptera</i>	Golden-winged warbler		NM	C
<i>Vermivora pinus</i>	Blue-winged warbler			C
Mammals				
<i>Myotis grisescens</i>	Gray bat	E	E	
<i>Sorex longirostris</i>	Southeastern shrew		NM	

^aThis list identifies sensitive wildlife species recently found on the ORR. Some of these (e.g., anhinga) have been seen only once or a few times; others (e.g., sharp-shinned hawk, southeastern shrew) are comparatively common and widespread on the reservation (updated December 2005).

^bLand and surface waters of the ORR exclusive of the Clinch River, which borders the ORR.

^cC = birds of concern, E = endangered, NM = in need of management, T = threatened.

^dPartners in Flight.

^eThe peregrine falcon was federally delisted on August 25, 1999.

^fThe bald eagle was proposed for federal delisting on July 6, 1999.

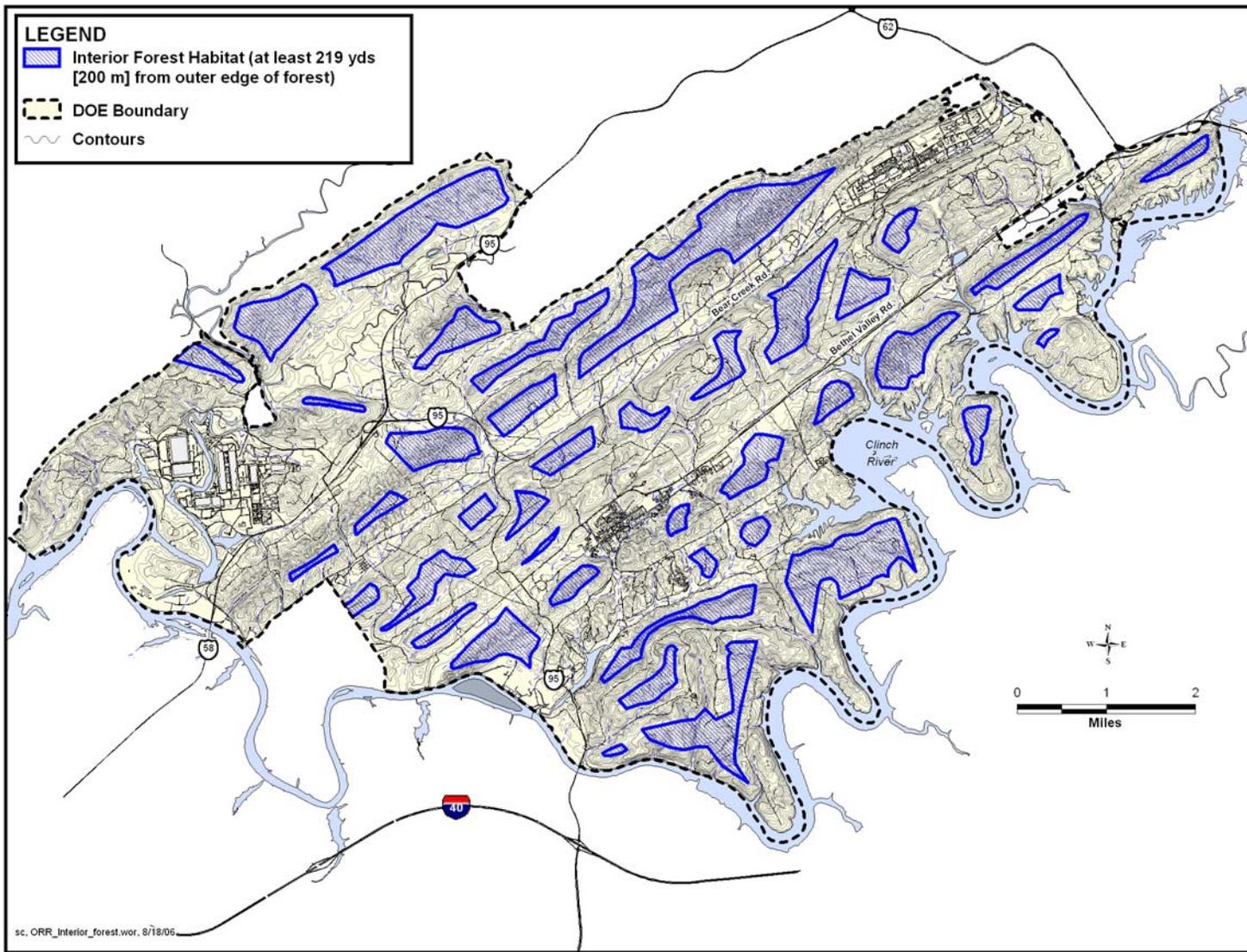


Fig. 9. Interior forest habitat on the ORR.

Studies conducted by wildlife biologist Stanley Temple indicate that the edge effect extends into a forest as much as 219 yd (200 m) (Temple and Cary 1988). Thus, researchers have used this distance as a criterion for identifying “interior” forest areas that would remain unaffected by forest fragmentation. When the 219-yd (200-m) buffer area is taken into consideration, the true nonimpacted interior forest could be eliminated or reduced to very small and/or narrow areas when encroached upon by surrounding roads, power-line corridors, and other openings. The ORR currently supports about 4100 acres (1659 ha) of interior forest. This acreage will decrease in certain areas of the reservation with additional clearing for new buildings and new roads and as a result of further road-widening projects.

An important barometer in the determination of forest habitat quality is the presence of certain neo-tropical migrant bird species. These species are impacted by decreases in acreage and the fragmentation of forest habitats. Fortunately, the ORR continues to support many such species, including the Acadian flycatcher, ovenbird, hooded warbler, northern parula, Kentucky warbler, and Louisiana water thrush.

Continued fragmentation of forest habitat on the ORR will result in the loss of species such as those noted above. Exercising care concerning road placement, minimizing road widenings, and allowing the forest canopy to close over existing roads will help mitigate impacts on interior forest resources.

10. WETLANDS

The ecological functioning of approximately 580 acres (235 ha) of wetlands known to date on the ORR provides water-quality benefits, stormwater control, wildlife habitat, rare-species habitat, and landscape and biological diversity (Fig. 6).

Wetlands occur across the ORR at low-elevation positions, primarily in the riparian zones of headwater streams and their receiving streams, as well as in Clinch River embayments. Most of the wetlands on the ORR are classified as palustrine forested, scrub-shrub, and emergent wetlands (Cowardin et al. 1979). Wetlands identified to date range in size from several square yards at small seeps and springs to approximately 25 acres (10 ha) at White Oak Lake. A high percentage of the wetlands on the ORR encompass less than 1 acre (1/2 ha) and occur in headwater areas. Wetlands greater than 1 acre (0.4 ha) are typically associated with river embayments, other areas affected by the fluctuating water levels of the Clinch River reservoirs (e.g., Poplar Creek), areas in which water has been artificially impounded (e.g., White Oak Lake), and beaver ponds.

Activities that affect wetlands are regulated under federal law (Sect. 404 of the Clean Water Act, Federal Water Pollution Control Act, 33 USC 1251) and state law (Tennessee Water Quality Control Act, TN Code Annotated 70-324). Federal and state permits are required to conduct dredge-and-fill activities in a jurisdictional wetland (i.e., an area that meets the criteria established by the U.S. Army Corps of Engineers for a wetland). Impacts to wetlands are avoided whenever possible. If impacts are unavoidable, they are minimized through steps such as project design changes or the implementation of best management practices. Compensatory mitigation in the form of wetland restoration, creation, or enhancement is a required permit condition under certain circumstances.

11. CULTURAL RESOURCES

Cultural resources on the ORR include (1) surface and buried archaeological materials (artifacts) and sites dating to the prehistoric, historic, and ethnohistoric periods; (2) standing structures that are more than 50 years old or, if newer, are important because they represent a major historical theme or era; (3) cultural and natural places, selected natural resources, and objects with importance for Native Americans; and (4) American folklife traditions and arts. Six properties on the ORR are included in the National Register of Historic Places: (1) Oak Ridge Turnpike Checking Station, (2) Bear Creek

Road Checking Station, (3) New Bethel Baptist Church, (4) George Jones Memorial Baptist Church (also known as Wheat Church), (5) Freels Cabin, and (6) the ORNL Graphite Reactor. Figure 10 shows the general locations of registered historic places, cemeteries, churches, a national historic landmark, and old home structures. Many other sites on the ORR, both historic and archaeological, have been determined to be eligible for listing in the National Register of Historic Places. The X-10 Graphite Reactor at ORNL was also designated as a national historic landmark on December 21, 1965, based on the national and international significance of its contributions to science and technology.

12. SPECIAL DESIGNATIONS

The ORR has evolved into a biologically rich resource over the last 60 years (see Chap. 8).

The combination of long-term protection for the land area and the biological richness of the ORR with the available research capability and proximity of diverse scientific expertise has resulted in the following state, regional, national, and international designations:

- the DOE National Environmental Research Park,
- ParkNet (a network of seven DOE National Environmental Research Parks),
- the National Environmental Research Park Biosphere Reserve,
- a unit of the Southern Appalachian Biosphere (with the Great Smoky Mountains National Park, Coweeta Hydrologic Laboratory, and others),
- the Southern Appalachian Man and the Biosphere Cooperative (with the U.S. Department of Agriculture; TVA; the Economic Development Administration; EPA, Region IV; the U.S. Fish and Wildlife Service; the U.S. Geological Survey; the National Park Service; the U.S. Forest Service; and the states of Tennessee, North Carolina, and Georgia),
- Oak Ridge Wildlife Management Area, managed by the Tennessee Wildlife Resources Agency (TWRA),
- the Three Bend Scenic and Wildlife Management Refuge Area,
- the Black Oak Ridge Conservation Easement Area, and
- the DOE National Environmental Research Park User Facility.

Figure 11 shows land management and operational uses on the ORR, including special designations.

12.1 OAK RIDGE WILDLIFE MANAGEMENT AREA

The entire ORR is a Tennessee Wildlife Management Area (Fig. 11) through an agreement between DOE and TWRA. The agreement provides for protection of wildlife habitat and species (including several threatened and endangered species) and restoration of other wildlife habitat and species. Management of the ORR for wildlife is also a type of land use.

About 2920 acres (1182 ha) of the Oak Ridge Wildlife Management Area are specifically managed by TWRA under a separate agreement with DOE. This area is known as the Three Bend Scenic and Wildlife Management Refuge Area and includes most of Solway, Freels, and Gallaher Bends along the Clinch River on the southern boundary of the ORR (Fig. 11).

Approximately 3000 acres (1214 ha) in the northwestern part of the ORR were placed in a conservation easement in April 2005. TWRA manages the land in accordance with a plan developed jointly by the Tennessee Department of Environment and Conservation (TDEC) and TWRA with

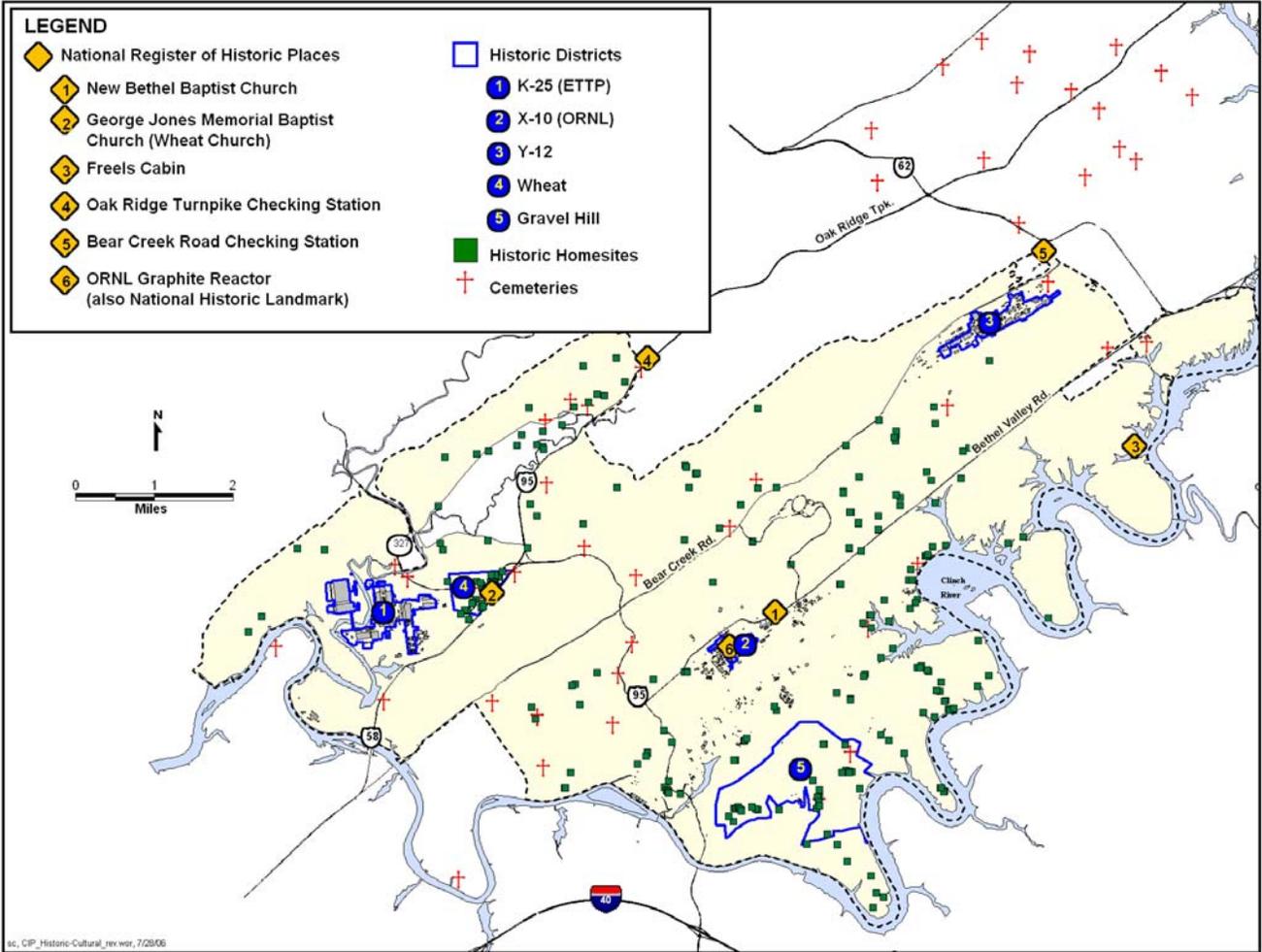


Fig. 10. Historic and cultural resources of the ORR.

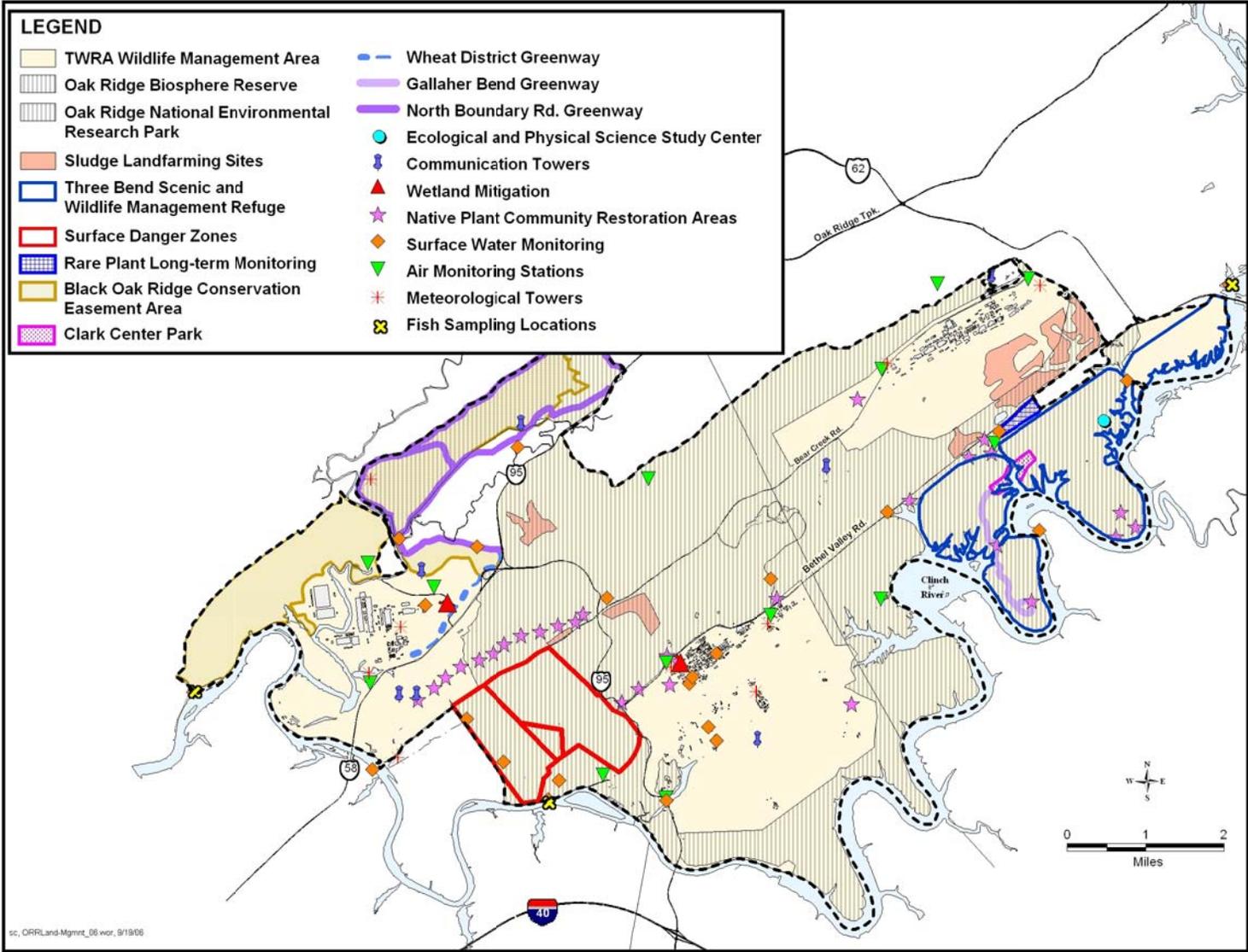


Fig. 11. Land management and operational uses on the ORR.

input from the public. The agreement enables DOE to assist in paying for natural resource damages at the Lower Watts Bar reservoir caused by DOE's activities on the ORR.

12.2 NATURE CONSERVANCY BIODIVERSITY RANKED AREAS

More than 270 occurrences of significant plant and animal species were recognized by The Nature Conservancy in its report of biodiversity on the ORR as part of Common Ground, the DOE Future Land Use Initiative (The Nature Conservancy 1995). In addition, using a national ranking system, The Nature Conservancy identified more than 69 preliminary conservation sites with occurrences of rare species and communities and other important features (e.g., caves, springs). These sites generally had clusters of important species or communities, with special emphasis placed on those species and elements designated as globally imperiled, rare, or uncommon in The Nature Conservancy and Natural Heritage Network ranking system. The sites also include the landscape features and ecological processes (i.e., watersheds) believed to be important for sustaining the occurrences of important species and communities.

The sites were evaluated and given a biological significance ranking (BSR) based on their conservation significance. Sites on the ORR were rated BSR-2 (very high significance), BSR-3 (high significance), and BSR-4 (moderate significance). The BSR-5 category (of general biodiversity interest) was not used in The Nature Conservancy's report, although it notes that "forested land on ORR would fit in this or an above category." The Nature Conservancy areas of biological significance are identified in Fig. 12. The Nature Conservancy maintains ORR records of rare plant and animal species in the Biological and Conservation Database.

12.3 NATURE CONSERVANCY LANDSCAPE COMPLEXES

The Nature Conservancy report also recommended protection of three large land areas (Fig. 12) on which are found many highly ranked conservation sites (i.e., those with rare communities and rare species, hardwood forests greater than 100 acres [40.5 ha] and critical watersheds) (The Nature Conservancy 1995).

12.4 RESEARCH PARK ENDANGERED SPECIES HABITATS (NATURAL AREAS)

Rare plant and animal species (state and/or federal candidate and/or listed) are provided protection through preservation of the habitat that is required for their survival. Such important habitat is established on the best available information about the need of the rare species and is protected through Research Park Natural Area designations. Figure 13 shows the ORR areas designated as habitat for rare species.

12.5 RESEARCH PARK ENDANGERED SPECIES POTENTIAL HABITATS (REFERENCE AREAS)

Reference areas serve two functions. They provide protection to habitat with high potential for rare plant or animal species while also protecting common or representative plant or animal communities that can serve as baseline areas for research and monitoring. Many of the areas originally designated as Research Park Reference Areas have been found to contain rare plant or animal species and have been assigned the Research Park Natural Area designation. Figure 13 shows these areas as potential habitat for rare species.

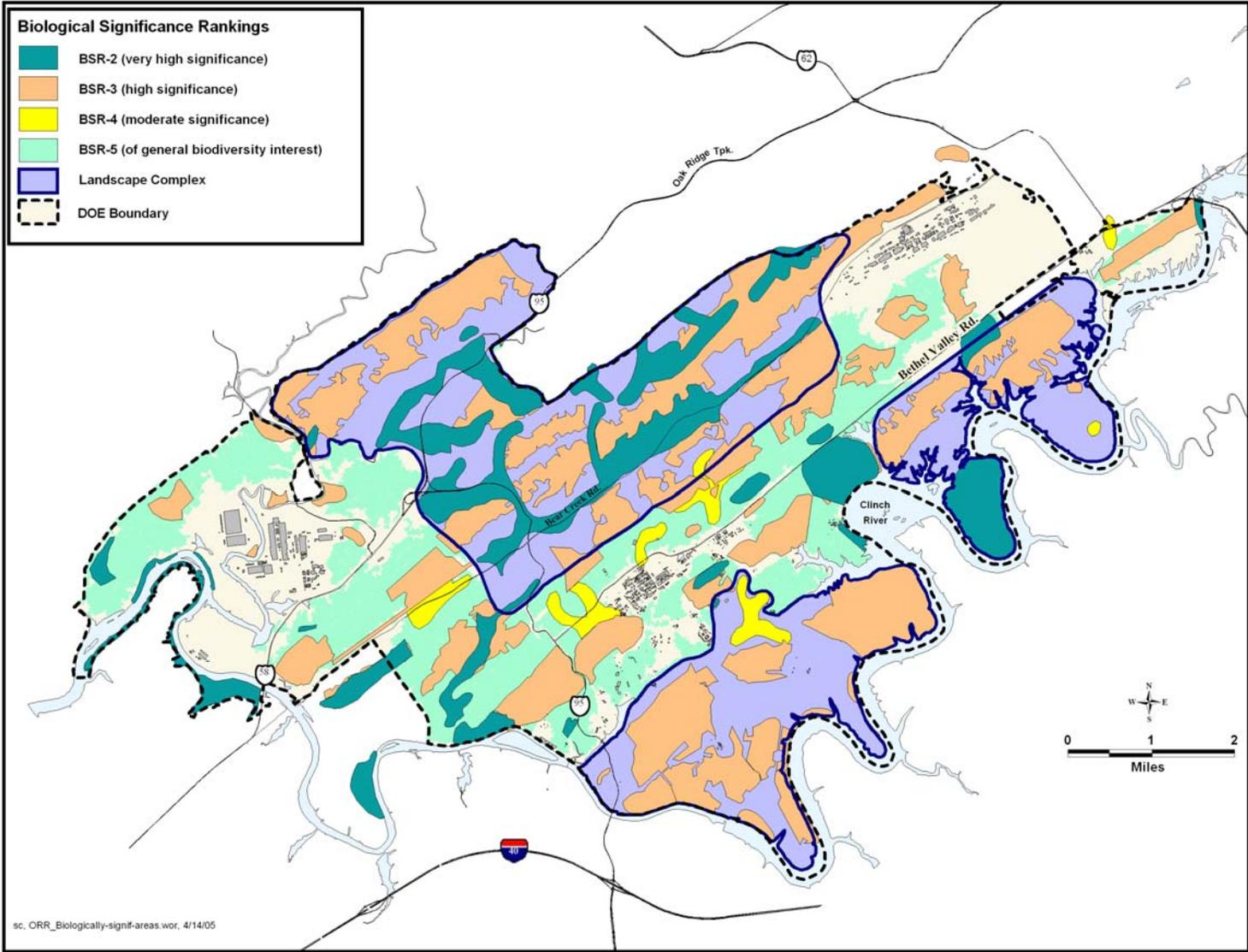


Fig. 12. Biologically significant areas on the ORR.

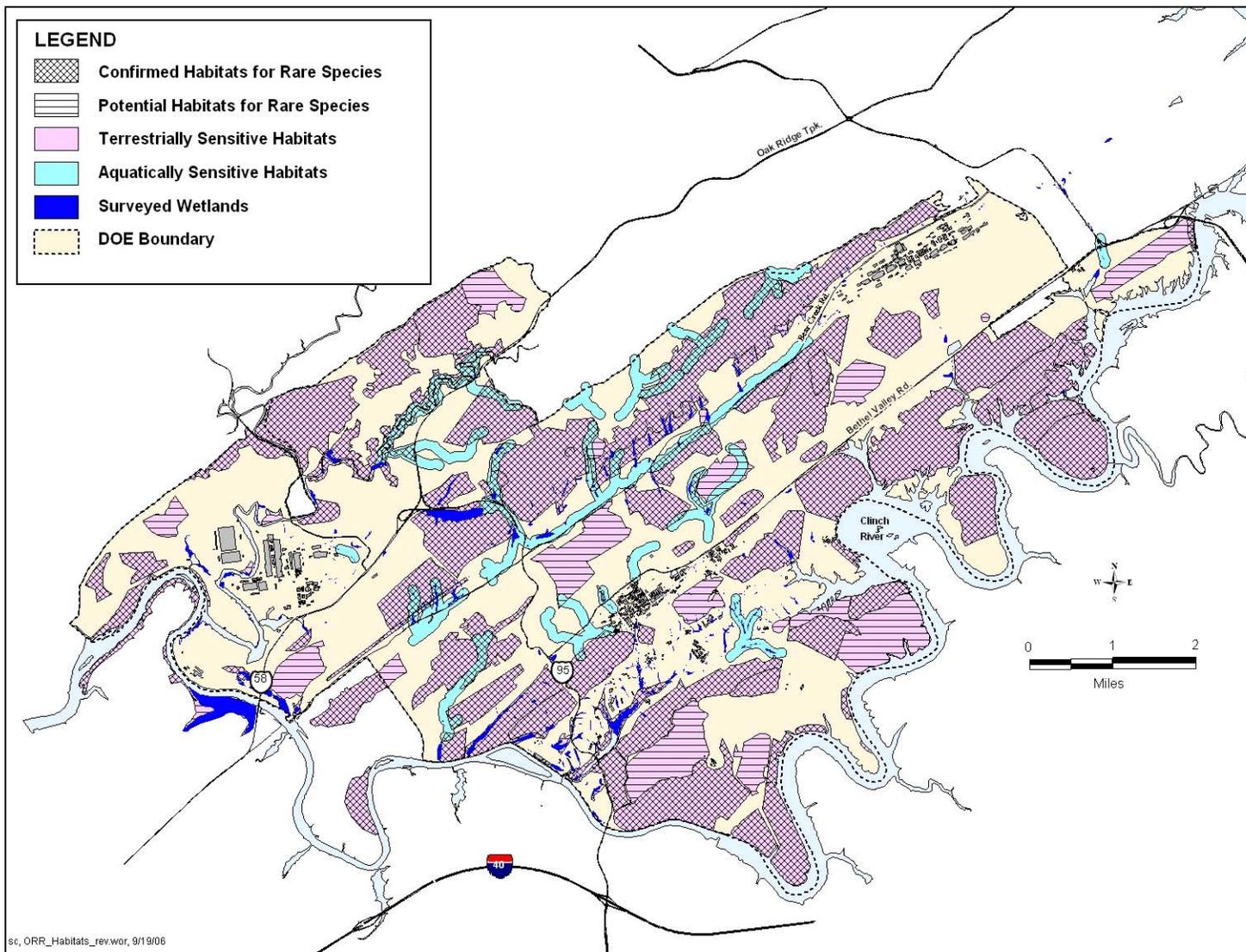


Fig. 13. Confirmed and potential habitats for rare plants and wildlife on the ORR.

12.6 BIOSPHERE RESERVE

The Oak Ridge National Environmental Research Park Biosphere Reserve was designated in 1988 (see Fig. 11). Biosphere reserves are areas of terrestrial and coastal ecosystems that are internationally recognized within the framework of the United Nations Educational, Scientific, and Cultural Organization Man and the Biosphere (MAB) Program. Collectively, they constitute a MAB World Network. Each biosphere reserve is encouraged to fulfill three functions, as appropriate, within its management framework: (1) a conservation function (contributing to the conservation of landscapes, ecosystems, species, and genetic variation), (2) a development function (fostering economic and human development that is socioculturally and ecologically sustainable), and (3) a logistic function (providing support for research, monitoring, education, and information exchange related to local, national, and global issues of conservation and development). The Oak Ridge National Environmental Research Park Biosphere Reserve is managed by ORNL for DOE. In addition, the Oak Ridge National Environmental Research Park Biosphere Reserve is a unit within the regional zone of the Southern Appalachian Biosphere Reserve. The MAB World Network is comprised of more than 360 biosphere reserves. The Southern Appalachian Man and the Biosphere Program is one of the most active of 47 U.S. biosphere reserves and is regarded as an international model.

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APPENDIX A
PLANTS FOUND ON THE OAK RIDGE RESERVATION

Table A. Vascular plants found on the Oak Ridge Reservation

Genus	Species	Common name	Genus	Species	Common name
Abutilon	theophrasti	Velvet leaf	Krigia	virginica	Virginia dwarf dandelion
Acalypha	gracilens	Narrow-leaved three-seeded mercury	Kuhnia	eupatoriodes	False boneset
Acalypha	rhomboidea	Three-seeded mercury	Kummerowia	stipulacea	Korean bush-clover
Acalypha	virginica	Virginia three-seeded mercury	Kummerowia	striata	Japanese clover
Acer	negundo	Box-elder	Kyllinga	gracillima	Pasture spike sedge
Acer	rubrum	Red maple	Kyllinga	pumila	Low spike sedge
Acer	saccharinum	Silver maple	Lactuca	canadensis	Wild lettuce
Acer	saccharum	Sugar maple	Lactuca	floridana	Woodland blue lettuce
Achillea	millefolium	Yarrow	Lactuca	saligna	Willow-leaved lettuce
Aconitum	uncinatum	Monk's hood	Lactuca	serriola	Prickly lettuce
Acorus	americanus	Sweet-flag	Lamium	amplexicaule	Henbit
Actaea	pachypoda	Doll's eyes	Lamium	purpureum	Purple dead-nettle
Adiantum	pedatum	Maidenhair fern	Lathyrus	latifolius	Everlasting pea
Aesculus	flava	Yellow buckeye	Lechea	racemulosa	Pinweed
Aesculus	sylvatica	Painted buckeye	Leersia	oryzoides	Rice cutgrass
Agalinis	purpurea	Purple gerardia	Leersia	virginica	Virginia cutgrass
Agalinis	tenuifolia	Slender gerardia	Lemna	minor	Duckweed
Agastache	nepetoides	Yellow giant-hyssop	Leonurus	cardiaca	Motherwort
Ageratina	altissima	White snakeroot	Lepidium	campestre	Cow-ress
Ageratina	aromatica	—	Lepidium	virginicum	Poor man's pepper
Agrimonia	parviflora	Southern agrimony	Lespedeza	bicolor	Shrubby bushclover
Agrimonia	pubescens	Downy agrimony	Lespedeza	capitata	Round-headed bush-clover
Agrimonia	rostellata	Woodland agrimony	Lespedeza	cuneata	Cuneate bus-clover
Agrostemma	githago	Corncockle	Lespedeza	hirta	Hairy bush-clover
Agrostis	hyemalis	Hairgrass	Lespedeza	intermedia	—
Agrostis	perennans	Upland bentgrass	Lespedeza	procumbens	Low bush-clover
Agrostis	stolonifera	Creeping bentgrass	Lespedeza	repens	Trailing bush-clover
Ailanthus	altissima	Tree-of-heaven	Lespedeza	violacea	Bush-clover
Albizia	julibrissin	Mimosa	Lespedeza	virginica	Slender bush-clover
Alisma	subcordatum	Water-plaintain	Leucospora	multifida	—
Allium	ampeloprasum	Garlic	Leucothoe	fontanesiana	Dog-hobble
Allium	canadense	Wild garlic	Liatris	aspera	Lacerate blazing star
Allium	cernuum	Nodding onion	Liatris	spicata	Sessile blazing star
Allium	vineale	Field garlic	Ligusticum	canadense	Lovage
Alnus	serrulata	Common alder	Ligustrum	sinense	Privet
Alopecurus	carolinianus	Carolina-foxtail	Lilium	canadense	Canada lily

Table A. (continued)

Genus	Species	Common name	Genus	Species	Common name
Amaranthus	hybridus	Amaranth	Linaria	canadensis	Toadflax
Ambrosia	artemisiifolia	Ragweed	Linaria	vulgaris	Butter-and-eggs
Ambrosia	bidentata	Ragweed	Lindera	benzoin	Spicebush
Ambrosia	trifida	Ragweed	Lindernia	dubia	False pimpernell
Amelanchier	arborea	Downy juneberry	Linum	medium	Common yellow fax
Amelanchier	laevis	Smooth juneberry	Linum	striatum	Ridgestem yellow flax
Amianthium	muscaetoxicum	Fly poison	Linum	sulcatum	Grooved yellow flax
Ammannia	coccinea	Toothcup	Linum	virginianum	Virginia flax
Amorpha	fruticosa	False indigo	Liparis	liliifolia	Lily-leaved twayblade
Ampelopsis	cordata	Raccoon-grape	Liparis	loeselii	Fen orchid
Amphicarpeaea	bracteata	Hog-peanut	Liquidambar	styraciflua	Sweetgum
Amsonia	tabernaemontana	Willow amsonia	Liriodendron	tulipifera	Tulliptree
Anagallis	arvensis	Pimpernel	Lithospermum	canescens	Orange puccoon
Andropogon	gerardii	Big bluestem	Lobelia	cardinalis	Cardinal flower
Amaranthus	hybridus	Amaranth	Lobelia	inflata	Indian tobacco
Andropogon	ternarius	Silver bluestem	Lobelia	puberula	Downy lobelia
Andropogon	virginicus	Virginia broomsedge	Lobelia	siphilitica	Great lobelia
Anemone	quinquefolia	Wood anemone	Lobelia	spicata	Lobelia
Anemone	virginiana	Thimble weed	Lolium	multiflorum	Italian ryegrass
Angelica	venenosa	Hairy angelica	Lolium	perenne	Perennial ryegrass
Antennaria	plantaginifolia	Pussy-toes	Lonicera	japonica	Japanese honeysuckle
Antennaria	solitaria	Pussy-toes	Lonicera	maackii	—
Anthoxanthum	odoratum	Sweet vernal grass	Lotus	corniculatus	Birdfoot trefoil
Apios	americana	Ground-nut	Ludwigia	alternifolia	Alternate-leaved seedbox
Aplectrum	hyemale	Putty root	Ludwigia	decurrens	Decurrent seedbox
Apocynum	cannabinum	Dogbane	Ludwigia	palustris	Water-purslane
Aquilegia	canadensis	Columbine	Luzula	acuminata	Wood-rush
Arabidopsis	thaliana	Mouse-ear cress	Luzula	bulbosa	Wood-rush
Arabis	canadensis	Sicklepod	Luzula	echinata	Wood-rush
Arabis	laevigata	Smooth rockcress	Luzula	multiflora	Wood-rush
Aralia	racemosa	Spikenard	Lycopodium	obscurum	Treelike clubmoss
Aralia	spinosa	Devil's walking stick	Lycopus	americanus	American bugleweed
Arctium	minus	Burdock	Lycopus	virginicus	Virginia water-horehound
Arenaria	patula	Sandwort	Lygodium	palmatum	Climbing fern

Table A. (continued)

Genus	Species	Common name	Genus	Species	Common name
Arenaria	serpyllifolia	Thyme-leaf sandwort	Lyonia	ligustrina	Maleberry
Arisaema	dracontium	Green dragon	Lysimachia	ciliata	Fringed loosestrife
Arisaema	triphillum	Jack-in-the-pulpit	Lysimachia	lanceolata	Lance-leaved loosestrife
Aristida	dichotoma	Churchmouse three-awn grass	Lysimachia	nummularia	Moneywort
Aristida	longespica	Slimspike three-awn grass	Lysimachia	quadrifolia	Smooth loosestrife
Aristida	oligantha	Prairie three-awn grass	Lysimachia	tonsa	Appalachian loosestrife
Aristida	purpurascens	Purple three-awn grass	Lythrum	alatum	Winged loosestrife
Aristolochia	macrophylla	Dutchman's pipe	Lythrum	salicaria	Purple loosestrife
Aristolochia	serpentaria	Virginia-snakeroot	Maclura	pomifera	Osage-orange
Aronia	arbutifolia	Hairy chokeberry	Magnolia	acuminata	Cucumber-tree
Arthraxon	hispidus	—	Magnolia	tripetala	Umbrella magnolia
Aruncus	dioicus	Goat's beard	Mahonia	bealei	Oregon grape
Arundinaria	gigantea	Cane	Malaxis	unifolia	Adder's mouth
Asarum	canadense	Wild ginger	Manfreda	virginica	False aloe
Asclepias	amplexicaulis	Blunt-leaved milkweed	Matelea	gonocarpa	Climbing milkweed
Asclepias	incarnata	Swamp milkweed	Mecardonia	acuminata	—
Asclepias	quadrifolia	—	Medeola	virginiana	Indian cucumber
Asclepias	syriaca	Common milkweed	Medicago	lupulina	Black medick
Asclepias	tuberosa	Butterfly-weed	Melica	mutica	Melica grass
Asclepias	variegata	White milkweed	Melilotus	alba	White sweet-clover
Asclepias	verticillata	Whorled milkweed	Melilotus	officinalis	Yellow sweet-clover
Asclepias	viridiflora	Milkweed	Menispermum	canadense	Moonseed
Asimina	triloba	Paw-paw	Mentha	spicata	Spearmint
Asparagus	officinalis	Asparagus	Mentha	x piperita	Peppermint
Asplenium	platyneuron	Ebony spleenwort	Microstegium	vimineum	Nepal grass
Asplenium	resiliens	Black-stemmed spleenwort	Mimulus	alatus	Winged monkey flower
Asplenium	rhizophyllum	Walking fern	Mimulus	ringens	Monkey flower
Asplenium	ruta-muraria	Wall-rue	Mitchella	repens	Partridgeberry
Asplenium	trichomanes	Maidenhair spleenwort	Mitella	diphylla	Bishop's cap
Aster	cordifolius	Heart-leaved aster	Mollugo	verticillata	Carpet-weed
Aster	divaricatus	White wood aster	Monarda	didyma	Bee-balm
Aster	dumosus	Bushy aster	Monarda	fistulosa	Wild bergamot
Aster	laevis	Smooth aster	Monotropa	hypopithys	Pine-sap
Aster	lateriflorus	Calico aster	Monotropa	uniflora	Indian pipe
Aster	novae-anglae	New England aster	Morus	rubra	Red mulberry

Table A. (continued)

Genus	Species	Common name	Genus	Species	Common name
Aster	oblongifolius	Aromatic aster	Mosla	dianthera	—
Aster	ontarionis	Bottomland aster	Muhlenbergia	frondosa	Muhly
Aster	patens	Late purple aster	Muhlenbergia	schreberi	Nimblewill
Aster	pilosus	Downy aster	Muhlenbergia	sylvatica	Woodland muhly
Aster	shortii	Midwestern heart-leaved aster	Muhlenbergia	tenuiflora	Muhly
Aster	surculosos	Recurved aster	Murdannia	keisak	—
Aster	undulatus	Clasping heart-leaved aster	Myosotis	macrosperma	Large-seeded forget-me-not
Aster	urophyllus	Arrow-leaved aster	Myosotis	verna	Early forget-me-not
Astilbe	baternata	False goat's beard	Myosurus	minimus	Mouse-tail
Astragalus	canadensis	Milkvetch	Myriophyllum	spicatum	European water-milfoil
Athyrium	filix-femina	Lady fern	Najas	guadalupensis	Southern water-nymph
Aureolaria	laevigata	Smooth false-foxglove	Nasturtium	officinale	Watercress
Aureolaria	patula	Spreading false-foxglove	Nicandra	physalodes	Apple-of-Peru
Aureolaria	virginica	Downy false-foxglove	Nyssa	sylvatica	Black gum
Barbarea	verna	Early winter-cress	Obolaria	virginica	Pennywort
Barbarea	vulgaris	Yellow rocket	Oenothera	biennis	Evening primrose
Bartonia	paniculata	Screwstem	Oenothera	fruticosa	Sundrops
Belamcanda	chinensis	Blackberry lily	Oenothera	laciniata	Cut-leaved primrose
Betula	nigra	River birch	Onoclea	sensibilis	Sensitive fern
Bidens	cernua	Stick-tights	Ophioglossum	engelmannii	Limestone adder's tongue fern
Bidens	frondosa	Beggar-ticks	Ophioglossum	pycnostichium	Southeastern adder's tongue fern
Bidens	polylepis	Ozark tickseed	Opuntia	humifusa	Prickly pear cactus
Bidens	tripartita	Stick-tight	Orbexilum	onobrychis	Tall psoralea
Bidens	bipinnata	Spanish-needles	Orbexilum	pedunculatum	Sampson's snakeroot
Bignonia	capreolata	Cross-vine	Ornithogalum	umbellatum	Star of Bethlehem
Blephilia	ciliata	Woodmint	Orobanche	uniflora	One-flowered cancer-root
Boehmeria	cylindrica	False-nettle	Orontium	aquaticum	Golden club
Botrychium	baternatum	Sparse-lobed grape fern	Osmorhiza	claytonii	Bland sweet cicely
Botrychium	dissectum	Common grape fern	Osmorhiza	longistylis	Long styled sweet cicely
Botrychium	virginianum	Rattlesnake fern	Osmunda	cinnamomea	Cinnamon fern
Bouteloua	curtipendula	Side-oats gramma grass	Osmunda	regalis	Royal fern
Brachyeletrum	erectum	—	Ostrya	virginiana	Hop-hornbeam
Brassica	rapa	Rape mustard	Oxalis	grandis	Large wood sorrel
Bromus	altiissimus	—	Oxalis	stricta	Wood sorrel
Bromus	commutatus	Common brome grass	Oxalis	violacea	Wood sorrel

Table A. (continued)

Genus	Species	Common name	Genus	Species	Common name
Bromus	hordeaceus	Soft chess	Oxydendrum	arborescens	Sourwood
Bromus	japonicus	Japanese chess	Oxypolis	rigidior	Cowbane
Bromus	pubescens	—	Pachysandra	procumbens	Allegheny-spurge
Bromus	tectorum	Brome grass	Panax	quinquefolius	Ginseng
Buglossoides	arvensis	—	Panicum	acuminatum	Panic grass
Bulbostylis	capillaris	Sedge	Panicum	acuminatum	Panic grass
Bumelia	lycioides	Smooth southern buckthorn	Panicum	anceps	Panic grass
Cacalia	atriplicifolia	Pale Indian-plantain	Panicum	angustifolium	Panic grass
Calamintha	nepeta	Basil-thyme	Panicum	boscii	Panic grass
Callitriche	heterophylla	Water star-wort	Panicum	capillare	Panic grass
Calycanthus	floridus	Sweetshrub	Panicum	clandestinum	Panic grass
Calystegia	sepium	Hedge bindweed	Panicum	commutatum	Panic grass
Calystegia	spithamaea	Low bindweed	Panicum	depauperatum	Panic grass
Campanula	americana	Tall bellwort	Panicum	dichotomiflorum	Panic grass
Campanula	divaricata	Southern harebell	Panicum	dichotomum	Panic grass
Campsis	radicans	Trumpet-creper	Panicum	flexile	Panic grass
Capsella	bursa-pastoris	Shepherd's purse	Panicum	laxiflorum	Panic grass
Cardamine	douglasii	Pink spring-cress	Panicum	microcarpon	Panic grass
Cardamine	hirsuta	Hairy bittercress	Panicum	ovale	Panic grass
Cardamine	parviflora	—	Panicum	polyanthes	Panic grass
Cardamine	pennsylvanica	Pennsylvania bittercress	Panicum	rigidulum	Panic grass
Cardamine	rhombioides	Spring-cress	Panicum	scoparium	Panic grass
Carex	abscondita	Thicket sedge	Panicum	sphaerocarpon	Panic grass
Carex	albicans	Sedge	Panicum	virgatum	Panic grass
Carex	albicans	Sedge	Paronychia	fastigiata	Forked chickweed
Carex	albolutescens	Light-colored sedge	Parthenium	integrifolium	Wild quinine
Carex	albursina	Sedge	Parthenocissus	quinquefolia	Virginia creeper
Carex	amphibola	Sedge	Paspalum	boscianum	—
Carex	atlantica	Sedge	Paspalum	dilatatum	—
Carex	atlantica	Howe's sedge	Paspalum	laeve	—
Carex	baileyi	Bailey's sedge	Paspalum	pubiflorum	—
Carex	blanda	Sedge	Paspalum	setaceum	—
Carex	bromoides	Sedge	Paspalum	setaceum	—
Carex	caroliniana	Carolina sedge	Passiflora	incarnata	Purple passion flower
Carex	cephalophora	Sedge	Passiflora	lutea	Yellow passion flower

Table A. (continued)

Genus	Species	Common name	Genus	Species	Common name
Carex	cherokeensis	Cherokee sedge	Paulownia	tomentosa	Princess-tree
Carex	complanata	Sedge	Pellaea	atropurpurea	Purple-stemmed cliffbrake
Carex	conjuncta	Sedge	Pellaea	glabella	Smooth cliffbrake
Carex	crinita	Drooping sedge	Penstemon	canescens	Hairy beard-tongue
Carex	crus-corvi	Sedge	Penstemon	digitalis	Large-flowered beard-tongue
Carex	debilis	Necklace sedge	Penstemon	laevigatus	Smooth beard-tongue
Carex	digitalis	Sedge	Penstemon	pallidus	Eastern white beard-tongue
Carex	eburnea	Black-fruited sedge	Penthorum	sedoides	Ditch stone-crop
Carex	festucacea	Sedge	Perilla	frutescens	Beefsteak plant
Carex	frankii	Frank's sedge	Phacelia	bipinnatifida	Purple phacelia
Carex	granularis	Granular sedge	Phacelia	purshii	Pursh's purple phacelia
Carex	gravidata	Heavy sedge	Phalaris	arundinacea	Reed canary grass
Carex	grayi	Gray's sedge	Phaseolus	polystachyus	Wild bean
Carex	grisea	Sedge	Philadelphus	hirsutus	Hairy mock-orange
Carex	intumescens	Intumescent sedge	Philadelphus	inodorus	Mock-orange
Carex	jamesii	Sedge	Phleum	pratense	Common timothy
Carex	laxiflora	Broad-leaved sedge	Phlox	amoena	Hairy phlox
Carex	leptalea	Sedge	Phlox	amplifolia	Wide-leaved phlox
Carex	louisianica	Louisiana sedge	Phlox	divaricata	Forest phlox
Carex	lupulina	Large hop sedge	Phlox	glaberrima	Smooth phlox
Carex	lurida	Smaller hop sedge	Phlox	maculata	Meadow phlox
Carex	meadii	Sedge	Phlox	paniculata	Summer phlox
Carex	muhlenbergii	Sedge	Phlox	stolonifera	Crawling phlox
Carex	nigromarginata	Black-margined sedge	Phoradendron	leucarpum	Mistletoe
Carex	normalis	Sedge	Phryma	leptostachya	Lopseed
Carex	oligocarpa	Sedge	Phyla	lanceolata	Fog-fruit
Carex	oxylepis	Sedge	Phyllanthus	caroliniensis	Phyllanthus
Carex	oxylepis	Sedge	Physalis	longifolia	Downy ground-cherry
Carex	pennsylvanica	Sedge	Physalis	pubescens	Hairy ground-cherry
Carex	platyphylla	Sedge	Physalis	virginiana	Virginia ground-cherry
Carex	prasina	Drooping sedge	Physostegia	virginiana	False dragonhead
Carex	projecta	Sedge	Phytolacca	americana	Pokeweed
Carex	purpurifera	Sedge	Pilea	pumila	Clearweed
Carex	retroflexa	Sedge	Pinus	echinata	Short-leaf pine
Carex	rosea	Sedge	Pinus	strobus	White pine

Table A. (continued)

Genus	Species	Common name	Genus	Species	Common name
Carex	scoparia	Sedge	Pinus	taeda	Loblolly pine
Carex	shortiana	Sedge	Pinus	virginiana	Scrub pine
Carex	squarrosa	Round-headed sedge	Plantago	aristata	Plantain
Carex	stipata	Stipitate sedge	Plantago	lanceolata	Plantain
Carex	striatula	Sedge	Plantago	pusilla	Small plantain
Carex	styloflexa	Sedge	Plantago	rugelii	Plantain
Carex	swanii	Swan's sedge	Plantago	virginica	Plantain
Carex	tribuloides	Sedge	Platanthera	clavellata	Green woodland orchid
Carex	venusta	Sedge	Platanthera	flava	Northern tubercled orchid
Carex	virescens	Sedge	Platanthera	lacera	Green-fringed orchid
Carex	vulpinoidea	Fox sedge	Platanthera	peramoena	Purple-fringeless orchid
Carex	willdenowii	Sedge	Platanus	occidentalis	Sycamore
Carpinus	caroliniana	Iron wood	Pluchea	camphorata	Camphorweed
Carya	cordiformis	Bitternut hickory	Poa	alsodes	—
Carya	glabra	Pignut hickory	Poa	annua	Annual bluegrass
Carya	ovalis	Sweet pignut hickory	Poa	autumnalis	Autumn bluegrass
Carya	ovata	Shagbark hickory	Poa	compressa	Bluegrass
Carya	tomentosa	Mockernut hickory	Poa	cuspidata	Woodland bluegrass
Castanea	dentata	American chestnut	Poa	pratensis	Junegrass
Catalpa	bignonioides	Catalpa	Poa	sylvestris	Woodland bluegrass
Caulophyllum	thalictroides	Blue cohosh	Podophyllum	peltatum	May-apple
Ceanothus	americanus	New Jersey tea	Polemonium	reptans	Spreading Jacob's ladder
Celastrus	orbiculatus	Oriental bittersweet	Polygala	curtissii	Curtiss' milkwort
Celastrus	scandens	Climbing bittersweet	Polygala	incarnata	Pink milkwort
Celtis	laevigata	Smooth hackberry	Polygala	sanguinea	Blood-milkwort
Celtis	occidentalis	Common hackberry	Polygala	senega	Seneca-snakeroot
Centaurea	cyanus	Bachelor's button	Polygala	verticillata	Loose milkwort
Centaurea	maculosa	Bachelor's button	Polygala	verticillata	Whorled milkwort
Centrosema	virginianum	Butterfly-pea	Polygonatum	biflorum	Smooth Solomon's seal
Cephalanthus	occidentalis	Buttonbush	Polygonum	caespitosum	Smartweed
Cerastium	fontanum	Mouse-ear chickweed	Polygonum	cuspidatum	Japanese knotweed
Cerastium	glomeratum	Mouse-ear chickweed	Polygonum	hydropiper	Water-pepper
Ceratophyllum	demersum	Hornwort	Polygonum	hydropiperoides	Water smartweed
Cercis	canadensis	Redbud	Polygonum	lapathifolium	Smartweed
Chaenorrhinum	minus	Lesser toadflax	Polygonum	pensylvanicum	Smartweed

Table A. (continued)

Genus	Species	Common name	Genus	Species	Common name
Chaerophyllum	procumbens	Spreading chervil	Polygonum	persicaria	Smartweed
Chaerophyllum	tainturieri	Wild cervil	Polygonum	punctatum	Smartweed
Chamaecrista	fasciculata	Partridge-pea	Polygonum	sagittatum	Teartumb
Chamaecrista	nictitans	Sensitive-pea	Polygonum	scandens	Climbing buckwheat
Chamaelirium	luteum	Fairy wand	Polygonum	virginianum	Virginia knotweed
Chasmanthium	latifolium	Spangle grass	Polymnia	canadensis	Leaf-cup
Chasmanthium	laxum	Slender spike grass	Polymnia	uvedalia	Bear's foot
Chasmanthium	sessiliflorum	Long-leaf spike grass	Polypodium	polypodioides	Resurrection fern
Cheilanthes	alabamensis	Alabama lipfern	Polypodium	virginianum	Rock polypody fern
Cheilanthes	lanosa	Hairy lipfern	Polypremum	procumbens	—
Chelone	glabra	White turtlehead	Polystichum	acrostichoides	Christmas fern
Chenopodium	album	White goosefoot	Poncirus	trifoliata	Trifoliolate orange
Chenopodium	ambrosioides	Fragrant goosefoot	Populus	alba	Silvery poplar
Chimaphila	maculata	Striped pipsissewa	Populus	deltoides	Eastern cottonwood
Chionanthus	virginicus	Fringe-tree	Populus	x jackii	—
Chrysanthemum	leucanthemum	Daisy	Porteranthus	trifoliatus	Bowman's root
Cichorium	intybus	Chicory	Potamogeton	crispus	Pondweed
Cicuta	maculata	Water-hemlock	Potamogeton	diversifolius	Pondweed
Cimicifuga	racemosa	Black cohosh	Potamogeton	foliosus	Pondweed
Cimicifuga	rubifolia	Appalachian bugbane	Potamogeton	pusillus	Pondweed
Cinna	arundinacea	Reedgrass	Potentilla	canadensis	Dwarf cinquefoil
Circaea	lutetiana	Larger enchanter's-nightshade	Potentilla	norvegica	Rough cinquefoil
Cirsium	arvense	Canada thistle	Potentilla	recta	Rough-fruited cinquefoil
Cirsium	discolor	Thistle	Prenanthes	serpentaria	Rattlesnakeroot
Cirsium	muticum	Swamp thistle	Prenanthes	trifoliolata	Lion's foot
Cirsium	vulgare	Bull thistle	Prunella	vulgaris	Heal-all
Claytonia	caroliniana	Broad-leaved spring beauty	Prunus	americana	Wild plum
Claytonia	virginica	Narrow-leaved spring beauty	Prunus	munsoniana	Munson plum
Clematis	viorna	Leather flower	Prunus	serotina	Black cherry
Clematis	virginiana	Virgin's bower	Ptelea	trifoliata	Wafer ash
Clitoria	mariana	Butterfly-pea	Pteridium	aquilinum	Bracken fern
Cocculus	carolinus	Snailseed	Pueraria	lobata	Kudzu
Collinsonia	canadensis	Stoneroot	Pycnanthemum	incanum	Hoary mountain-mint
Collinsonia	verticillata	Whorled stoneroot	Pycnanthemum	incanum	Hoary mountain-mint
Commandra	umbellata	Bastard toad-flax	Pycnanthemum	pilosum	Mountain-mint

Table A. (continued)

Genus	Species	Common name	Genus	Species	Common name
Commelina	communis	Common dayflower	Pycnanthemum	tenuifolium	Narrow-leaved mountain-mint
Commelina	erecta	Erect dayflower	Pycnanthemum	virginianum	Mountain-mint
Commelina	virginica	Virginia dayflower	Pyrrhopappus	carolinianus	False dandelion
Conoclinium	coelestinum	Mist flower	Pyrularia	pubera	Buffalo-nut
Conopholis	americana	Squawroot	Quercus	alba	White oak
Consolida	ambigua	Rocket larkspur	Quercus	bicolor	Swamp white oak
Convallaria	majalis	Lily-of-the-valley	Quercus	coccinea	Scarlet oak
Conyza	canadensis	Horseweed	Quercus	falcata	Southern red oak
Corallorrhiza	odontorrhiza	Autumn coralroot	Quercus	marilandica	Blackjack oak
Corallorrhiza	wisteriana	Spring coralroot	Quercus	michauxii	Swamp chestnut oak
Coreopsis	auriculata	Lobed tickseed	Quercus	montana	Chestnut oak
Coreopsis	major	Wood tickseed	Quercus	muehlenbergii	Chinkapin oak
Coreopsis	tinctoria	Plains tickseed	Quercus	palustris	Pin oak
Coreopsis	tripteris	Tall tickseed	Quercus	rubra	Northern red oak
Cornus	amomum	Silky dogwood	Quercus	shumardii	Shumard oak
Cornus	drummondii	Rough-leaved dogwood	Quercus	stellata	Post oak
Cornus	florida	Flowering dogwood	Quercus	velutina	Black oak
Cornus	foemina	Southern swamp dogwood	Ranunculus	abortivus	Small-flowered crowfoot
Coronilla	varia	Crown-vetch	Ranunculus	acris	Common buttercup
Corydalis	flavula	Short-spurred corydalis	Ranunculus	bulbosus	Bulbous buttercup
Corylus	americana	American hazelnut	Ranunculus	carolinianus	Carolina buttercup
Crataegus	calpodenron	Hawthorn	Ranunculus	fascicularis	Thick-root buttercup
Crataegus	crus-galli	Hawthorn	Ranunculus	hispidus	Hispid buttercup
Crepis	pulchra	Hawk's beard	Ranunculus	parviflorus	Small-flowered buttercup
Crotalaria	sagittalis	Weedy rattlebox	Ranunculus	pusilus	—
Croton	glandulosus	Tooth-leaved croton	Ranunculus	recurvatus	Hooked buttercup
Croton	monanthogynus	—	Ranunculus	repens	Creeping buttercup
Cryptotaenia	canadensis	Honewort	Ranunculus	sardos	—
Cunila	origanoides	Dittany	Ranunculus	sceleratus	Cursed crowfoot
Cuphea	viscosissima	Clammy cuphea	Ratibida	pinnata	Gray coneflower
Cuscuta	campestris	Field dodder	Rhamnus	caroliniana	Carolina buckthorn
Cuscuta	compacta	Bracted dodder	Rhexia	mariana	Pale meadow beauty
Cuscuta	gronovii	Dodder	Rhexia	virginica	Meadow beauty
Cynanchum	laeve	Sandvine	Rhododendron	maximum	Rosebay rhododendron
Cynodon	dactylon	Bermuda grass	Rhododendron	minus	Small-leaved rhododendron

Table A. (continued)

Genus	Species	Common name	Genus	Species	Common name
Cynoglossum	virginianum	Wild comfrey	Rhododendron	periclymenoides	Pinxter-bush
Cyperus	acuminatus	Umbrella sedge	Rhus	aromatica	Fragrant sumac
Cyperus	croceus	Umbrella sedge	Rhus	copallina	Winged sumac
Cyperus	echinatus	Umbrella sedge	Rhus	glabra	Smooth sumac
Cyperus	esculentus	Chufa	Rhynchosia	tomentosa	Hairy rhynchosia
Cyperus	ferruginescens	Umbrella sedge	Rhynchospora	capitellata	Beak-rush
Cyperus	flavescens	Umbrella sedge	Rhynchospora	colorata	White-top sedge
Cyperus	lancastrensis	Umbrella sedge	Rhynchospora	globularis	Beak-rush
Cyperus	odoratus	Umbrella sedge	Robinia	hispida	Bristly locust
Cyperus	pseudovegetus	Umbrella sedge	Robinia	pseudoacacia	Black locust
Cyperus	retrofractus	Umbrella sedge	Rorippa	palustris	Common yellow-cress
Cyperus	strigosus	Umbrella sedge	Rorippa	sessiliflora	Southern yellow-cress
Cypripedium	acaule	Pink lady's slipper	Rosa	carolina	Carolina rose
Cystopteris	bulbifera	Bulbet fern	Rosa	multiflora	Multiflora rose
Cystopteris	protrusa	Southern fragile fern	Rosa	setigera	Prairie rose
Dactylis	glomerata	Orchard grass	Rotala	ramosior	Toothcup
Danthonia	spicata	Poverty grass	Rubus	argutus	Highbush blackberry
Dasystoma	macrophylla	Mullein-foxtail	Rubus	flagellaris	Northern dewberry
Datura	stramonium	Jimson weed	Rubus	phoenicolasius	Wineberry
Daucus	carota	Queen Anne's lace	Rudbeckia	fulgida	Eastern coneflower
Delphinium	exaltatum	Tall larkspur	Rudbeckia	hirta	Black-eyed Susan
Delphinium	tricorne	Dwarf larkspur	Rudbeckia	laciniata	Golden glow
Dennstaedtia	punctilobula	Hay-scented fern	Rudbeckia	triloba	Three-lobed coneflower
Dentaria	diphylla	Toothwort	Ruellia	caroliniensis	Carolina ruellia
Dentaria	heterophylla	Pepperwort	Ruellia	purshiana	Pursh's wild petunia
Dentaria	laciniata	Cut-leaved toothwort	Ruellia	strepens	Ruellia
Dentaria	multifida	Fine-leaved toothwort	Rumex	acetosella	Shep sorrel
Deparia	acrostichoides	Silvery glade fern	Rumex	conglomeratus	Dock
Desmanthus	illinoensis	Bundleflower	Rumex	crispus	Curled dock
Desmodium	canescens	Tick-trefoil	Rumex	obtusifolius	Bitter dock
Desmodium	ciliare	Tick-trefoil	Sabatia	angularis	Rose-pink
Desmodium	cuspidatum	Tick-trefoil	Sagittaria	australis	Appalachian arrow-head
Desmodium	glutinosum	Whorled tick-trefoil	Sagittaria	calycina	Mississippi arrow-head
Desmodium	marilandicum	Narrow tick-trefoil	Sagittaria	latifolia	Broad-leaved arrow-head
Desmodium	nudiflorum	Naked-flowered tick-trefoil	Salix	alba	White willow

Table A. (continued)

Genus	Species	Common name	Genus	Species	Common name
Desmodium	nuttallii	Nuttall's tick-trefoil	Salix	babylonica	Weeping willow
Desmodium	paniculatum	Panicled tick-trefoil	Salix	caroliniana	Carolinia willow
Desmodium	pauciflorum	Few-flowered tick-trefoil	Salix	exigua	Sandbar willow
Desmodium	rotundifolium	Prostrate tick-trefoil	Salix	humilis	Prairie willow
Desmodium	viridiflorum	Tick-trefoil	Salix	nigra	Black willow
Dianthus	armeria	Deptford pink	Salvia	lyrata	Lyre-leaved mint
Diervilla	lonicera	Bush honeysuckle	Salvia	urticifolia	Nettle-leaved sage
Digitaria	filiformis	Crabgrass	Sambucus	canadensis	American elder
Digitaria	ischaemum	Smooth crabgrass	Samolus	parviflorus	Water-pimpernel
Digitaria	sanguinalis	Crabgrass	Sanguinaria	canadensis	Bloodroot
Diodia	teres	Rough buttonweed	Sanicula	canadensis	Canada snakeroot
Diodia	virginiana	Virginia buttonweed	Sanicula	odorata	Black snakeroot
Dioscorea	batatas	Chinese yam	Sanicula	smallii	Southern snakeroot
Dioscorea	villosa	Wild yam	Saponaria	officinalis	Soapwort
Diospyros	virginiana	Persimmon	Sassafras	albidum	Sassafras
Diphasiastrum	digitatum	Ground cedar	Satureja	vulgaris	Basil
Diplazium	pycnocarpon	Glade fern	Salix	babylonica	Weeping willow
Dipsacus	fullonum	Teasel	Saururus	cernuus	Lizard's tail
Dirca	plaustris	Leatherwood	Saxifraga	careyana	Carey's saxifrage
Disporum	lanuginosum	Mandarin lily	Schizachyrium	scoparium	Little bluestem
Dodecatheon	meadia	Shooting star	Schrankia	microphylla	Sensitive-brier
Doellingeria	infirmus	Entire-leaved aster	Scirpus	americanus	Threesquare bulrush
Draba	brachycarpa	Short-fruited whitlow-grass	Scirpus	atrovirens	Black bulrush
Draba	ramosissima	Branched whitlow grass	Scirpus	cyperinus	Wool-grass
Draba	verna	Whitlow grass	Scirpus	fluviatilis	River bulrush
Dryopteris	intermedia	Fancy woodfern	Scirpus	pendulus	Bulrush
Dryopteris	marginalis	Marginal woodfern	Scirpus	polyphyllus	Many-leaved bulrush
Duchesnea	indica	Barren strawberry	Scirpus	purshianus	Bluntscale bulrush
Echinacea	purpurea	Purple coneflower	Scirpus	tabernaemontanii	Great bulrush
Echinochloa	crusgalli	Barnyard grass	Scleria	oligantha	Nut-rush
Echinochloa	muricata	Barnyard grass	Scleria	pauciflora	Nut-rush
Eclipta	prostrata	Yerba-de-tajo	Scleria	triglomerata	Nut-rush
Elaeagnus	pungens	Oleaster	Scrophularia	marilandica	Figwort
Elaeagnus	umbellata	Oleaster	Scutellaria	elliptica	Hairy skullcap
Eleocharis	acicularis	Spike-rush	Scutellaria	incana	Downy skullcap

Table A. (continued)

Genus	Species	Common name	Genus	Species	Common name
Eleocharis	erythropoda	Spike-rush	Scutellaria	integrifolia	Entire-leaved skullcap
Eleocharis	obtusa	Spike-rush	Scutellaria	lateriflora	Maddog skullcap
Eleocharis	palustris	Spike-rush	Scutellaria	leonardii	Skullcap
Eleocharis	parvula	Spike-rush	Scutellaria	nervosa	Skullcap
Eleocharis	quadrangulata	Spike-rush	Scutellaria	elliptica	Hairy skullcap
Eleocharis	tenuis	Spike-rush	Scutellaria	pseudoserrata	Skullcap
Elephantopus	carolinianus	Elephant's foot	Sedum	pulchellum	Widow's cross
Elephantopus	tomentosus	Elephant's foot	Sedum	ternatum	Wild stonecrop
Eleusine	indica	Goosegrass	Selaginella	apoda	Meadow spikemoss
Elodea	canadensis	Common water-weed	Senecio	anonymus	Yellow ragwort
Elodea	nuttallii	Free-flowered water-weed	Senecio	aureus	—
Elymus	hystrix	Bottlebrush-grass	Senecio	obovatus	Golden ragwort
Elymus	villosus	Downy wild rye	Senna	marilandica	Wild senna
Elymus	virginicus	Wild rye	Senna	obtusifolia	Sickle-pod
Elymus	virginicus	Wild rye	Sericocarpus	asteriodes	White-topped aster
Epifagus	virginiana	Beech drops	Sericocarpus	linifolius	—
Epigaea	repens	Trailing arbutus	Setaria	faberi	Foxtail
Epilobium	coloratum	Willow-herb	Setaria	parviflora	Foxtail
Equisetum	arvense	Field horsetail	Setaria	pumila	Foxtail
Equisetum	hyemale	Scouring rush	Setaria	viridis	Green foxtail
Eragrostis	cilianensis	Lovegrass	Sherardia	arvensis	Field-madder
Eragrostis	curvula	South African lovegrass	Sibara	virginica	Sibara
Eragrostis	frankii	—	Sida	spinosa	Prickly mallow
Eragrostis	hypnoides	Creeping lovegrass	Silene	antirrhina	Sleepy catchfly
Eragrostis	pectinacea	Carolina lovegrass	Silene	stellata	Starry campion
Eragrostis	spectabilis	Tumblegrass	Silene	virginica	Fire pink
Erechtites	hieracifolia	Pilewort	Silphium	asteriscus	Rosin-weed
Erianthus	alopecuroides	Beardgrass	Silphium	compositum	Lesser basal-leaved rosin-weed
Erianthus	giganteus	Tall beardgrass	Silphium	terebinthinaceum	Prairie dock
Eriogenia	bulbosa	Salt-and-pepper	Silphium	trifoliatum	Whorled rosin-weed
Erigeron	annuus	Annual fleabane	Sisyrinchium	albidum	Blue-eyed grass
Erigeron	philadelphicus	Fleabane	Sisyrinchium	angustifolium	Blue-eyed grass
Erigeron	pulchellus	Robin's plantain	Sisyrinchium	atlanticum	Blue-eyed grass
Erigeron	strigosus	Fleabane	Sisyrinchium	mucronatum	Blue-eyed grass
Erysimum	cheiranthoides	Worm-seed mustard	Smilacina	racemosa	False Solomon's seal

Table A. (continued)

Genus	Species	Common name	Genus	Species	Common name
Erythronium	americanum	Trout-lily	Smilax	bona-nox	Catbrier
Erythronium	umblicatum	Trout-lily	Smilax	ecirrata	Carrion flower
Euonymus	americanus	Heart's-a-bursting	Smilax	glauca	Glaucous catbrier
Euonymus	atropurpureus	Wahoo	Smilax	pulverulenta	Vining carrion flower
Eupatorium	album	White eupatorium	Smilax	rotundifolia	Greenbrier
Eupatorium	altissimum	Tall eupatorium	Smilax	taminoides	Bristly greenbrier
Eupatorium	capillifolium	Dog-fennel	Solanum	carolinense	Horse-nettle
Eupatorium	fistulosum	Joe-Pye-weed	Solanum	ptycanthum	Nightshade
Eupatorium	hyssopifolium	Narrow-leaved snakeroot	Solidago	arguta	—
Eupatorium	perfoliatum	Boneset	Solidago	caesia	—
Eupatorium	pilosum	Ragged eupatorium	Solidago	canadensis	Goldenrod
Eupatorium	purpureum	Woodland Joe-Pye-weed	Solidago	erecta	Erect goldenrod
Eupatorium	rotundifolium	Round-leaved snakeroot	Solidago	flexicaulis	Zig-zag goldenrod
Eupatorium	serotinum	Acuminate-leaved snakeroot	Solidago	gigantea	Tall goldenrod
Eupatorium	sessilifolium	Upland boneset	Solidago	nemoralis	Southern gray goldenrod
Euphorbia	corollata	Flowering spurge	Smilax	bona-nox	Catbrier
Euphorbia	dentata	Toothed spurge	Solidago	odora	Fragrant goldenrod
Euphorbia	heterophylla	Fire-on-the-mountain	Solidago	patula	Rough-leaved goldenrod
Euphorbia	humistrata	Spurge	Solidago	rigida	Stiff goldenrod
Euphorbia	maculata	Nodding spurge	Solidago	rugosa	Wrinkled-leaved goldenrod
Euphorbia	mercurialina	Cumberland spurge	Solidago	speciosa	Showy goldenrod
Euphorbia	nutans	Eyebane	Solidago	sphacelata	Short pappus goldenrod
Euthamia	graminifolia	Common flat-topped goldenrod	Solidago	ulmifolia	Elm-leaved goldenrod
Fagus	grandifolia	American beech	Sonchus	asper	Prickly sow-thistle
Festuca	arundinacea	Meadow fescue	Sorghastrum	nutans	Indian grass
Festuca	pratensis	Fescue	Sorghum	halepense	Johnson grass
Festuca	rubra	Red fescue	Sparganium	americanum	Bur-reed
Festuca	subverticillata	Woodland fescue	Sphenopholis	nitida	Shining sphenopholis
Fimbristylis	autumnalis	—	Sphenopholis	obtusata	Blunt sphenopholis
Fleishmannia	incarnata	Pink eupatorium	Spigelia	marilandica	Indian pink
Fothergilla	major	Witch-alder	Spiraea	tomentosa	Hardhack
Fragaria	virginiana	Wild strawberry	Spiranthes	cernua	Nodding lady's tresses
Fraxinus	americana	White ash	Spiranthes	lacera	Slender lady's tresses
Fraxinus	pennsylvanica	Green ash	Spiranthes	lucida	Shining lady's tresses
Fraxinus	quadrangulata	Blue ash	Spiranthes	ovalis	Lesser lady's tresses

Table A. (continued)

Genus	Species	Common name	Genus	Species	Common name
Galactia	volubilis	Milk pea	Spiranthes	tuberosa	Little lady's tresses
Galax	urceolata	Galax	Spiranthes	vernalis	Early lady's tresses
Galearis	spectabilis	Showy orchis	spirodela	polyrhiza	Duckweed
Galium	aparine	Cleavers	spirodela	punctata	Duckweed
Galium	circaezans	Wild licorice	Sporobolus	clandestinus	Rough dropseed
Galium	obtusum	Blunt-leaved bedstraw	Sporobolus	indicus	Smutgrass
Galium	parisiense	—	Sporobolus	neglectus	—
Galium	pedemontanum	Narrow bedstraw	Sporobolus	ozarkanus	—
Galium	pilosum	Hairy bedstraw	Sporobolus	vaginiflorus	Poverty-grass
Galium	tinctorium	Marsh bedstraw	Stachys	tenuifolia	Hedge-nettle
Galium	triflorum	Fragrant bedstraw	Staphylea	trifolia	Bladdernut
Gaultheria	procumbens	Wintergreen	Stellaria	media	Common chickweed
Gaura	biennis	Biennial gaura	Stellaria	pubera	Star chickweed
Gaura	filipes	Threadstalk gaura	Stenanthium	gramineum	Featherbells
Gaylussacia	baccata	Black huckleberry	Stipa	avenacea	Needlegrass
Gentiana	saponaria	Soap gentian	Strophostyles	helvula	Annual woolly bean
Gentiana	villosa	Hairy gentain	Strophostyles	umbellata	Wild bean
Gentianella	quinquefolia	Stiff gentian	Stylophorum	diphyllum	Celandine-poppy
Geranium	carolinianum	Carolina cranesbill	Stylosanthes	biflora	Pencil flower
Geranium	columbinum	Longstalk crane's-bill	Symphoricarpos	orbiculatus	Coral berry
Geranium	maculatum	Wild geranium	Taenidia	integerrima	Yellow pimpernel
Geum	canadense	White avens	Taraxacum	officinale	Common dandelion
Geum	vernum	Early avens	Tephrosia	spicata	Goat's rue
Geum	virginianum	Small-flowered avens	Tephrosia	virginiana	Goat's rue
Glechoma	hederacea	Ground-ivy	Teucrium	canadense	Woodsage
Gleditsia	triacanthos	Honey locust	Thalictrum	dioicum	Early meadow-rue
Glyceria	striata	Striate mannagrass	Thalictrum	revolutum	Skunk meadow-rue
Gnaphalium	obtusifolium	Catfoot	Thalictrum	thalictroides	Rue-anemone
Gnaphalium	purpureum	Purple cudweed	Thaspium	barbinode	Bearded meadow-parsnip
Goodyera	pubescens	Downy rattlesnake-plantain	Thaspium	trifoliatum	Smooth meadow-parsnip
Gratiola	neglecta	Hedge-hyssop	Thelypteris	hexagonoptera	Broad beech fern
Gratiola	virginiana	Virginia hedge-hyssop	Thelypteris	noveboracensis	New York fern
Hackelia	virginiana	Beggar's lice	Thelypteris	palustris	Marsh fern
Hamamelis	virginiana	Witch-hazel	Thlaspi	perfoliatum	Thoroughwort penny-cress
Hedeoma	pulegioides	American pennyroyal	Thuja	occidentalis	White cedar

Table A. (continued)

Genus	Species	Common name	Genus	Species	Common name
Hedyotis	caerulea	Bluets	Tiarella	cordifolia	Foamflower
Hedyotis	crassifolia	—	Tilia	americana	American basswood
Hedyotis	longifolia	Long-leaved bluets	Tipularia	discolor	Crane-fly orchid
Hedyotis	nigricans	—	Toxicodendron	radicans	Poison ivy
Hedyotis	nutalliana	—	Tradescantia	subaspera	Mountain spiderwort
Hedyotis	purpurea	Woodland bluets	Tragopogon	dubius	—
Helenium	autumnale	Autumn sneezeweed	Trichostema	brachiatum	False pennyroyal
Helenium	flexuosum	Dark-eyed sneezeweed	Trichostema	dichotomum	Bluecurls
Helianthus	angustifolius	Narrow-leaved sunflower	Tridens	flavus	Purple top
Helianthus	atrorubens	Sunflower	Trifolium	campestre	Low hop-clover
Helianthus	decapetalus	Wide-leaved sunflower	Trifolium	hybridum	Alsike clover
Helianthus	hirsutus	Hairy sunflower	Trifolium	pratense	Red clover
Helianthus	maximiliani	Sunflower	Trifolium	repens	White clover
Helianthus	microcephalus	Small wood sunflower	Trillium	luteum	Yellow trillium
Helianthus	occidentalis	Naked stemmed sunflower	Trillium	sulcatum	Trillium
Helianthus	strumosus	Rough-leaved sunflower	Trillium	vaseyi	Vasey's trillium
Helianthus	tuberosus	Jerusalem-artichoke	Triodanis	perfoliata	Venus' looking-glass
Heliopsis	helianthoides	Ox-eye	Triosteum	angustifolium	Horse-gentian
Hemerocallis	fulva	Day-lily	Tripsacum	dactyloides	Gama grass
Hepatica	acutiloba	Sharp-lobed hepatica	Tsuga	canadensis	Hemlock
Hepatica	americana	Round-lobed hepatica	Tussilago	farfara	Coltsfoot
Heterotheca	camporum	Prairie golden aster	Typha	latifolia	Wideleaf cattail
Heterotheca	graminifolia	Grass-leaved golden aster	Ulmus	alata	Winged elm
Heterotheca	mariana	Shaggy golden aster	Ulmus	americana	American elm
Heuchera	americana	Alumroot	Ulmus	rubra	Slippery elm
Heuchera	villosa	Hairy alumroot	Urtica	dioica	Stinging nettle
Hexalectris	spicata	Crested coralroot	Uvularia	grandiflora	Large-flowered bellwort
Hexastylis	arifolia	Little brown jugs	Uvularia	perfoliata	Perfoliate bellwort
Hibiscus	laevis	Smooth rose-mallow	Uvularia	sessilifolia	Wild oats
Hibiscus	moscheutos	Swamp rose-mallow	Vaccinium	arboreum	Farkleberry
Hibiscus	trionum	Flower of an hour	Vaccinium	pallidum	Pale lowbush blueberry
Hieracium	gronovii	Hairy hawkweed	Vaccinium	stamineum	Deerberry
Hieracium	venosum	Rattlesnake hawkweed	Valerianella	locusta	European corn salad
Holcus	lanatus	Velvet grass	Valerianella	radiata	Corn salad
Holosteum	umbellatum	Jagged chickweed	Verbascum	blattaria	Moth mullein

Table A. (continued)

Genus	Species	Common name	Genus	Species	Common name
Hordeum	pusillum	Little barley	Verbascum	thapsus	Mullein
Huperzia	lucidula	Shining clubmoss	Verbena	simplex	Vervain
Hybanthus	concolor	Green violet	Verbena	urticifolia	White vervain
Hydrangea	arborescens	Hydrangea	Verbesina	alternifolia	Wingstem
Hydrastis	canadensis	Golden seal	Verbesina	occidentalis	Southern flatseed-sunflower
Hydrophyllum	canadense	Maple-leaved waterleaf	Verbesina	virginica	Frostweed
Hydrophyllum	macrophyllum	Hairy waterleaf	Vernonia	gigantea	Tall ironweed
Hymenocallis	occidentalis	Spider lily	Veronica	agrestis	Field speedwell
Hypericum	densiflorum	Shrubby St. John's-wort	Veronica	anagallis-aquatica	Water speedwell
Hypericum	denticulatum	Coppery St. John's-wort	Veronica	arvensis	Corn speedwell
Hypericum	dolabriforme	—	Veronica	hederaefolia	Ivy-leaved speedwell
Hypericum	drummondii	Nits-and-lice	Veronica	officinalis	Common speedwell
Hypericum	gentianoides	Pinweed	Veronica	peregrina	Speedwell
Hypericum	gymnanthum	—	Veronica	serpyllifolia	Thyme-leaved speedwell
Hypericum	mutilum	Dwarf St. John's-wort	Veronicastrum	virginicum	Culver's root
Hypericum	perforatum	Common St. John's-wort	Viburnum	acerifolium	Maple-leaved viburnum
Hypericum	prolificum	—	Viburnum	prunifolium	Smooth blackhaw
Hypericum	punctatum	Dotted St. John's-wort	Viburnum	rufidulum	Rusty blackhaw
Hypericum	sphaerocarpum	—	Viburnum	sp.?	Wild raisin?
Hypericum	stragalum	—	Vicia	angustifolia	Narrow-leaved vetch
Hypoxis	hirsuta	Yellow star grass	Vicia	caroliniana	Pale vetch
Ilex	ambigua	Beadle's holly	Vicia	villosa	Hairy vetch
Ilex	opaca	American holly	Vinca	minor	Periwinkle
Ilex	verticillata	Winterberry	Viola	canadensis	Canadian violet
Impatiens	capensis	Orange jewelweed	Viola	conspersa	Dog violet
Impatiens	pallida	Pale jewelweed	Viola	cucullata	Marsh violet
Ipomoea	coccinea	Scarlet morning-glory	Viola	hastata	Halbert-leaved violet
Ipomoea	hederacea	Ivy-leaved morning-glory	Viola	hirsutula	Southern wood violet
Ipomoea	lacunosa	Small white morning-glory	Viola	palmata	Wood-violet
Ipomoea	pandurata	Wild potato vine	Viola	rafinesquii	Wild pansy
Ipomoea	purpurea	Purple morning-glory	Viola	sagittata	Arrow-leaved violet
Iris	cristata	Crested dwarf iris	Viola	sororia	Blue violet
Iris	pseudacorus	Yellow European iris	Viola	striata	Pale violet
Iris	virginica	Blue flag	Viola	triloba	Three-lobed violet
Isoetes	caroliniana	Carolina quillwort	Viola	tripartita	Oval-leaved violet

Table A. (continued)

Genus	Species	Common name	Genus	Species	Common name
Isotria	verticillata	Whorled popgonia	Viola	tripartita	Three-parted violet
Itea	virginica	Sweet-spire	Vitis	aestivalis	Summer grape
Iva	annua	Rough marsh-elder	Vitis	cinerea	Downy grape
Jeffersonia	diphylla	Twin leaf	Vitis	riparia	Frost-grape
Juglans	nigra	Black walnut	Vitis	rotundifolia	Muscadine
Juncus	acuminatus	Rush	Vitis	vulpina	Frost-grape
Juncus	biflorus	Rush	Vulpia	myuros	Rat-tail fescue
Juncus	brachycarpus	Rush	Vulpia	octoflora	Six-weeks fescue
Juncus	brachycephalus	Rush	Waldsteinia	fragarioides	Barren strawberry
Juncus	coriaceus	Rush	Woffia	brasiliensis	Water-meal
Juncus	debilis	Rush	Woffia	columbiana	Water-meal
Juncus	dudleyi	Rush	Woodsia	obtusa	Blunt-lobed woodsia
Juncus	effusus	Soft rush	Woodwardia	areolata	Netted chain fern
Juncus	interior	Rush	Xanthium	strumarium	Cocklebur
Juncus	marginatus	Rush	Yucca	flaccida	Yucca
Juncus	scirpoides	Rush	Zizia	aptera	Golden alexanders
Juncus	secundus	Rush	Zizia	aurea	—
Juncus	tenuis	Path rush			
Juniperus	virginiana	Red cedar			
Justicia	americana	Water-willow			
Kalmia	latifolia	Mountain laurel			
Krigia	biflora	Dwarf dandelion			

APPENDIX B
ANIMALS FOUND ON THE OAK RIDGE RESERVATION

Table B.1. Fishes on the Oak Ridge Reservation^a

Family	Genus and species	Common name
Petromyzontidae	<i>Ichthyomyzon castaneus</i> Girard	Chestnut lamprey
Polyodontidae	<i>Polyodon spathula</i> (Walbaum)	Paddlefish
Lepisosteidae	<i>Lepisosteus oculatus</i> Winchell	Spotted gar
Hiodontidae	<i>Hiodon tergisus</i> Lesueur	Mooneye
Clupeidae	<i>Alosa chrysochloris</i> (Rafinesque)	Skipjack herring
Clupeidae	<i>A. pseudoharengus</i> (Wilson)	Alewife
Clupeidae	<i>Dorosoma cepedianum</i> (Lesueur)	Gizzard shad
Clupeidae	<i>D. petenense</i> (Gunther)	Threadfin shad
Cyprinidae	<i>Campostoma oligolepis</i> Hubbs & Greene	Largescale stoneroller
Cyprinidae	<i>Carassius auratus</i> (Linnaeus)	Goldfish
Cyprinidae	<i>Ctenopharyngodon idella</i> (Valenciennes)	Grass carp
Cyprinidae	<i>Cyprinella spiloptera</i> (Cope)	Spotfin shiner
Cyprinidae	<i>C. whipplei</i> Girard	Steelcolor shiner
Cyprinidae	<i>Cyprinus carpio</i> Linnaeus	Carp
Cyprinidae	<i>Erimonax monachus</i> ^c (Cope)	Spotfin chub
Cyprinidae	<i>Hybopsis amblops</i> (Rafinesque)	Bigeye chub
Cyprinidae	<i>Luxilus chrysocephalus</i> Rafinesque	Striped shiner
Cyprinidae	<i>Lythrurus ardens</i> (Cope)	Rosefin shiner
Cyprinidae	<i>Notemigonus crysoleucas</i> (Mitchill)	Golden shiner
Cyprinidae	<i>Notropis atherinoides</i> Rafinesque	Emerald shiner
Cyprinidae	<i>Phoxinus tennesseensis</i> Starnes & Jenkins	Tennessee dace
Cyprinidae	<i>Pimephales notatus</i> (Rafinesque)	Bluntnose minnow
Cyprinidae	<i>P. promelas</i> Rafinesque	Fathead minnow
Cyprinidae	<i>Semotilus atromaculatus</i> (Mitchill)	Creek chub
Catostomidae	<i>Carpiodes carpio</i> (Rafinesque)	River carpsucker
Catostomidae	<i>C. cyprinus</i> (Lesueur)	Quillback
Catostomidae	<i>Catostomus commersoni</i> (Lacepede)	White sucker

Table B.1. (continued)

Family	Genus and species	Common name
Catostomidae	<i>Hypentelium nigricans</i> (Lesueur)	Northern hog sucker
Catostomidae	<i>Ictiobus bubalus</i> (Rafinesque)	Smallmouth buffalo
Catostomidae	<i>I. niger</i> (Rafinesque)	Black buffalo
Catostomidae	<i>Minytrema melanops</i> (Rafinesque)	Spotted sucker
Catostomidae	<i>Moxostoma anisurum</i> (Rafinesque)	Silver redhorse
Catostomidae	<i>M. duquesnei</i> (Lesueur)	Black redhorse
Catostomidae	<i>M. erythrurum</i> (Rafinesque)	Golden redhorse
Ictaluridae	<i>Ameiurus melas</i> (Rafinesque)	Black bullhead
Ictaluridae	<i>A. natalis</i> (Lesueur)	Yellow bullhead
Ictaluridae	<i>Ictalurus furcatus</i> (Lesueur)	Blue catfish
Ictaluridae	<i>I. punctatus</i> (Rafinesque)	Channel catfish
Ictaluridae	<i>Pylodictis olivaris</i> (Rafinesque)	Flathead catfish
Esocidae	<i>Esox lucius</i> Linnaeus	Northern pike
Esocidae	<i>E. masquinongy</i> Mitchill	Muskellunge
Atherinidae	<i>Labidesthes sicculus</i> (Cope)	Brook silverside
Poeciliidae	<i>Gambusia affinis</i> (Baird and Girard)	Mosquitofish
Gasterosteidae	<i>Culaea inconstans</i> (Kirtland)	Brook stickleback
Cottidae	<i>Cottus carolinae</i> (Gill)	Banded sculpin
Percichthyidae	<i>Morone chrysops</i> (Rafinesque)	White bass
Percichthyidae	<i>M. mississippiensis</i> Jordan and Eigenmann	Yellow bass
Percichthyidae	<i>M. saxatilis</i> (Walbaum)	Striped bass
Centrarchidae	<i>Ambloplites rupestris</i> (Rafinesque)	Rock bass
Centrarchidae	<i>Lepomis auritus</i> (Linnaeus)	Redbreast sunfish
Centrarchidae	<i>L. cyanellus</i> Rafinesque	Green sunfish
Centrarchidae	<i>L. gulosus</i> (Cuvier)	Warmouth
Centrarchidae	<i>L. macrochirus</i> Rafinesque	Bluegill
Centrarchidae	<i>L. megalotis</i> (Rafinesque)	Longear sunfish
Centrarchidae	<i>L. microlophus</i> (Gunther)	Redear sunfish
Centrarchidae	<i>Micropterus dolomieu</i> Lacepede	Smallmouth bass
Centrarchidae	<i>M. punctulatus</i> (Rafinesque)	Spotted bass

Table B.1. (continued)

Family	Genus and species	Common name
Centrarchidae	<i>M. salmoides</i> (Lacepede)	Largemouth bass
Centrarchidae	<i>Pomoxis annularis</i> Rafinesque	White crappie
Centrarchidae	<i>P. nigromaculatus</i> (Lesueur)	Black crappie
Percidae	<i>Etheostoma blennioides</i> Rafinesque	Greenside darter
Percidae	<i>E. duryi</i> Henshall	Blackside snubnose darter
Percidae	<i>E. jessiae</i> (Jordan & Brayton)	Blueside darter
Percidae	<i>E. kennicotti</i> (Putnam)	Stripetail darter
Percidae	<i>E. rufilineatum</i> (Cope)	Redline darter
Percidae	<i>E. simoterum</i> (Cope)	Snubnose darter
Percidae	<i>Perca flavescens</i> (Mitchill)	Yellow perch
Percidae	<i>Percina caprodes</i> (Rafinesque)	Logperch
Percidae	<i>P. sciera</i> (Swain)	Dusky darter
Percidae	<i>Sander canadense</i> (Griffith & Smith)	Sauger
Percidae	<i>S. vitreus</i> (Mitchill)	Walleye
Sciaenidae	<i>Aplodinotus grunniens</i> (Rafinesque)	Freshwater drum

^aBased on "A Checklist of Fishes on the Department of Energy Oak Ridge Reservation," Michael G. Ryon and James M. Loar, Oak Ridge National Laboratory, *Journal of the Tennessee Academy of Science*, Vol. 63, Number 4, October 1988, updates by M. G. Ryon, August 2006.

^bTaxonomic classifications and names based on J. S. Nelson, E. J. Crossman, H. Espinosa-Perez, L. T. Findley, C. R. Gilbert, R. N. Lea, and J. D. Williams, *Common and Scientific Names of Fishes from the United States, Canada, and Mexico*, American Fisheries Society, Special Publication 29, Bethesda, Maryland, 2004.

^cSpecimen was collected in section of East Fork Poplar Creek in Oak Ridge, Tennessee, between two parcels of the Oak Ridge Reservation.

Table B.2. Reptiles, amphibians, and mammals on the Oak Ridge Reservation

Common name	Scientific name
Reptiles and amphibians	
Spotted salamander	<i>Ambystoma maculatum</i>
Marbled salamander	<i>Ambystoma opacum</i>
Eastern tiger salamander	<i>Ambystoma tigrinum</i>
Red spotted newt	<i>Notophthalmus viridescens</i>
Dusky salamander	<i>Desmognathus fuscus</i>
Two-lined salamander	<i>Eurycea bislineata</i>
Longtail salamander	<i>Eurycea longicauda</i>
Cave salamander	<i>Eurycea lucifuga</i>
Spring salamander	<i>Gyrinophilus porphyriticus</i>
Slimy salamander	<i>Plethodon glutinosus</i>
Four-toed salamander	<i>Hemidactylium scutatum</i>
Red salamander	<i>Pseudotriton ruber</i>
Eastern spadefoot toad	<i>Scaphiopus holbrookii</i>
American toad	<i>Bufo americanus</i>
Spring peeper	<i>Pseudacris crucifer</i>
Gray treefrog	<i>Hyla versicolor</i>
Eastern narrow mouth toad	<i>Gastrophryne carolinensis</i>
Chorus frog	<i>Pseudacris triseriata</i>
Bull frog	<i>Rana catesbeiana</i>
Green frog	<i>Rana clamitans</i>
Southern leopard frog	<i>Rana utricularia</i>
Snapping turtle	<i>Chelydra serpentina</i>
Stripeneck musk turtle	<i>Sternotherus minor</i>
Stinkpot	<i>Sternotherus odoratus</i>
Eastern box turtle	<i>Terrapene carolina</i>
Map turtle	<i>Graptemys geographica</i>
Painted turtle	<i>Chrysemys picta</i>
Red-eared slider	<i>Trachemys scripta elegans</i>
Cumberland slider	<i>Trachemys scripta troosti</i>
Spinny softshell	<i>Apalone spinifra</i>
Fence lizard	<i>Sceloporus undulatus</i>
Six-lined racerunner	<i>Cnemidophorus sexlineatus</i>
Ground skink	<i>Scincella lateralis</i>
Five-lined skink	<i>Eumeces fasciatus</i>
Worm snake	<i>Carphophis amoenus</i>

Table B.2. (continued)

Common name	Scientific name
Black racer	<i>Coluber constrictor</i>
Ringneck snake	<i>Diadophis punctatus</i>
Corn snake	<i>Elaphe guttata</i>
Rat snake	<i>Elaphe obsoleta</i>
Black kingsnake	<i>Lampropeltis getula</i>
Northern water snake	<i>Nerodia sipedon</i>
Brown snake	<i>Storeria dekayi</i>
Eastern garter snake	<i>Thamnophis sirtalis</i>
Smooth earth snake	<i>Virginia valeriae</i>
Copperhead	<i>Agkistrodon contortrix</i>
Mammals	
Opposum	<i>Didelphis virginiana</i>
Southeastern shrew ^a	<i>Sorex longirostris</i>
Shorttailed shrew	<i>Blarina brevicauda</i>
Least shrew	<i>Cryptotis parva</i>
Eastern mole	<i>Scalopus aquaticus</i>
Gray bat ^b	<i>Myotis grisescens</i>
Eastern pipistrelle	<i>Pipistrellus subflavus</i>
Silver-haired bat	<i>Lasionycteris noctivagans</i>
Big brown bat	<i>Eptesicus fuscus</i>
Eastern red bat	<i>Lasiurus borealis</i>
Evening bat	<i>Nycticeius humeralis</i>
Eastern cottontail	<i>Sylvilagus floridanus</i>
Eastern chipmunk	<i>Tamias striatus</i>
Groundhog	<i>Marmota monax</i>
Eastern gray squirrel	<i>Sciurus carolinensis</i>
Southern flying squirrel	<i>Glaucomys volans</i>
Beaver	<i>Castor canadensis</i>
Eastern harvest mouse	<i>Reithrodontomys humulis</i>
White-footed mouse	<i>Peromyscus leucopus</i>
Golden mouse	<i>Peromyscus nuttalli</i>
Deer mouse	<i>Peromyscus maniculatus</i>
Hispid cotton rat	<i>Sigmodon hispidus</i>
Pine vole	<i>Pitymys pinetorum</i>
Meadow vole	<i>Microtus pennsylvanicus</i>
Muskrat	<i>Ondatra zibethica</i>
Norway rat	<i>Rattus norvegicus</i>

Table B.2. (continued)

Common name	Scientific name
House mouse	<i>Mus musculus</i>
Coyote	<i>Canis latrans</i>
Red fox	<i>Vulpes vulpes</i>
Gray fox	<i>Urocyon cinereoargenteus</i>
Raccoon	<i>Procyon lotor</i>
Mink	<i>Mustela vison</i>
Striped skunk	<i>Mephitis mephitis</i>
Whitetailed deer	<i>Odocoileus virginianus</i>
Elk	<i>Cervus canadensis</i>

^aDeemed by state as in need of management.

^bFederally endangered.

Table B.3. Birds on the Oak Ridge Reservation

Common name	Scientific name	Presence	Status
Loons			
Common loon	<i>Gavia immer</i>	Winter	
Grebes			
Pied-billed grebe	<i>Podilymbus podiceps</i>	Casual visitor	
Horned grebe	<i>Podiceps auritus</i>	Winter	
Eared grebe	<i>Podiceps nigricollis</i>	Transient	
Cormorants			
Double-crested cormorant	<i>Phalacrocorax auritus</i>	Casual visitor	
Darters			
Anhinga	<i>Anhinga anhinga</i>	Transient	NM
Bitterns and herons			
Great blue heron	<i>Ardea herodias</i>	Breeder	
Great egret	<i>Ardea alba</i>	Casual visitor	NM
Snowy egret	<i>Egretta thula</i>	Migrant	NM
Little blue heron	<i>Egretta caerulea</i>	Casual visitor	NM
Green heron	<i>Butorides virescens</i>	Breeder	
Black-crowned night-heron	<i>Nycticorax nycticorax</i>	Breeder	
Swans, geese, and ducks			
Mute swan	<i>Cygnus olor</i>	Casual visitor	
Canada goose	<i>Anser canadensis</i>	Breeder	
Ross' goose	<i>Chen rossii</i>	Migrant	
Snow goose	<i>Chen caerulescens</i>	Migrant	
Greater white-fronted goose	<i>Anser albifrons</i>	Migrant	
Wood duck	<i>Aix sponsa</i>	Breeder	
Green-winged teal	<i>Anas crecca</i>	Winter	
American black duck	<i>Anas rubripes</i>	Winter	
Mallard	<i>Anas platyrhynchos</i>	Breeder	

Table B.3. (continued)

Common name	Scientific name	Presence	Status
Northern pintail	<i>Anas acuta</i>	Winter	
Blue-winged teal	<i>Anas discors</i>	Winter	
Gadwall	<i>Anas strepera</i>	Winter	
American wigeon	<i>Anas americana</i>	Winter	
Northern shoveler	<i>Anas clypeata</i>	Winter	
Canvasback	<i>Aythya valisineria</i>	Winter	
Ring-necked duck	<i>Aythya collaris</i>	Winter	
Greater scaup	<i>Aythya marila</i>	Winter	
Lesser scaup	<i>Aythya affinis</i>	Winter	
Bufflehead	<i>Bucephala clangula</i>	Winter	
Hooded merganser	<i>Lophodytes cucullatus</i>	Winter	
Red-breasted merganser	<i>Mergus serrator</i>	Winter	
Common merganser	<i>Mergus merganser</i>	Winter	
Ruddy duck	<i>Oxyura jamaicensis</i>	Winter	
Vultures			
Black vulture	<i>Coragyps atratus</i>	Breeder	
Turkey vulture	<i>Cathartes aura</i>	Breeder	
Kites, hawks, eagles, and allies			
Osprey	<i>Pandion haliaetus</i>	Breeder	
Bald eagle	<i>Haliaeetus leucocephalus</i>	Casual visitor	FT, NM
Northern harrier	<i>Circus cyaneus</i>	Winter	NM
Sharp-shinned hawk	<i>Accipiter striatus</i>	Possible breeder	NM
Cooper's hawk	<i>Accipiter cooperii</i>	Possible breeder	
Red-shouldered hawk	<i>Buteo lineatus</i>	Breeder	
Red-tailed hawk	<i>Buteo jamaicensis</i>	Breeder	
Broad-winged hawk	<i>Buteo platypterus</i>	Breeder	
Falcons			
American kestrel	<i>Falco sparverius</i>	Breeder	
Peregrine falcon	<i>Falco peregrinus</i>	Migrant	SE
Grouse, turkey, and quail			
Ruffed grouse	<i>Bonasa umbellus</i>	Casual visitor	
Wild turkey	<i>Meleagris gallopavo</i>	Breeder	
Northern bobwhite	<i>Colinus virginianus</i>	Breeder	
Rails and coots			
Sora	<i>Porzana carolina</i>	Migrant	
American coot	<i>Fulica americana</i>	Casual visitor	
Cranes			
Sandhill crane	<i>Grus canadensis</i>	Migrant	
Plovers			
Killdeer	<i>Charadrius vociferus</i>	Breeder	
Semipalmated plover	<i>Charadrius semipalmatus</i>	Migrant	
Sandpipers and allies			
Greater yellowlegs	<i>Tringa melanoleuca</i>	Migrant	
Lesser yellowlegs	<i>Tringa flavipes</i>	Migrant	
Solitary sandpiper	<i>Tringa solitaria</i>	Migrant	
Spotted sandpiper	<i>Actitis macularius</i>	Casual visitor	

Table B.3. (continued)

Common name	Scientific name	Presence	Status
Pectoral sandpiper	<i>Calidris melanotos</i>	Migrant	
White-rumped sandpiper	<i>Calidris fuscicollis</i>	Migrant	
Least sandpiper	<i>Calidris minutilla</i>	Migrant	
Common snipe	<i>Gallinago gallinago</i>	Winter	
American woodcock	<i>Scolopax minor</i>	Breeder	
Gulls and terns			
Bonaparte's gull	<i>Larus philadelphia</i>	Winter	
Ring-billed gull	<i>Larus delawarensis</i>	Winter	
Caspian tern	<i>Sterna caspia</i>	Transient	
Forster's tern	<i>Sterna forsteri</i>	Transient	
Pigeons and doves			
Rock pigeon	<i>Columba livia</i>	Breeder	
Mourning dove	<i>Zenaida macroura</i>	Breeder	
Cuckoos			
Yellow-billed cuckoo	<i>Coccyzus americanus</i>	Breeder	
Owls			
Northern saw-whet owl	<i>Aegolius acadicus</i>	Transient	
Eastern screech-owl	<i>Megascops asio</i>	Breeder	
Great horned owl	<i>Bubo virginianus</i>	Breeder	
Barred owl	<i>Strix varia</i>	Breeder	
Barn owl	<i>Tyto alba</i>	Possible breeder	NM
Goatsuckers			
Common nighthawk	<i>Chordeiles minor</i>	Breeder	
Chuck-will's-widow	<i>Caprimulgus carolinensis</i>	Breeder	C
Whip-poor-will	<i>Caprimulgus vociferus</i>	Breeder	
Swifts			
Chimney swift	<i>Chaetura pelagica</i>	Breeder	
Hummingbirds			
Ruby-throated hummingbird	<i>Archilochus colubris</i>	Breeder	
Kingfishers			
Belted kingfisher	<i>Ceryle alcyon</i>	Breeder	
Woodpeckers			
Red-bellied woodpecker	<i>Melanerpes carolinus</i>	Breeder	
Red-headed woodpecker	<i>Melanerpes erythrocephalus</i>	Breeder	
Yellow-bellied sapsucker	<i>Sphyrapicus varius</i>	Winter	NM
Downy woodpecker	<i>Picoides pubescens</i>	Breeder	
Hairy woodpecker	<i>Picoides villosus</i>	Breeder	
Northern flicker	<i>Colaptes auratus</i>	Breeder	
Pileated woodpecker	<i>Dryocopus pileatus</i>	Breeder	
Tyrant flycatchers			
Olive-sided flycatcher	<i>Contopus cooperi</i>	Migrant	NM
Eastern wood-pewee	<i>Contopus virens</i>	Breeder	
Acadian flycatcher	<i>Empidonax vireescens</i>	Breeder	
Willow flycatcher	<i>Empidonax trailii</i>	Breeder	
Eastern phoebe	<i>Sayornis phoebe</i>	Breeder	

Table B.3. (continued)

Common name	Scientific name	Presence	Status
Great crested flycatcher	<i>Myiarchus crinitus</i>	Breeder	
Eastern kingbird	<i>Tyrannus tyrannus</i>	Breeder	
Western kingbird	<i>Tyrannus verticalis</i>	Transient	
Larks			
Horned lark	<i>Eremophila alpestris</i>	Casual visitor	
Swallows			
Purple martin	<i>Progne subis</i>	Breeder	
Tree swallow	<i>Tachycineta bicolor</i>	Breeder	
Northern rough-winged swallow	<i>Stelgidopteryx serripennis</i>	Breeder	
Cliff swallow	<i>Petrochelidon fulva</i>	Breeder	
Barn swallow	<i>Hirundo rustica</i>	Breeder	
Bank swallow	<i>Petrochelidon pyrrhonota</i>	Migrant	
Jays and crows			
Blue jay	<i>Cyanocitta cristata</i>	Breeder	
American crow	<i>Corvus brachyrhynchos</i>	Breeder	
Titmice and chickadees			
Carolina chickadee	<i>Poecile carolinensis</i>	Breeder	
Tufted titmouse	<i>Baeolophus bicolor</i>	Breeder	
Nuthatches			
Red-breasted nuthatch	<i>Sitta canadensis</i>	Winter	
White-breasted nuthatch	<i>Sitta carolinensis</i>	Breeder	
Brown-headed nuthatch	<i>Sitta pusilla</i>	Breeder	C
Creepers			
Brown creeper	<i>Certhia americana</i>	Winter	
Wrens			
Carolina wren	<i>Thryothorus ludovicianus</i>	Breeder	
House wren	<i>Troglodytes aedon</i>	Breeder	
Winter wren	<i>Troglodytes troglodytes</i>	Winter	
Sedge wren	<i>Cistothorus platensis</i>	Migrant	
Marsh wren	<i>Cistothorus palustris</i>	Migrant	
Kinglets, gnatcatchers, and thrushes			
Golden-crowned kinglet	<i>Regulus satrapa</i>	Winter	
Ruby-crowned kinglet	<i>Regulus calendula</i>	Winter	
Blue-gray gnatcatcher	<i>Polioptila caerulea</i>	Breeder	
Eastern bluebird	<i>Sialia sialis</i>	Breeder	
Veery	<i>Catharus fuscescens</i>	Migrant	
Swainson's thrush	<i>Catharus ustulatus</i>	Migrant	
Hermit thrush	<i>Catharus guttatus</i>	Winter	
Wood thrush	<i>Hylocichla mustelina</i>	Breeder	C
American robin	<i>Turdus migratorius</i>	Breeder	
Varied thrush	<i>Ixoreus naevius</i>	Transient	
Pipits and wagtails			
American pipit	<i>Anthus rubescens</i>	Migrant	
Thrashers and mockingbirds			
Gray catbird	<i>Dumetella carolinensis</i>	Breeder	

Table B.3. (continued)

Common name	Scientific name	Presence	Status
Northern mockingbird	<i>Mimus polyglottos</i>	Breeder	
Brown thrasher	<i>Toxostoma rufum</i>	Breeder	
Waxwings			
Cedar waxwing	<i>Bombycilla cedrorum</i>	Breeder	
Shrikes			
Loggerhead shrike	<i>Lanius ludovicianus</i>	Transient	NM
Starlings			
European starling	<i>Sturnus vulgaris</i>	Breeder	
Vireos			
White-eyed vireo	<i>Vireo griseus</i>	Breeder	
Blue-headed vireo	<i>Vireo solitarius</i>	Migrant	
Yellow-throated vireo	<i>Vireo flavifrons</i>	Breeder	
Red-eyed vireo	<i>Vireo olivaceus</i>	Breeder	
Warbling vireo	<i>Vireo gilvus</i>	Casual visitor	
Wood warblers			
Blue-winged warbler	<i>Vermivora pinus</i>	Breeder	C
Golden-winged warbler	<i>Vermivora chrysotera</i>	Migrant	NM, C
Tennessee warbler	<i>Vermivora peregrina</i>	Migrant	
Nashville warbler	<i>Vermivora ruficapilla</i>	Migrant	
Northern parula	<i>Parula americana</i>	Breeder	
Yellow warbler	<i>Dendroica petechia</i>	Breeder	
Chestnut-sided warbler	<i>Dendroica pensylvanica</i>	Migrant	
Magnolia warbler	<i>Dendroica magnolia</i>	Migrant	
Cape May warbler	<i>Dendroica tigrina</i>	Migrant	
Black-throated blue warbler	<i>Dendroica caerulescens</i>	Migrant	C
Yellow-rumped warbler	<i>Dendroica coronata</i>	Winter	
Black-throated green warbler	<i>Dendroica virens</i>	Possible breeder	
Blackburnian warbler	<i>Dendroica fusca</i>	Migrant	
Yellow-throated warbler	<i>Dendroica dominica</i>	Breeder	
Pine warbler	<i>Dendroica pinus</i>	Breeder	
Prairie warbler	<i>Dendroica discolor</i>	Breeder	C
Palm warbler	<i>Dendroica palmarum</i>	Migrant	
Bay-breasted warbler	<i>Dendroica castanea</i>	Migrant	
Blackpoll warbler	<i>Dendroica striata</i>	Migrant	
Cerulean warbler	<i>Dendroica cerulea</i>	Possible breeder	NM, C
Black-and-white warbler	<i>Mniotilta varia</i>	Possible breeder	
American redstart	<i>Setophaga ruticilla</i>	Possible breeder	
Prothonotary warbler	<i>Protonotaria citrea</i>	Breeder	C
Worm-eating warbler	<i>Helmitheros vermivorus</i>	Breeder	C
Ovenbird	<i>Seiurus aurocapillus</i>	Breeder	
Northern waterthrush	<i>Seiurus novaboracensus</i>	Migrant	
Louisiana waterthrush	<i>Seiurus motacilla</i>	Possible breeder	C
Kentucky warbler	<i>Oporornis formosus</i>	Breeder	C
Common yellowthroat	<i>Geothlypis trichas</i>	Breeder	
Hooded warbler	<i>Wilsonia citrina</i>	Breeder	
Wilson's warbler	<i>Wilsonia pusilla</i>	Migrant	

Table B.3. (continued)

Common name	Scientific name	Presence	Status
Canada warbler	<i>Wilsonia canadensis</i>	Migrant	
Yellow-breasted chat	<i>Icteria virens</i>	Breeder	
Tanagers			
Summer tanager	<i>Piranga rubra</i>	Breeder	
Scarlet tanager	<i>Piranga olivacea</i>	Breeder	
Cardinals, grosbeaks, and allies			
Northern cardinal	<i>Cardinalis cardinalis</i>	Breeder	
Rose-breasted grosbeak	<i>Pheucticus ludovicianus</i>	Migrant	
Blue grosbeak	<i>Passerina caerulea</i>	Breeder	
Indigo bunting	<i>Passerina cyanea</i>	Breeder	
Dickcissel	<i>Spiza americana</i>	Casual visitor	
Towhees, sparrows, and allies			
Eastern towhee	<i>Pipilo erythrophthalmus</i>	Breeder	
American tree sparrow	<i>Spizella arborea</i>	Winter	
Chipping sparrow	<i>Spizella passerina</i>	Breeder	
Field sparrow	<i>Spizella pusilla</i>	Breeder	C
Savannah sparrow	<i>Passerculus sandwichensis</i>	Migrant+winter	
Grasshopper sparrow	<i>Ammodramus savannarum</i>	Breeder	
Fox sparrow	<i>Passerella iliaca</i>	Winter	
Song sparrow	<i>Melospiza melodia</i>	Breeder	
Swamp sparrow	<i>Melospiza georgiana</i>	Winter	
White-throated sparrow	<i>Zonotrichia albicollis</i>	Winter	
White-crowned sparrow	<i>Zonotrichia leucophrys</i>	Migrant	
Vesper sparrow	<i>Poocetes gramineus</i>	Migrant	NM
Dark-eyed junco	<i>Junco hyemalis</i>	Winter	
Blackbirds and allies			
Bobolink	<i>Dolichonyx oryzivorus</i>	Migrant	
Red-winged blackbird	<i>Agelaius phoeniceus</i>	Breeder	
Eastern meadowlark	<i>Sturnella magna</i>	Breeder	
Common grackle	<i>Quiscalus quiscula</i>	Breeder	
Brown-headed cowbird	<i>Molothrus ater</i>	Breeder	
Orchard oriole	<i>Icterus spurius</i>	Breeder	
Baltimore oriole	<i>Icterus galbula</i>	Breeder	
Finches			
Purple finch	<i>Carpodacus purpureus</i>	Winter	
House finch	<i>Carpodacus mexicanus</i>	Breeder	
Pine siskin	<i>Carduelis pinus</i>	Migrant	
American goldfinch	<i>Carduelis tristis</i>	Breeder	
Evening grosbeak	<i>Coccothraustes vespertinus</i>	Migrant	
Old world sparrows			
House sparrow	<i>Passer domesticus</i>	Breeder	

C = Partners in Flight-designated birds of concern.

FT = Federally threatened.

NM = Deemed by the state as in need of management.

SE = State endangered.

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