S01030100-PIN10001
Rev. 1

# Spallation Neutron Source Second Target Station Construction Project Biological Assessment

M. K. McCracken
Evin T. Carter

**June 2024**

OAK RIDGE National Laboratory

ORNL IS MANAGED BY UT-BATTELLE LLC FOR THE US DEPARTMENT OF ENERGY

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Second Target Station Project

# SPALLATION NEUTRON SOURCE SECOND TARGET STATION CONSTRUCTION PROJECT BIOLOGICAL ASSESSMENT

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June 2024

Prepared by
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, TN 37831
managed by
UT-BATTELLE LLC
for the
US DEPARTMENT OF ENERGY
under contract DE-AC05-00OR22725

# APPROVALS

ISSUE DATE:

| Second Target Station (STS) Construction Project Biological Assessment | | June 2024 |
|---|---|---|
| PREPARED BY<br>M.K. McCracken<br>Evin T. Carter | PROJECT<br>Second Target Station | DOCUMENT NUMBER:<br>S01030100-PIN10001 Rev. 1 |
| | | |

| | Signature / Date | | | | | |
|---|---|---|---|---|---|---|
| | Rev. 00 | Date | Rev. 01 | Date | Rev. 02 | Date |
| Project Director | | | Graeme R. Murdoch | | | |
| ESH&Q Manager | | | Steven M. Trotter | | | |

| Revision | Description |
|---|---|
| 00 | Initial Release – supersedes S01030100-PIN10001 Rev. 0. SPALLATION NEUTRON SOURCE SECOND TARGET STATION OAK RIDGE NATIONAL LABORATORY BIOLOGICAL ASSESSMENT, March 2023. |
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# 1. INTRODUCTION

The Endangered Species Act of 1973 (16 U.S.C. 153 *et seq*.), as amended (ESA or Act) in section 7(a)(1) directs Federal agencies to conserve and recover listed species and use their authorities in the furtherance of the purposes of the Act by carrying out programs for the conservation of endangered and threatened species so that listing is no longer necessary (50 CFR §402). Furthermore, the Act in section 7(a)(2) directs Federal agencies to consult (referred to as section 7 consultation) with the U.S. Fish and Wildlife Service (USFWS) when their activities "may affect" a listed species or designated critical habitat.

## 1.1 PURPOSE OF THIS BIOLOGICAL ASSESSMENT

This biological assessment (BA) analyzes the potential effects of the proposed Spallation Neutron Source Second Target Station STS construction project on the U. S. Department of Energy Oak Ridge Reservation (ORR) on Federal listed threatened, endangered, proposed, and under consideration for Federal listing bat species, pursuant to section 7(a)(2) of the ESA. Federal listed threatened and endangered bat species meeting the following criteria are addressed in this assessment:

1. known to occur in the ORR based on confirmed mist net captures
2. known to occur in the ORR based on consistently detected and vetted acoustic recordings
3. may occur in the ORR based on unconfirmed sightings and acoustic recordings
4. presence of potential habitat for the species on the ORR or
5. reasonable expectation of adverse effects to these species owing to the project.

## 1.2 CURRENT MANAGEMENT DIRECTION

Current management direction for Federal listed and proposed threatened and endangered species can be found in the following documents, filed at our office:

- Endangered Species Act of 1973, as amended (ESA or Act)
- Migratory Bird Treaty Act (MBTA)
- National Environmental Policy Act (NEPA)
- Conservation Strategy for Forest-dwelling Bats in Tennessee (USFWS)
- Gray Bat Recovery Plan (USFWS)
- Indiana Bat and Northern Long-eared Bat Conservation Research/Monitoring Needs (USFWS)
- Guidance on Developing and Implementing an Indiana Bat Conservation Plan (USFWS)
- Management direction specific to the ORR, formed with consideration of the above documents, can be found in the following documents:
    - Wildlife Management Plan for the Oak Ridge Reservation (Carter et al. 2020b)
    - Forest Management Plan for the DOE Oak Ridge Reservation (Parr et al. 2015)

## 2. CONSULTATION HISTORY

**Table 2.1. Consultation History: Spallation Neutron Sources Second Target Station.**

| US DOE Oak Ridge Reservation, Oak Ridge, Tennessee | | | | |
|---|---|---|---|---|
| **Date** | **Contact type** | **From** | **To** | **Subject** |
| 12/03/2021 | Email | McCracken | Pelren, Sykes | STS Construction project |
| 12/09/2021 | Email | Alexander | McCracken | Point locations requested for project |
| 12/09/2021 | Email | McCracken | Alexander | Replied with point locations |
| 12/10/2021 | Email | McCracken | Sikula | Re: Biological Assessment information |
| 12/15/2021 | Email | Alexander | McCracken | Set up a meeting? |
| 12/15/2022 | Email | McCracken | Alexander | Will request a virtual meeting |
| 12/16/2022 | Email | Alexander | McCracken | Agreed with meeting date of 01/05/2022 |
| 01/05/2022 | Online meeting | Sikula, Alexander, Sykes, Pelren, Shaw, Santiago, Trotter, McCracken, Giffen, Carter, DOE rep. | | Discussed the STS Construction project potential effects on Federal listed bat species present on the ORR. Mentioned a potential mitigation plan. |
| 01/26/2022 | Email | Sikula | McCracken | Provided information on consultation for SNS/STS project |
| 02/04/2022 | Email | Alexander | McCracken | Request phone call re: STS construction project |
| 02/04/2022 | Email | McCracken | Alexander | Replied to have a phone call |
| 02/04/2022 | Phone call | Alexander | McCracken | Discussed best path forward to see if formal consultation is necessary for STS construction project |
| 03/02/2022 | Email | McCracken | Alexander | Request site visit by USFWS to SNS/STS site and proposed mitigation sites |
| 03/02/2022 | Email | Alexander | McCracken | Set up meeting last week of March |
| 03/03/2022 | Email | McCracken | Alexander | Meeting on 03/38/2022? |
| 03/03/2022 | Email | Alexander | McCracken | Agreed to on site meeting: USFWS, DOE, Natural Resources Management, STS project manager |
| 03/28/2022 | Site Visit | Shewairy, Doty, Elbert, Sikula, Alexander, Pelren, Trotter, Giffen, Carter, McCracken, Darling | | Meeting:<br>1. Trotter summary of STS project<br>2. McCracken summary of Federal listed species recorded during acoustic surveys of STS construction project site<br>3. Visit to STS facility<br>4. Visit to STS construction project impact area<br>5. Visit to suggested mitigation areas: Gallaher Bend |
| 03/29/2022 | Email | Alexander | McCracken | Request shape files of STS construction project area and mitigation area and Power Point slides |
| 03/30/2022 | Email | McCracken | Alexander | Provided shape files and Power Point slides |
| 03/30/2022 | Email | Sikula | McCracken | Summary of site visit |
| 04/21/2022` | Email | McCracken | Alexander | Request to proceed with GPA ground truthing survey of STS construction project site |
| 04/21/2022 | Email | Alexander | McCracken | Approval granted for GPS survey |

**Table 2.1. Consultation History: Spallation Neutron Sources Second Target Station (continued).**

| US DOE Oak Ridge Reservation, Oak Ridge, Tennessee | | | | |
|---|---|---|---|---|
| **Date** | **Contact type** | **From** | **To** | **Subject** |
| 06/07/2022 | Phone call | McCracken | Sikula | Request guidance to proceed with consultation |
| 06/07/2022 | Email | Sikula | McCracken | Provided a template for Biological Assessment for STS construction project to provide to USFWS |
| 04/25/2024 | Phone call | McCracken | Alexander | Discuss submitting BA without additional acoustic bat surveys |

Shewairy= John Shewairy, DOE Manager for the Oak Ridge Reservation
Doty=Walt Doty, DOE Oak Ridge Site Office, NEPA Officer
McCracken=Kitty McCracken, ORNL Natural Resources Management Team, Ecosystem Management Coordinator
Giffen=Neil Giffen, ORNL Natural Resources Manager for the Oak Ridge Reservation
Carter=Evin Carter, ORNL Natural Resources Management Team, Wildlife Ecologist
Darling=Sarah Darling, ORNL Natural Resources Management Team, Wildlife Technician
Trotter=Steven Trotter, Spallation Neutron Source Second Target Station, ESHQ Manager
Elbert=Daniel Elbert, USFWS Tennessee Ecological Services Field Office, Field Supervisor
Alexander=Steve Alexander, USFWS Tennessee Field Office
Sikula=Nicole Sikula, USFWS Tennessee Ecological Services Field Office, Deputy Field Supervisor
Pelren=David Pelren, USFWS Tennessee Field Office
Sykes=Robbie Sykes, USFWS Tennessee Field Office

## 3. PROPOSED MANAGEMENT ACTION AND ALTERNATIVES CONSIDERED

The US Department of Energy's (DOE) Oak Ridge National Laboratory (ORNL) is a leading institution in advanced materials, supercomputing, neutrons, and nuclear science. As a research laboratory managed by UT-Battelle, LLC for DOE, ORNL has national priorities in energy, security, and scientific discovery that necessitate facility improvements and expansions. DOE is also committed to environmental stewardship. The laboratory is located on the ~32,700-acre Oak Ridge Reservation (ORR), much of which is categorized as a National Environmental Research Park and a State Wildlife Management Area. DOE works with the Tennessee Wildlife Resources Agency (TWRA), Tennessee Department of Environment and Conservation (TDEC), US Fish and Wildlife Service (USFWS), US Department of Agriculture (USDA), and other agencies to serve as an effective steward of the ORR. Accordingly, project managers must conform to environmental regulations, agreements, and policies at the Federal, State, and institutional levels. Per 40 CFR (Code of Federal Regulations) 1508.14, research and science education activities must also be considered, as these may have effects on the National Environmental Research Park. Impact on activities, such as deer harvest, must be considered on the Oak ridge Wildlife Management Area if they will be affected by other aspects of the human environment.

The Spallation Neutron Source (SNS) is a premiere facility at ORNL that provides advanced capabilities in neutron scattering to promote new discoveries and research opportunities in material sciences, physics, chemistry, biological sciences, and others. A conceptual design for an additional neutron source, termed the Second Target Station (STS), has been in development for several years. The STS is intended to complement and enhance existing ORNL capabilities, notably research and exploration of complex materials. The proposed STS construction project will involve development of existing natural areas on the ORR, which contain sensitive resources that require mitigation or avoidance in accordance with existing policies and regulation.

Figure 3.1 indicates the location of the STS construction project review area within the ORR and as it relates to the existing Spallation Neutron Source facilities. Total review area for the original SNS

construction comprised ~224 acres (90.6 ha). While the planned STS facility footprint was included in the original EIS and consultation process (DOE/EIS-0247), construction laydown areas and an access road were not considered or evaluated. A Supplement Analysis was submitted in February 2000 (DOE/EIS-0247/SA1) which evaluated a superconducting linear accelerator which would replace the original ambient temperature linear accelerator. An additional Supplement Analysis was submitted in July 2021 which discusses changes beyond the original EIS (DOE/EIS-0247-SA-02). The proposed STS construction area beyond the original EIS project area consists of an operations area for construction trailers, materials laydown, and construction machinery comprising approximately 73 acres (29.54 ha) (see Figure 3.2.a.). Access road options are also shown in Figure 3.2.a, including their respective acreages. Figure 3.2.b. shows an additional 12 acres of forest habitat that will be cleared to provide for construction and soil spoils and as an access road from Spallation Drive to the construction operations and support area, and an alternative access road 12-acre area, therefore a total 97acres (39.25 ha) will be cleared. Analysis of the STS construction project area and preferred access road option indicate that this approximately 97 acres contains abundant potential roost trees for Federal listed bat species, with the remaining acreage suitable for bat foraging. A final access road plan has not been selected. If the alternative access road areas involve impacts to bat habitat, these will be included in discussions with USFWS. The review area under consideration here is located primarily within forested natural areas of the ORR with minor development in the form of power-line rights-of-way and secondary roads. The STS construction project will include the removal of existing forest, which contains many suitable roost trees for Federal and State listed bat species. Construction activities will include drilling and excavation associated with removal of large amounts of soil and rock for construction of the SNS/STS facilities. Environmental effects will include noise, vibration, increased $CO_2$ emissions, alteration of existing wetlands and waterways, increased water temperature from cooling tower discharges, airborne dust from construction of roads and buildings, and other heavy equipment activities. Other effects on the environment were discussed in the original EIS.

A report was prepared for the DOE Oak Ridge Site Office in September 2020 (Carter et al., 2020). The report includes natural resource surveys conducted in 2009, 2019, and 2020, as well as historical data for the STS construction project area (see appendix A). Surveys conducted within the STS construction project area indicate the presence of three species currently Federal listed and two species under consideration or proposed for Federal listing through the ESA. The DOE has assumed presence of multiple species of Federal listed bats. These species are further detailed in Section 5.1 of this BA. Furthermore, based on this assumption and habitat quality within the STS construction project area, the DOE Oak Ridge Site Office will set aside a Mitigation Area (MA) on the 3-Bends Scenic and Wildlife Management Refuge Area to compensate for any known or predicted impacts originating from this project. This MA will be permanently conserved and will provide similar habitat to that which will be removed or altered as part of the STS construction project. The extent of this MA will be decided through consultation with the USFWS. Additional actions (e.g., habitat improvement, research, and monitoring) will be developed in consultation with the USFWS. These efforts will be applied to provide further lift in conservation value for Federal listed species listed herein. The potential mitigation area is shown in Figure 3.3.

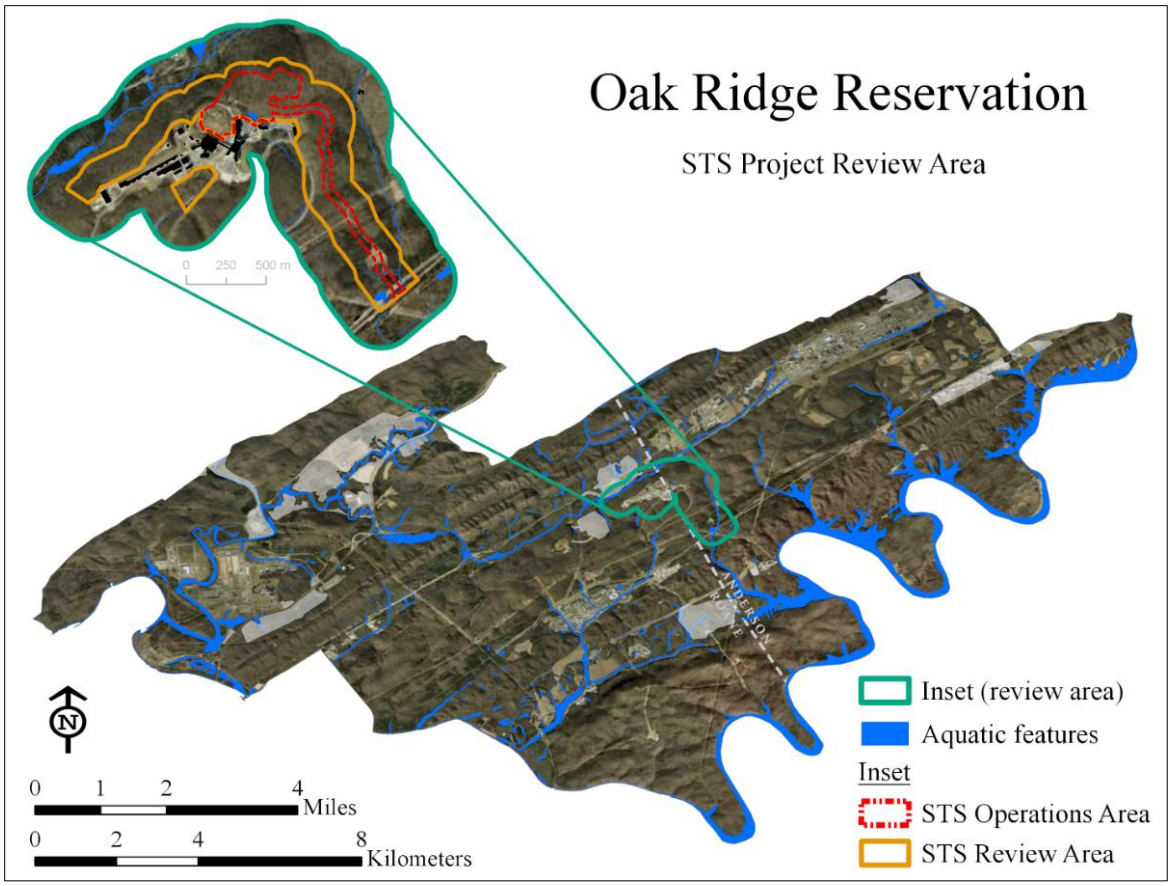


**Figure 3.1. Location of the Spallation Neutron Source Second Target Station construction project within the Oak Ridge Reservation.** The map inset indicates areas not considered in previous consultation with USFWS regarding the STS construction project (outlined in orange).

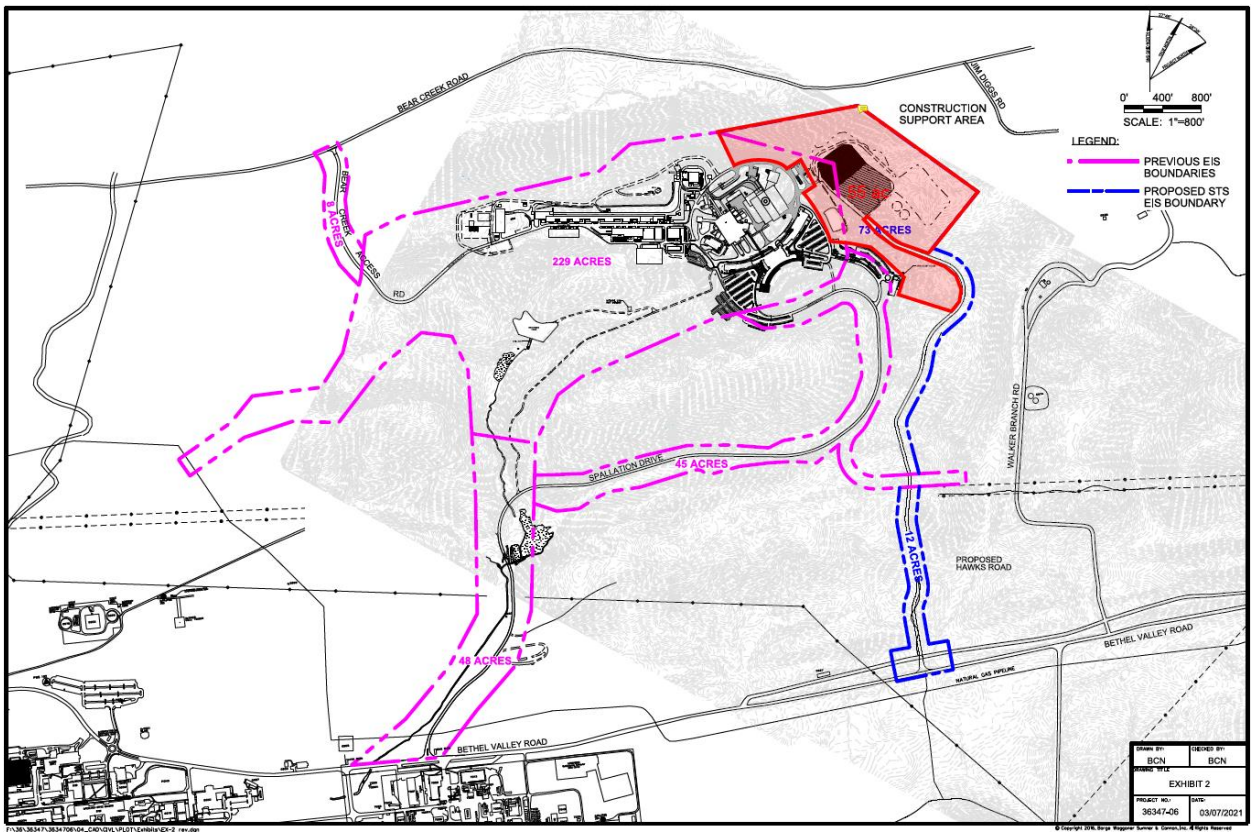


**Figure 3.2.a. Spallation Neutron Source Second Target Station construction project and Access Road Alternatives.** The map indicates the 73-acre portion of the construction project area (shown in red) which has significant listed bat habitat. The access road alternatives and their respective acreages are indicated as well.

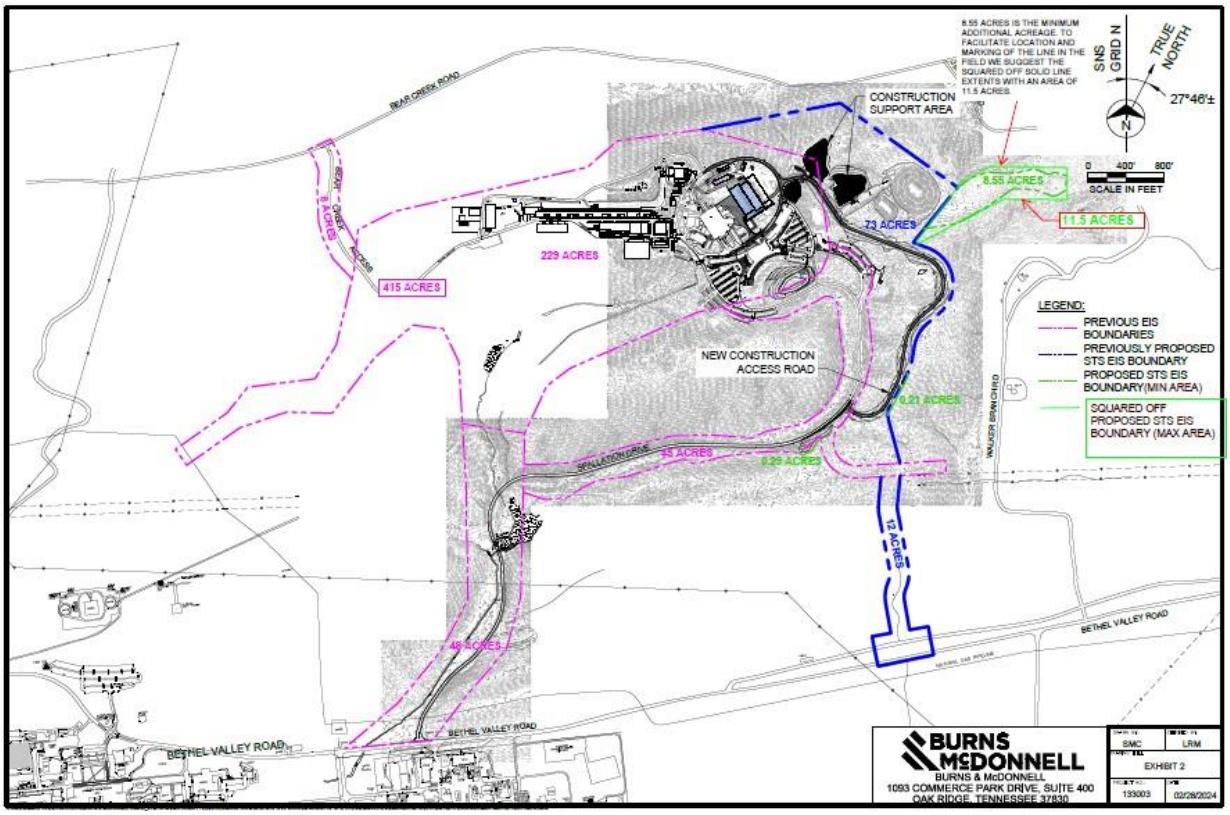


**Figure 3.2.b. Spallation Neutron Source Second Target Station construction project with preferred access road alternative and soil spoils area.** This map indicates the 73-acre portion of the STS construction project area plus 11.5 forested acres (outlined in green) to be cleared for use as a spoils area. An additional 0.5 acres for preferred construction road access is shown in green. The preferred access road route is indicated in black. The 12-acre alternate access road, also indicated, is primarily dense pine forest. The total 97 acres has significant roosting habitat for Federal listed bats but was not included in the original SNS EIS.

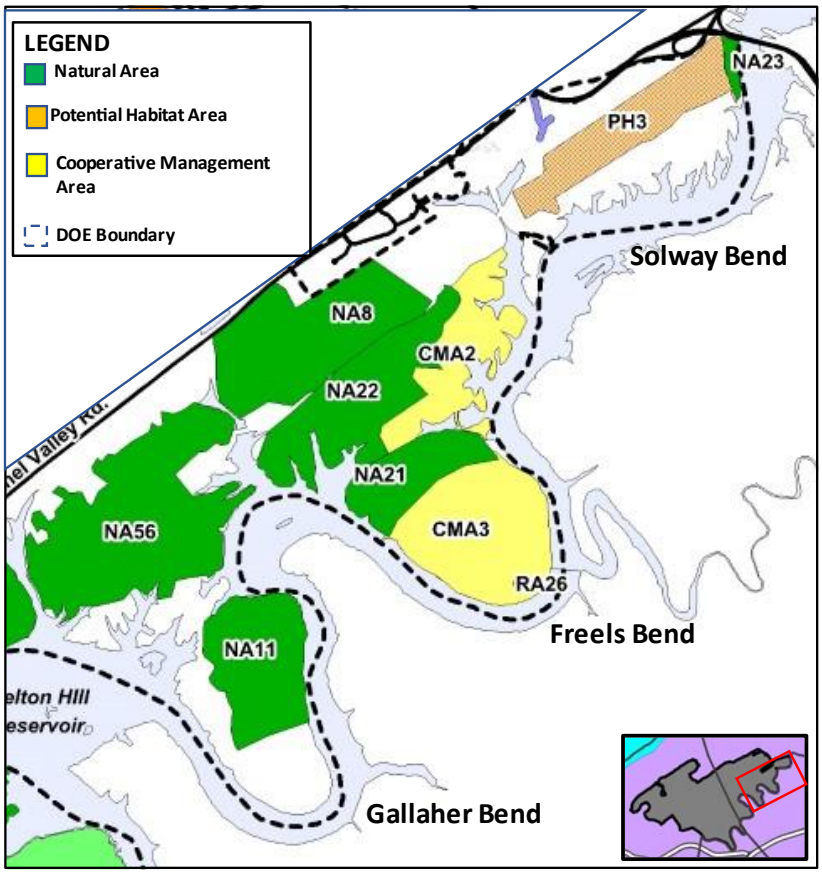


**Figure 3.3. Location of proposed mitigation areas located on 3-Bends Scenic and Wildlife Management Refuge Area, Oak Ridge Reservation.** Natural Areas (NA) and Potential Habitat Areas (PH) have abundant suitable roosting habitat for Federal listed bat species named in this BA.

## 4. ACTION AREA DESCRIPTION

The STS construction project area is located in Anderson and Roane Counties, Tennessee on the US DOE Oak Ridge Reservation. The DOE Oak Ridge Reservation is an approximately 32,700-acre tract of land located in East Tennessee within the Ridge and Valley Physiographic Province of the Eastern Unites States. The climate in East Tennessee runs Humid Sub-tropical to Humid Continental.

The STS construction project area lies between Bethel Valley Road to the south and Bear Creek Road to the north. Spallation Drive allows access to existing SNS facilities, and these abut the STS construction project area. A TVA ROW crosses a portion of the STS Construction project site. A scrap wood burn yard and an access road lie within the project area. Mature forest makes up most of the STS construction project area.

This section summarizes current knowledge of the vegetation communities and ecosystem within the STS construction project area from on-the-ground surveys during summer 2009 and, more recently, from fall 2019 to summer 2020 by the ORNL Natural Resources Management Program and Aquatic Ecology Group staff (Carter et al. 2020; Appendix).

At the time of this report, the proposed STS construction project area consist of an operations area comprising approximately 97 acres (39.25 ha) which was not part of the original SNS EIS review area for

potential construction comprising ~224 acres (90.6 ha). The primary goal was to evaluate potential effects on sensitive resources that might result from development of the STS construction project area.

Forest conditions were assessed based on a forest inventory conducted in 2013 and on ground observations from the 2019–2020 surveys specific to the STS construction project area. A forest inventory that included the SNS Project area was concluded in November 2013 (Johnston, unpublished report to the ORNL Natural Resources Management Program). More than 470 sampling points were taken on a 300 by 300 ft grid covering the 970-acre (393-ha) compartment. Land use categories in the STS construction project survey area include forest, rights-of-way, developed areas, and edge. Forest comprises approximately 75.6% (169.40 acres) of the area, followed by developed areas (12.3%, 27.39 acres) and rights-of-way (11.1%, 24.75 acres) (Figure 4.1). Less than 1% (1.44 acres, located between Bethel Valley and Old Bethel Valley Roads) would be considered edge (Figure 4.1). Thirty-six tree species from 23 genera were documented within the STS construction project survey area (Table 4.1).

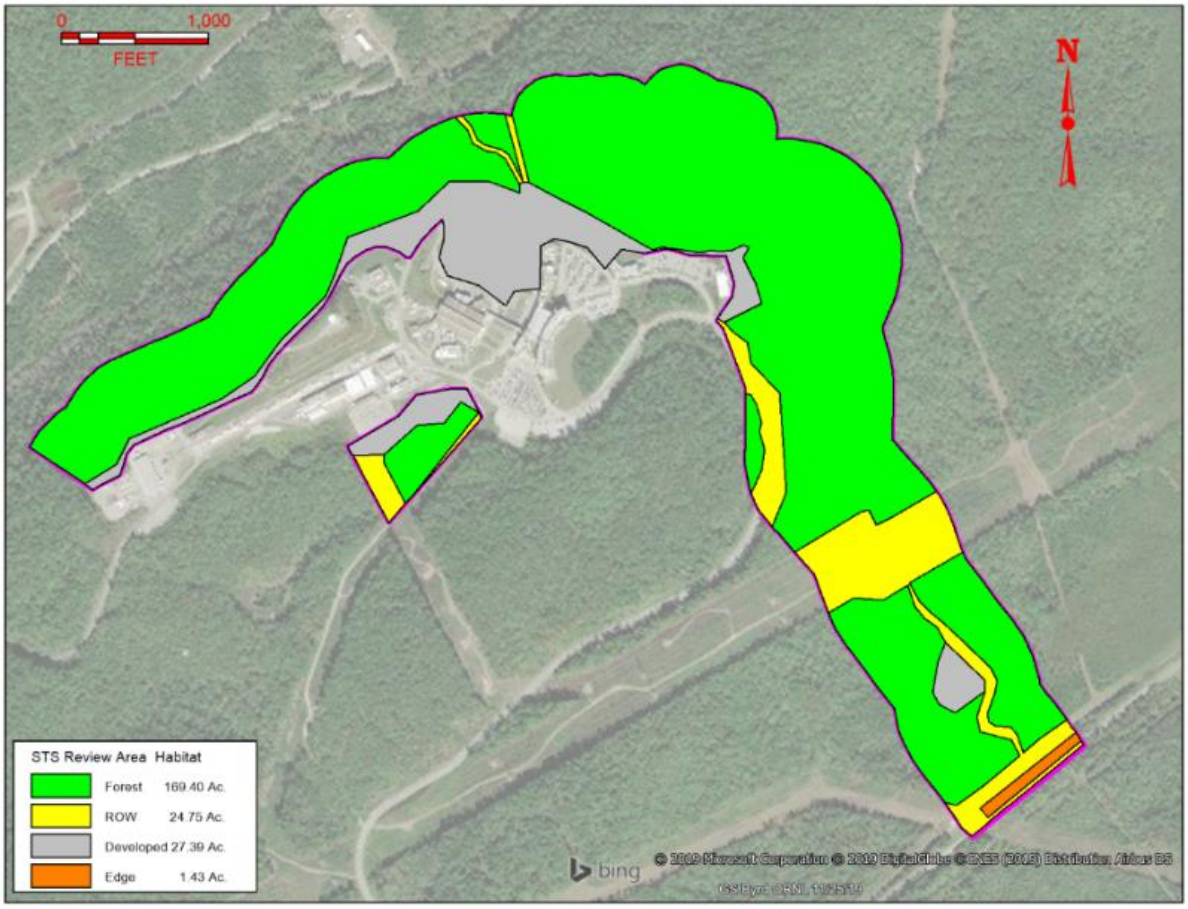


**Figure 4.1. Forest cover and land use within the STS construction project area based on 2013 forest inventory data.**

**Table 4.1. List of 36 tree species inventoried within the STS construction project survey area.**

| Species | Common name | Status |
|---|---|---|
| *Acer rubrum* | Red maple | Native |
| *Acer saccharum* | Sugar maple | Native |
| *Aralia spinosa* | Devil's walking stick | Native |
| *Carya cordiformis* | Bitternut hickory | Native |
| *Carya glabra* | Pignut hickory | Native |
| *Carya tomentosa* | Mockernut hickory | Native |
| *Celtis occidentalis* | Hackberry | Native |
| *Cercis canadensis* | Eastern redbud | Native |
| *Cornus florida* | Flowering dogwood | Native |
| *Fagus grandifolia* | American beech | Native |
| *Fraxinus americana* | White ash | Native |
| *Juglans nigra* | Black walnut | Native |
| *Juniperus virginiana* | Eastern redcedar | Native |
| *Liquidambar styraciflua* | Sweetgum | Native |
| *Liriodendron tulipifera* | Tulip poplar | Native |
| *Morus rubra* | Red mulberry | Native |
| *Nyssa sylvatica* | Black gum | Native |
| *Oxydendron arboreum* | Sourwood | Native |
| *Paulownia tomentosa* | Princess tree | Non-native, invasive |
| *Pinus echinata* | Shortleaf pine | Native |
| *Pinus strobus* | White pine | Native |
| *Pinus taeda* | Loblolly pine | Native |
| *Pinus virginiana* | Virginia pine | Native |
| *Plantanus occidentalis* | American sycamore | Native |
| *Prunus serotina* | Black cherry | Native |
| *Pyrus calleryana* | Callery pear | Non-native, invasive |
| *Quercus alba* | White oak | Native |
| *Quercus coccinea* | Scarlet oak | Native |
| *Quercus falcata* | Southern red oak | Native |
| *Quercus montana* | Chestnut oak | Native |
| *Quercus rubra* | Northern red oak | Native |
| *Quercus stellata* | Post oak | Native |
| *Quercus velutina* | Black oak | Native |
| *Sassafras albidum* | Sassafras | Native |
| *Ulmus alata* | Winged elm | Native |
| *Ulmus rubra* | Slippery elm | Native |

The majority of the STS construction project area is dry upland forest and is characterized by rolling hills, swales, and moderate slopes. The area slopes upward and eastward on the site from the moister, more steeply sloping forested area to the west. Chestnut Ridge Road is a defining boundary between the drier and moister forested areas at the site. This forest is bordered on the south by a relatively sharp edge in

most locations that is characterized by grassy fields, scattered shrubs, and disturbed areas. This habitat is characterized by an overstory of white oak (*Quercus alba*), scarlet oak (*Quercus coccinea*), southern red oak (*Quercus falcata*), tulip poplar (*Liriodendron tulipifera*), and pignut hickory (*Carya glabra*). There is also a scattering of chestnut oak (*Quercus montana*) and red maple (*Acer rubrum*) in the overstory in this area. The understory is relatively open and contains saplings of several different species, including American beech (*Fagus grandifolia*), black cherry (*Prunus serotina*), sourwood (*Oxydendrum arboreum*), sweetgum (*Liquidambar styraciflua*), and common pawpaw (*Asimina triloba*). Groundcover in the area is also scattered and includes Virginia creeper (*Parthenocissus quinquefolia*), Christmas fern (*Polystichum acrostichoides*), greenbriar (*Smilax sp.*), poison ivy (*Toxicodendron radicans*), muscadine (*Vitis rotundifolia*), and striped pipsissewa (*Chimaphila maculata*).

**Table 4.2. Plant species list for the dry upland forest.**

| Scientific name | Common name |
|---|---|
| *Liriodendron tulipifera* | Tulip poplar |
| *Carya glabra* | Pignut hickory |
| *Nyssa sylvatica* | Black gum |
| *Quercus falcata* | Southern red oak |
| *Quercus coccinea* | Scarlet oak |
| *Quercus alba* | White oak |
| *Quercus montana* | Chestnut oak |
| *Acer rubrum* | Red maple |
| *Sassafras albidum* | Sassafras |
| *Fagus grandifolia* | American beech |
| *Prunus serotina* | Black cherry |
| *Asimina triloba* | Common pawpaw |
| *Vaccinium pallidum* | Lowbush blueberry |
| *Oxydendrum arboreum* | Sourwood |
| *Liquidambar styraciflua* | Sweetgum |
| *Juniperus virginiana* | Eastern red cedar |
| *Parthenocissus quinquefolia* | Virginia creeper |
| *Polystichum acrostichoides* | Christmas fern |
| *Smilax sp.* | Catbriar |
| *Toxicodendron radicans* | Poison ivy |
| *Vitis rotundifolia* | Muscadine |
| *Chimaphila maculata* | Striped pipsissewa |
| *Microstegium vimineum* | Nepal grass |
| *Lespedeza cuneata* | Sericea lespedeza |
| *Coronilla varia* | Crown-vetch |
| *Cirsium sp.* | Thistle |
| *Festuca sp.* | Fescue |

The forest along Chestnut Ridge in the northern-most portion of the STS construction project area is characterized by a northward facing slope that grades down into the Bear Creek watershed. Signs of overland flow in the direction of the watershed are noticeable in certain areas of this forest. This forest is

bordered on the south by a sharp edge in certain locations and by a relatively gradual edge in other locations. Edges are characterized by grassy fields, scattered shrubs, and disturbed areas.

This area of the forest on the north side of the current SNS facility is noticeably moister than the upland forested areas to the east. It is also a noticeably richer forest with more plant diversity. The overstory includes tulip poplar, pignut hickory, chestnut oak, southern red oak, white oak, sweetgum, scrub pine (*Pinus virginiana*) and white pine (*Pinus strobus*). A few very large chestnut oaks and white pines and one very large sweetgum are notable. The diverse understory includes black gum (*Nyssa sylvatica*), hemlock (*Tsuga canadensis*), sassafras (*Sassafras albidum*), American beech, flowering dogwood (*Cornus florida*), ironwood (*Carpinus caroliniana*), black cherry, sugar maple (*Acer saccharum*), redbud (*Cercis canadensis*), common pawpaw, umbrella magnolia (*Magnolia tripetala*), lowbush blueberry (*Vaccinium pallidum*), sourwood, sweetgum, Carolina buckthorn (*Rhamnus caroliniana*), yellow buckeye (*Aesculus octandra*) and devils-walkingstick (*Aralia spinosa*). Muscadine is also prevalent in the area.

The groundcover in this forest is extremely diverse, with the presence of a variety of ferns and herbaceous species. Ferns recorded in the area include Christmas fern, maidenhair fern (*Adiantum pedatum*), common grape fern (*Botrychium dissectum*), rattlesnake fern (*Botrychium virginianum*) and broad beech fern (*Thelypteris hexagonoptera*). Other groundcover plants in the area include striped pipsissewa, little brown jug (*Hexastylis arifolia*), prostrate tick-trefoil (*Desmodium rotundifolium*), downy rattlesnake plantain (*Goodyera pubescens*), false Solomon's-seal (Maianthemum stellatum), lopseed (*Phyrma leptostachya*), wild yam (*Dioscorea villosa*), doll's eyes (*Actaea pachypoda*), black snakeroot (*Sanicula odorata*), Virginia-snakeroot (*Aristolochia serpentaria*), yellow passionflower (*Passiflora lutea*), tickseed (*Coreopsis sp.*), crested dwarf iris (*Iris cristata*), wood anemone (*Anemone quinquefolia*), may-apple (*Podophyllum peltatum*), yellow forest violet (*Viola pubescens*), and jack-in-the-pulpit (*Arisaema triphyllum*). Of particular significance on this slope is the presence of whorled stoneroot (*Collinsonia verticillata*). Ginseng (*Panax quinquefolius*) was recorded on this same slope.

**Table 4.3. Plant species list for the moist forest.**

| Scientific name | Common name |
|---|---|
| *Lireodendron tulipifera* | Tulip poplar |
| *Carya glabra* | Pignut hickory |
| *Nyssa sylvatica* | Black gum |
| *Quercus falcata* | Southern red oak |
| *Quercus alba* | White oak |
| *Quercus montana* | Chestnut oak |
| *Pinus virginiana* | Scrub pine |
| *Pinus strobus* | White pine |
| *Acer rubrum* | Red maple |
| *Tsuga canadensis* | Hemlock |
| *Aesculus octandra* | Yellow buckeye |
| *Sassafras albidum* | Sassafras |
| *Fagus grandifolia* | American beech |
| *Cornus florida* | Flowering dogwood |
| *Carpinus caroliniana* | Ironwood |
| *Prunus serotina* | Black cherry |
| *Acer saccharum* | Sugar maple |
| *Ilex opaca* | American holly |
| *Cercis canadensis* | Redbud |

**Table 4.3. Plant species list for the moist forest (continued).**

| Scientific name | Common name |
|---|---|
| *Asimina triloba* | Common pawpaw |
| *Magnolia tripetala* | Umbrella magnolia |
| *Vaccinium pallidum* | Lowbush blueberry |
| *Oxydendrum arboretum* | Sourwood |
| *Liquidambar styraciflua* | Sweetgum |
| *Rhamnus caroliniana* | Carolina buckthorn |
| *Aralia spinosa* | Devil's walkingstick |
| *Lonicera japonica* | Japanese honeysuckle |
| *Lonicera maackii* | Bush honeysuckle |
| *Morus sp.* | Mulberry |
| *Euonymus* | Euonymus |
| *Rhus copallina* | Winged sumac |
| *Rhus glabra* | Smooth sumac |
| *Rubus sp.* | Blackberry |
| *Parthenocissus quinquefolia* | Virginia creeper |
| *Polystichum acrostichoides* | Christmas fern |
| *Adiantum pedatum* | Maidenhair fern |
| *Botrychium dissectum* | Common grape fern |
| *Thelypteris hexagonoptera* | Broad beech fern |
| *Botrychium virginianum* | Rattlesnake fern |
| *Panax quinuefolius* | Ginseng |
| *Smilax sp.* | Catbriar |
| *Toxicodendron radicans* | Poison ivy |

Rare plant surveys were conducted primarily to confirm more detailed assessment in 2009. However, new transects were conducted in 2019 and 2020 along the previously unplanned access roads (Carter et al., 2020), which will connect the STS construction area to Bethel Valley Road or Spallation Drive. (Figures 3.2.a. and 3.2.b.).

No new listed plant populations were found during 2019 to 2020 plant surveys, and no new significant disturbances of the vegetation were seen in the natural vegetation areas. The mature forest on the northwest side of the STS construction project area appears unchanged. More than 100 whorled horsebalm (*Collinsonia verticillata*) plants and 5 sites for American ginseng (*Panax quinquefolius*) occur in this forest. A small population of pink lady-slipper (*Cypripedium acaule*) occurs in the southern portion of the survey area.

The STS construction project area is primarily upland forest. However, it contains extensive wet weather conveyances, and portions of stream and wetland are intersected by the project area (Figure 4.2). A constructed detention pond near the central portion of the STS construction project area (Figure 4.2) is expected to provide foraging opportunities for bats. Other stream and wetland environments in the project area are surrounded by relatively dense understory and midstory vegetation. These areas do not provide quality roosting opportunities, and they are too cluttered to provide direct foraging opportunities. However, they exist along edges such as ROWs and gravel access roads and contain unique faunal

communities (e.g., four-toed salamander breeding habitat) that are likely to contribute to the overall diversity and production of invertebrate prey.

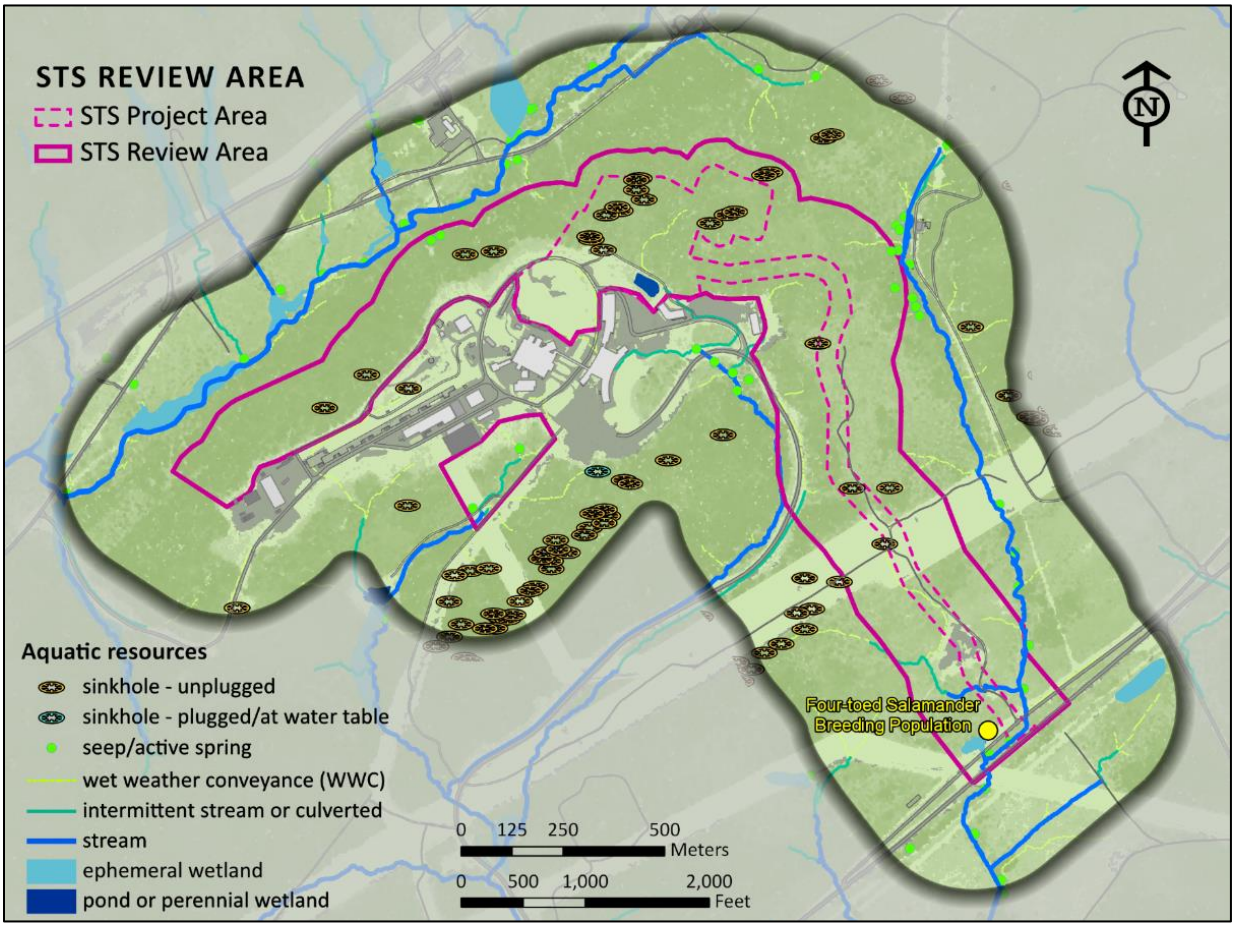


**Figure 4.2. Aquatic resources within the SNS/STS review and construction project area (solid and dashed magenta line, respectively).** Note the occurrence of streams and a breeding population of the State listed four-toed salamander (yellow circle) in the southeasternmost portion of the review area.

## 5. PRE-FIELD REVIEW

A list of Federal listed and proposed species in the action area was obtained from the USFWS IPaC website prior to surveys to guide field efforts for the STS construction project area. This list was reconfirmed on 04/23/2024. Using this list, we determined which of those species had a potential to occur within the project area (shown in Table 5.1 below).

In addition, Table *5.1* summarizes Federal listed/proposed species, species' habitat requirements, and known occurrence information of species that may occur in the project area. Bats listed as In Need of Management by the Tennessee Wildlife Resources Agency are also included in Table 5.1.

### 5.1 SPECIES CONSIDERED AND EVALUATED

In the following table, species from the USFWS official species list (dated 04/23/2024) which are known or expected to occur within the STS construction project area if suitable habitat is present are identified, or if not, why they are excluded from further analysis (with rationale).

**Table 5.1. Federal and State listed bat species within the STS construction project area.**
The USFWS species list (USFWS 2022) was obtained from IPaC website on 04/23/2024 and reviewed. Species/ critical habitat not having the potential to occur were excluded from further review with a no effect determination with the below rationale.

| Species Common and Scientific Name | Status[1] | Potential to Occur | Critical Habitat | Rationale for Exclusion[2] | Habitat Description and Range in Action Area |
|---|---|---|---|---|---|
| ***MAMMALS*** | | | | | |
| Indiana Bat *Myotis sodalis* | *E, SE* | *Probable* | ***No*** | | *Species range includes entire action area. Much of project area is forested, with multiple potential live roost trees with peeling bark and snags with cavities and peeling bark. Forested areas with open understory and midstory for foraging. May include maternity roosts. No hibernacula in project area.* |
| Grey Bat *Myotis grisescens* | *E, SE* | *Yes* | ***No*** | | *Species range includes entire action area. No known caves are in project area. Much of the project area is forested with open understory and midstory for foraging.* |
| Northern Long-eared Bat *Myotis septentrionalis* | *E, ST* | *Probable* | ***No*** | | *Species range includes entire action area. Much of the project area is forested with multiple potential live roost trees with peeling bark, and snags/fallen trees with cavities and peeling bark. Forested areas with open understory and midstory for foraging. May include maternity roosts. No known hibernacula in project area.* |
| Little Brown Bat *Myotis lucifugus* | *C, ST* | *Yes* | ***No*** | | *Species range includes entire action area. Much of the project area is forested with multiple potential roost trees, cavities, and other structures. Forested area and edge habitat for foraging. No known hibernacula in project area.* |
| Tricolored Bat *Perimyotis subflavus* | *C, ST* | *Yes* | ***No*** | | *Species range includes entire action area. Much of the project area is forested with multiple potential roosts. Suitable foraging area throughout project area. No known hibernacula within project area, but potential hibernacula exist within 1 mile of site, and known hibernacula exist within 2 miles of the site* |
| Eastern Small-footed Bat *Myotis leibii* | *SD* | *Possible* | ***No*** | | *Species range includes entire action area. Much of the project area is forested. Forest areas with open understory and midstory for foraging. No known caves, large rock faces with crevices, or buildings for roosting within project area.* |
| Rafinesque' s Big-eared Bat *Corynorhinus rafinesquii* | *SD* | *Probable* | ***No*** | | *Species range includes entire action area. Much of the project area is forested with some hollow trees for roosting. Forest areas with open understory and midstory for foraging. No known caves or buildings within project area.* |

[1] Status Codes: E=Federal listed endangered; T=Federal listed threatened; P= Federal proposed for listing; C= Federal candidate for listing; and CH=designated critical habitat; SE=State listed endangered; ST=State listed threatened; SD=State listed in need of management
[2] Exclusion Rationale Codes: ODR=outside known distributional range of the species; HAB= no habitat present in action area; ELE= outside of elevational range of species; and SEA=species not expected to occur during the season of use/impact

As indicated in the above table, there are 5 Federal listed threatened, endangered, or candidate/proposed species known to occur or with high potential to occur within the STS construction project area. These include Indiana Bat (*Myotis sodalis*), Gray Bat (*Myotis grisescens*), Northern Long-eared Bat (*Myotis septentrionalis*), Little Brown Bat (*Myotis lucifugus*), and Tricolored Bat *(Perimyotis subflavus*). Only those species will be addressed hereafter in this assessment (evaluated species). The remaining two species, listed as in-need-of-management by the State of Tennessee, Rafinesque's Big-eared Bat

(*Corynorhinus rafinesquii*) and Eastern Small-footed Bat (*Myotis leibii*), will be considered here only when their presence serves to provide broader context of site characteristics and habitat quality.

# 6. EVALUATED SPECIES INFORMATION

## 6.1 FIELD RECONNAISSANCE

Surveys conducted in 2009 and 2019/2020 (Figure 6.1) within the STS construction project area were used to map potential bat roost trees. Wildlife Acoustics SM4 Bat FS monitors equipped with SMM-U2 ultrasonic microphones were also used to conduct surveys for the species listed in section 5.1 of this report in 2019 and 2020 by the ORNL Natural Resources Management Program. These surveys were conducted during fall swarming season and summer forest dwelling/maternity season, respectively. Additionally, forest conditions were compiled primarily from a 2013 forest inventory effort and supplemented with ground observation in 2019 as well as LiDAR flyover data for the ORR at < 1-m resolution. As shown in Figure 6.1, a high density of suitable roost trees and snags and a sparse understory within the STS construction project area indicates high potential value as maternity sites for listed forest-dwelling bats. The individuals who obtained and compiled the data that are presented here have a combined 60 years of experience with forest-dwelling bats of the eastern United States and routinely assess forest bat resources on the ORR.

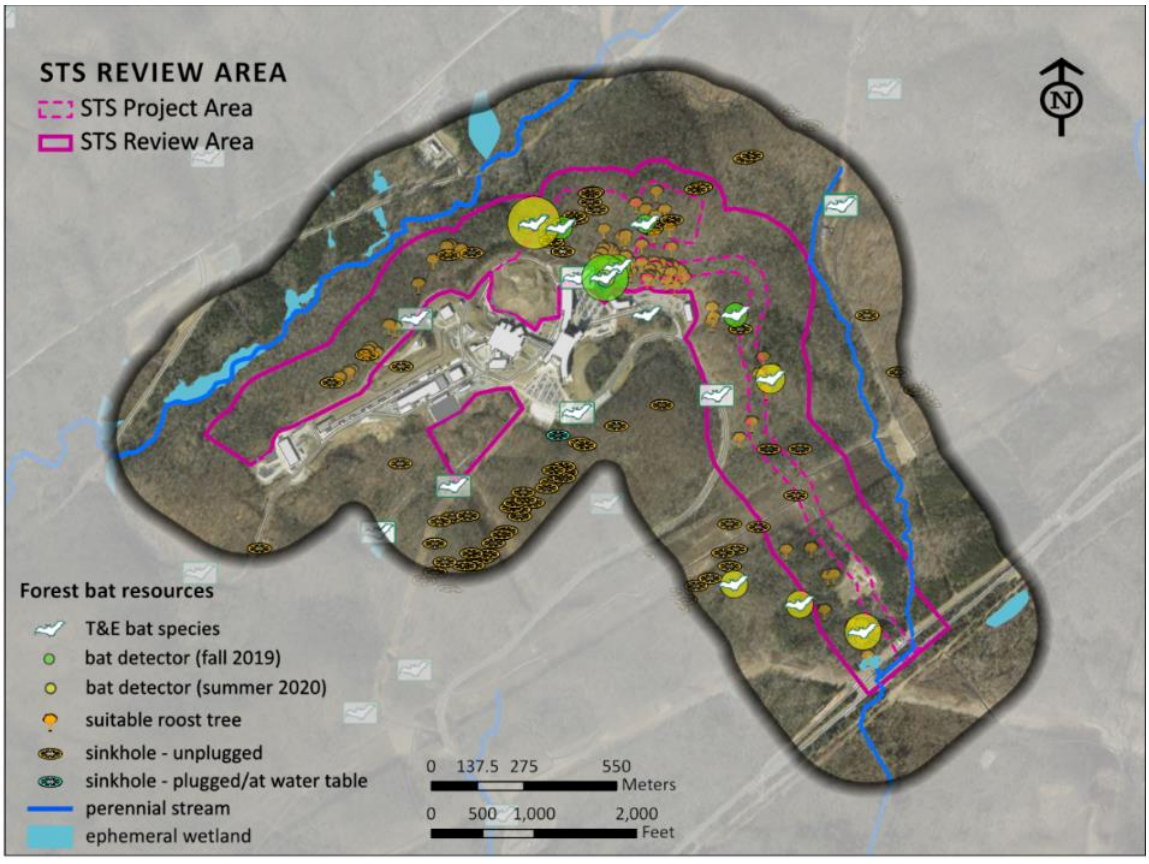


**Figure 6.1. Contemporary and historical forest bat resources.** All known locations within the vicinity of the SNS campus and current STS construction project area with records for threatened and endangered bat species are included Green circles depict bat detector locations from fall 2019 (n = 5); yellow circles represent bat detector locations from summer 2020 (n = 5). Each circle is sized relative to the number of bats detected at that location. Roost trees (orange) are based on 2009 and 2019/2020 surveys and are largely represented by white oak, dead snags.

*Bat acoustic surveys:* Five bat acoustic monitors (Wildlife Acoustics Song Meter SM4Bat FS Ultrasonic Recorders equipped with SMM-U2) were positioned in likely flyways and foraging zones throughout the project area from 15–28 October 2019 and 8-16 June 2020. Sites for acoustic recording were selected based on likelihood of use by bats as flyways to foraging grounds and/or for foraging. Microphones were mounted on 3-m poles and directed along the likely flyway. Recording began 30 min before sunset and ended 30 min after sunrise each night. All SM4Bat monitors were deployed for 14 consecutive nights, beginning October 15, 2019. Data were collected and analyzed using Kaleidoscope Pro Analysis Software, version 5 with both zero-crossing and full-spectrum analysis methods, as approved by the USFWS.

Results from five bat acoustic detectors deployed from 15–28 October 2019 (70 survey nights during fall swarming season) are included in Table 6.1. Table 6.2. results are from six bat acoustic detectors deployed from 8-16 June 2020 (54 survey nights during summer roosting season). In total, 15 native bat species were detected. Detection frequencies provide strong evidence for 10 species, reasonable evidence for 4 species, and 1 species was considered unlikely within the STS construction survey area. Both State and Federal listed species—including Federal endangered gray bats (*Myotis grisescens*), State threatened little brown bats (*Myotis lucifugus*) (under consideration for Federal listing), and State threatened tricolored bats(P*erimyotis subflavus*) (proposed for Federal listing)—were detected at high frequency. Four additional species with State and/or Federal listing status were considered probable or possible residents given either moderate detection frequency or incidental observation (Tables 6.1 and 6.2). Habitat suitable to each bat species was abundant throughout the project area but particularly within the open and mature forest in the northcentral portion of the STS construction project area (Figure 6.1). In lieu of additional acoustic surveys, information on bat species residing within the adjacent EMDF Project area was assumed to apply to the STS construction project area as well, per conversation with Steve Alexander, USFWS (4/24/2024).

**Table 6.1. Results from acoustic bat detectors: 15–28 October 2019.** The number of call detections is included for each detector. A low number of detections, within and between monitors, is considered poor evidence of presence. Shaded rows represent status species. Darker shading indicates greater confidence based on the number of calls, suitable habitat, and nearby location records. (SR: considered rare or regionally important by the State of Tennessee; SD: State deemed in need of management; ST: State threatened; SE: State endangered; FT: Federal threatened; FE: Federal endangered; FP: Federal listing petition currently under review).

| Species | Species code | Bat detector site | | | | | Considered present | Status |
|---|---|---|---|---|---|---|---|---|
| | | 1-19 | 2-19 | 3-19 | 4-19 | 5-19 | | |
| *Corynorhinus rafinesquii* | CORA | 0 | 3 | 4 | 0 | 0 | Probable | SD |
| *Eptesicus fuscus* | EPFU | 5 | 3 | 1 | 0 | 8 | Yes | |
| *Lasiurus borealis* | LABO | 6 | 3 | 51 | 86 | 191 | Yes | |
| *Lasiurus cinereus* | LACI | 77 | 34 | 23 | 0 | 15 | Yes | |
| *Lasionycteris noctivagans* | LANO | 41 | 14 | 15 | 0 | 137 | Yes | |
| *Myotis austroriparius* | MYAU | 0 | 0 | 0 | 0 | 1 | Unlikely | SR |
| *Myotis grisescens* | MYGR | 12 | 28 | 59 | 21 | 394 | Yes | FE, SE |
| *Myotis leibii* | MYLE | 1 | 2 | 1 | 0 | 2 | Probable | SD |
| *Myotis lucifugus* | MYLU | 3 | 9 | 13 | 3 | 58 | Yes | ST |
| *Myotis septentrionalis* | MYSE | 0 | 1 | 2 | 0 | 0 | Probable | FE, SE |
| *Myotis sodalis* | MYSO | 0 | 3 | 3 | 0 | 1 | Probable | FE, SE |
| *Nycticeius humeralis* | NYHU | 2 | 0 | 28 | 13 | 280 | Yes | |
| *Perimyotis subflavus* | PESU | 5 | 0 | 11 | 24 | 378 | Yes | FP, ST |
| *Tadarida brasiliensis* | TABR | 30 | 10 | 3 | 0 | 9 | Yes | |
| *Lasiurus seminolus* | LASE | 0 | 0 | 0 | 0 | 197 | Yes | |

**Table 6.2. Results from acoustic bat detectors: 8-16 June 2020.** The number of call detections is included for each detector.

| Species | Species code | Bat detector site | | | | | | Considered present | Status |
|---|---|---|---|---|---|---|---|---|---|
| | | 1-20 | 2-20 | 3-20 | 4-20 | 5-20 | 6-20 | | |
| *Corynorhinus rafinesquii* | CORA | 0 | 0 | 0 | 0 | 0 | 1 | Possible | SD |
| *Eptesicus fuscus* | EPFU | 0 | 1 | 0 | 0 | 0 | 393 | Yes | |
| *Lasiurus borealis* | LABO | 90 | 25 | 109 | 1 | 0 | 692 | Yes | |
| *Lasiurus cinereus* | LACI | 1 | 28 | 0 | 201 | 0 | 0 | Yes | |
| *Lasionycteris noctivagans* | LANO | 2 | 4 | 3 | 1 | 0 | 0 | Yes | |
| *Myotis austroriparius* | MYAU | 0 | 0 | 0 | 0 | 0 | 0 | Unlikely | SR |
| *Myotis grisescens* | MYGR | 184 | 2 | 0 | 1 | 5 | 46 | Yes | FE, SE |
| *Myotis leibii* | MYLE | 0 | 0 | 0 | 0 | 0 | 0 | Possible | SD |
| *Myotis lucifugus* | MYLU | 152 | 89 | 38 | 1 | 0 | 68 | Yes | ST |
| *Myotis septentrionalis* | MYSE | 0 | 0 | 0 | 0 | 0 | 0 | Possible | FE, SE |
| *Myotis sodalis* | MYSO | 18 | 2 | 1 | 0 | 0 | 0 | Probable | FE, SE |
| *Nycticeius humeralis* | NYHU | 0 | 0 | 0 | 1 | 0 | 3 | Possible | |
| *Perimyotis subflavus* | PESU | 0 | 2 | 9 | 3 | 0 | 190 | Yes | FP, ST |
| *Tadarida brasiliensis* | TABR | 2 | 0 | 2 | 2 | 0 | 3 | Yes | |
| *Lasiurus seminolus* | LASE | 0 | 1 | 2 | 2 | 0 | 3 | Yes | |

Note: See Table 6.1 for status abbreviation definitions.

- Acoustic surveys were conducted during two times of year important to the subject species' ecology: summer forest roosting/maternity season (May 15 thru August 15) and fall swarming season in preparation for hibernation (August 15 thru November 15).

- Suitable habitat was surveyed, and many potential roost trees were mapped. Acoustic monitoring surveys were conducted to identify listed species within the project area.

- The entire project area was surveyed for suitable foraging areas and roosting habitat. Bat acoustic monitors were placed in areas where bat species for this BA were likely to occur.

- Surveys were done by Kitty McCracken and other technical staff of the ORNL Natural Resources Management Team during 8-16 June 2020, and 15-28 October 2019.

- Bat species listed here were active on the landscape when surveys were done. Survey dates are 8-16 June 2020 and 15-28 October 2019.

- USFWS accepted protocols for Phase I forest bat surveys were used.

- The STS construction project area visits were completed by the preparing biologists.

- Please see results in section 6.1 of this BA. Results indicate that each of the listed species is likely to be present in the STS construction project area.

## 6.2 SPECIES STATUS AND BIOLOGY

Five bat species which are Federal listed as endangered, threatened, proposed for Federal listing, or under consideration for Federal listing are reviewed here. No caves are within the STS construction project area, but suitable winter hibernacula for some of these five species are within two to five miles of the STS construction project site. Abundant forest habitat is located within the STS construction project area, both for roost trees and foraging use.

- Gray bat (*Myotis grisescens*: Federal listing: endangered): East Tennessee is within the range of this species, including the STS construction project area. Gray bats are a cave obligate species, roosting in winter in dense concentrations in exceptionally cold caves. During summer maternity season, these bats roost in very warm caves. Fewer than 5% of available caves are suitable for Gray bat roosting at any time. Gray bats forage over waterways, such as rivers, lakes, and wetlands, as well as forested areas. They eat a variety of aquatic and terrestrial insects. The most important limiting factor to the continued existence of Gray bats is their highly specific roosting needs throughout the year. Approximately 95% of the entire known population of Gray bats roost in just nine caves, consequently, cave vandalism and commercialization has affected this species. Another potential limiting factor is pollution in waterways which may kill prey insects or contaminate them such that body burdens of contaminants can accumulate in the bats. On the ORR hundreds of Gray bat calls have been recorded at many survey locations reservation-wide, including during STS construction project surveys. Gray bats have been observed in several caves on the ORR and have been mist netted at multiple sites and occasionally found in buildings.

- Indiana bat (*Myotis sodalis*: Federal listing: endangered): East Tennessee is within the range of this species, including the STS construction project area. Indiana bats hibernate in caves from about mid-November to the end of March. Hibernating populations can range from a few hundred to several thousand per cave. Summer maternity and roosting sites are in forested areas, with Indiana bats roosting in hollows and crevices of trees or under loose bark of trees at least 5" diameter. Multiple trees are used by these bats throughout the summer roosting season, as different thermoregulatory needs may cause them to move. Tree roosts of the sort used by Indiana bats are temporary due to the changing conditions of each tree, hence a continually changing mosaic of multi-aged trees needs to be available to the bats from year to year. Indiana bats have been heavily impacted by White Nose Syndrome (WNS), an exotic, invasive fungal disease which infects many cave hibernating bat species. The diet of Indiana bats consists of many insect species available as they forage throughout forests and along forest edges. Main limiting factors for this species include vandalism or commercialization of caves for hibernation, deforestation of summer habitat resulting in loss of summer roosting and foraging habitat as developed areas expand, and pesticide poisoning as they eat contaminated insects. On the ORR, Indiana bats have been recorded in areas where suitable roost/maternity trees and snags are present. Forest surveys across the ORR have identified several patches of suitable roost trees, such as the STS construction project area. A modelling study and forest surveys indicate that though the ORR is approximately 70% forested, limited patches of suitable roosting/maternity habitat for the Indiana bat are present.

- Northern long-eared bat (*Myotis septentrionalis*: Federal listing: endangered): Northern long-eared bat range covers much of eastern North American, including the STS construction project area in East Tennessee. Northern long-eared bats hibernate in caves, but typically have not been observed forming large clusters of animals. During summer, they roost within forests, using tree crevices and loose bark, and may be found in smaller trees (<3"dbh) or even downed logs. Northern long-eared bats do not appear to form maternity colonies, but roost singly or in small clusters. More study needs to be done on habitat of this bat species. Northern long-eared bats forage within forested areas and along open forest corridors and along water/forest interfaces. As with Indiana bats, Northern long-eared bat

summer roosts degrade over time such that the bats need to live in a diverse forest with multi-aged trees available for roosting. Northern long-eared bats limiting factors include available summer roosting trees, impacts to their hibernacula, and WNS. This species, once common, was Federal listed threatened chiefly due to WNS and has been upgraded to a Federal listing of endangered. Although once one of the more common bats on the ORR, the Northern long-eared bat population has dramatically decreased, most likely due in part to the effects of White Nose Syndrome. However, suitable roosting habitat is present in some locations of the ORR and within the STS construction project area. Low numbers of acoustic recordings indicate that this species is likely still present in low numbers on the ORR.

- Tricolored bat (*Perimyotis subflavus*: Proposed for Federal listing and State listed as threatened in Tennessee): Tricolored bats range throughout the eastern United States and as far west as parts of Kansas, Oklahoma and much of Texas; they can be found south to eastern Mexico and Honduras and north as far as the Great Lakes. These bats generally hibernate singly in humid cave sites and show strong roost fidelity from year to year. Hibernation may start as early as the end of August and last until April. Summer roosts may include crevices high in trees near forest edges; however other summer roosting habitats may be used as well. They forage at forest edges, high in treetops and at water/forest interfaces such as riparian zones. Moths, beetles, and flies serve as major prey items for this species. Tricolored bat populations have been heavily impacted by WNS. Once common throughout their range, populations of these bats may have fallen as much as 90% due to WNS. Limiting factors include vandalism or commercialization of hibernacula, loss of summer roosting habitat as deforestation expands, WNS and pesticide poisoning and loss of prey through pesticide use. On the ORR and within the STS construction project area, Tricolored bats have been recorded at many survey sites, and have been found roosting in caves across the ORR during late winter cave surveys. Suitable roosting habitat is present throughout the STS construction project area.

- Little brown bat (*Myotis lucifugus*: Under consideration for Federal listing and State listed as threatened in Tennessee): The range of Little brown bat covers much of the U.S. and Canada, including the STS construction project area. They form large nursery colonies, often in building attics and other man-made structures. They also roost in tree cavities and crevices throughout forests. In winter Little brown bats hibernate in a variety of locations, including caves, mines, attics, and other locations that provide suitable cool temperature and humidity. Food includes many aquatic insect species, such as mayflies, caddis flies, as well as moths, beetles, mosquitos and craneflies, and these bats forage within forests, over meadows, ponds, farmland, and cliff faces. A major limiting factor is WNS from infected caves and mines. Once one of the most common bat species in eastern North America, Little brown bat populations have crashed mainly due to WNS, and this species is now uncommon throughout the eastern U.S. and Canada. Other limiting factors include death due to pesticides and pesticide exposure through prey, deforestation, and harm to cave roosts, both during hibernation and maternity seasons. On the ORR and within the STS construction project area Little brown bat acoustic recordings indicate the presence of this species.

## 7. ENVIRONMENTAL BASELINE

As defined under the ESA, the environmental baseline includes past and present impacts of all Federal, State, and private actions in the STS construction project area; the anticipated impacts of all proposed Federal actions in the action area that have already undergone formal or early section 7 consultation; and the impact of state and private actions which are contemporaneous with the section 7 consultation process. Future actions and their potential effects are not included in the environmental baseline. This section in combination with the previous section defines the current status of the species and its habitat in

the action area and provides a platform to assess the effects of the proposed action under consultation with the USFWS.

On April 23, 1999, DOE's Final Environmental Impact Statement on the Construction and Operation of the Spallation Neutron Source (Final EIS, DOE/EIS–0247) was submitted, On June 18, 1999, DOE) issued the Record of Decision (ROD) wherein DOE decided to proceed with construction and operation of a state-of-the-art Spallation Neutron Source facility at the preferred location, the Oak Ridge National Laboratory, Oak Ridge, Tennessee. The FEIS included consultation with the U. S. Fish and Wildlife Service, as referenced above. The footprint of this project included the Spallation Neutron Source and facilities as well as an area for a potential Second Target Station. In 2021 a Supplement Analysis was prepared to address the expanded footprint of the project. Specifically, the need for a new BA stems from the construction phase of the proposed STS. It involves clearing and development of an adjacent greenfield area located beyond the bounds of the original project footprint, tied to construction and operation of the STS construction project. The construction support area would be graveled and designated for a trailer area, construction craft parking spaces, and a construction laydown area. Temporary water and electrical utilities would be provided to serve the construction support area. An additional area, currently forested, would be cleared for use as a spoils area for soil excavated from construction of the STS. Access road options previously not part of the SNS project area will be considered here.

Natural resource surveys which provided information to the original EIS (1999) and the first EIS supplement (2000) found no Federal listed animals or plants in the impact area. However, since that time, new detection techniques using acoustic call analytical methods have since become common use in Phase I of USFWS surveys for bat species and are used for other species (frogs, birds).

Since the original EIS, several bat species have become State or Federal listed as endangered, threatened, or in need of management, mostly based on effects of White Nose Syndrome, an exotic fungal infection affecting many bat species which hibernate in caves. These include Northern long-eared bat (Federal listed as endangered), Tricolored bat (proposed for Federal listing and State listed in Tennessee as threatened), and Little brown bat (under consideration for Federal listing and State listed in Tennessee as threatened).

## 7.1 PREVIOUS CONSULTATIONS WITH THE USFWS WITHIN THE ACTION AREA

No previous consultations have occurred within the current action area. The current area includes new road and laydown areas, and an alteration to a cooling tower drainage plan. Consultation with USFWS was completed on the original Spallation Neutron Source Project, which did not include the current laydown areas and roads, but did consist of the Second Target Station. These consultations are listed below.

**Table 7.1. Past consultations with the USFWS and determinations for actions within the action area for all Federal listed/proposed species and designated/proposed critical habitat.**

| Project | Site | Type of Project | Species Addressed | Determination[1] | Date |
|---|---|---|---|---|---|
| *Spallation Neutron Source Project* | *ORNL* | *Site Preparation, facility construction and associated support, parking areas and roads* | *Gray bat* | *NLAA* | *1999* |
| *Spallation Neutron Sources Project revision 1* | *ORNL* | *Alterations to Facility design and construction* | *Gray Bat* | *NLAA* | *2000* |

[1] **ESA determinations**: **NE** = No effect, **NLAA** = May affect, not likely to adversely affect, **BE** = Beneficial Effect, and **LAA** = May affect, not likely to adversely affect.

## 7.2 PAST AND CURRENT ACTIVITIES WITHIN THE ACTION AREA

Current activities within the STS construction project area involve geotechnical studies which involve siting and drilling bore holes to assess geological conditions in support of planned roads, laydown areas, and construction support facilities. Noise during drilling and accessing boreholes will occur during daylight hours.

# 8. EFFECTS TO EVALUATED SPECIES AND DETERMINATIONS

This section discusses the effects to Federal listed or proposed bat species named in Section 5.1. Species in this section: Gray bat (Federal listed endangered); Indiana bat (Federal listed endangered); Northern long-eared bat (Federal listed endangered); Tricolored bat (proposed for Federal listing); and Little brown bat (under consideration for Federal listing).

## 8.1 FEDERAL LISTED BAT SPECIES

### 8.1.1 Direct and Indirect Effects:

A. Gray bat *(Myotis grisescens*—Federal listed as endangered).
   1. Direct adverse effects:
      a. Loss of potential travel corridors and foraging habitat from removal of 97 acres of forest.
      b. Possible disturbance during roosting and rearing of young due to increased noise levels due to construction.
      c. Alteration of water sources due temperature increases from cooling tower water influx in natural stream and water retention ponds after construction is completed and facility operation begins.
      d. Incidental take is not likely to occur because gray bats roost only in caves. No known caves are present in the STS construction project area.
   2. Gray bats may be affected and are likely to be adversely affected by the STS construction project through alteration of travel corridors and loss of potential foraging habitat.

B. The following Federal listed species are considered together due to similarities in habitat requirements:
   - Indiana bat *(Myotis sodalis*—Federal listed as endangered)
   - Northern long-eared bat *(Myotis septentrionalis—Federal listed as endangered)*
     1. Direct adverse effects:
        a. Loss of roosting habitat and loss of foraging habitat from removal of 97 acres of forest.
        b. Potential negative health effects due to increased $CO_2$ levels from construction equipment.
        c. Potential negative health effects due to increased airborne particulates from construction.
        d. Disturbance during roosting and rearing of young due to increased noise levels during construction and subsequent facility operations. Noise may cause bats to avoid forested areas beyond the construction site.
        e. Alteration of water sources due temperature increases from cooling tower water influx in natural stream and water retention ponds after construction is completed and ongoing facility operations.
     2. Incidental take may occur if tree removal takes place during spring emergence, summer roosting and maternity season, or during fall swarming. Incidental take may occur due to elevated $CO_2$ and/or dust levels.

3. Both bat species listed here may be affected and are likely to be adversely affected by the STS construction project.

### 8.1.2 Critical Habitat

No critical habitat for Gray bat, Indiana bat, or Northern long-eared bat has been identified within the STS construction project footprint.

## 8.2 BAT SPECIES PROPOSED OR UNDER CONSIDERATION FOR FEDERAL LISTING

A. The following species under consideration for Federal listing are considered together due to similarities in habitat requirements:
   - Tricolored bat (*Perimyotis subflavus*—proposed for Federal listing)
   - Little brown bat (*Myotis lucifugus*—under consideration for Federal listing)
     1. Direct adverse effects:
        a. Loss of roosting habitat and loss of foraging habitat from removal of 97 acres of forest.
        b. Potential negative health effects due to increased $CO_2$ levels from construction equipment.
        c. Potential negative health effects due to increased airborne particulates from construction.
        d. Disturbance during roosting and rearing of young due to increased noise levels during construction and subsequent facility operations. Noise may cause bats to avoid forested areas beyond the construction site.
        e. Alteration of water sources due to temperature increases from cooling tower water influx in natural stream and water retention ponds after construction is completed and ongoing facility operations.
     2. Incidental take may occur if tree removal takes place while bats are on the landscape, particularly during spring emergence, summer roosting and maternity season, or during fall swarming. Incidental take may occur due to elevated $CO_2$ and/or dust levels.
     3. Both bat species listed here may be affected and are likely to be adversely affected by the STS construction project.

### 8.2.1 Critical Habitat

No critical habitat for Tricolored bat or Little brown bat has been identified within the STS construction project footprint.

# 9. EXPOSURE ANALYSIS

The Spallation Neutron Source Second Target Station construction project will result in the permanent removal of approximately 85 acres of suitable roosting and foraging habitat, altered hydrology, and cooling tower discharges at the headwaters of multiple drainages that feed Bear Creek, White Oak Creek, and associated wetlands. An additional 12 acres with suitable roosting habitat may be deforested if the alternate access road is needed, for a total area of 97 acres. Many potential roost trees for forest dwelling/foraging bat species discussed in this Biological Assessment were found throughout the STS construction project area. Acoustic surveys completed during summer roosting/maternity season and fall swarming/mating season indicate the presence of Federal listed endangered Indiana bat, Northern long-eared bat, Gray bat, and proposed for Federal listing Tricolored bat, and under consideration for Federal listing Little brown bat. STS construction project proponents indicate that clearing will take place during winter when the bat species of concern are off the landscape and in hibernation, hence no incidental take is expected to occur at that time. There are no plans to restore the original habitat once facility construction is done.

Short-term stressors, such as construction noise, vibration, airborne particulates, and elevated $CO_2$ from construction vehicle traffic and construction itself, may cause each of these species' negative health effects. These cumulative effects, when added to the effects of White Nose Syndrome, may lead to death in animals with already compromised health. Alternatively, the short-term effects may cause the bat species named here to abandon acres of suitable habitat beyond the 97-acre forested area which will be removed.

**RESPONSE ANALYSIS:**

- ***SPECIES RESPONSE TO THE ACTION'S EFFECTS:*** The Federal listed endangered Indiana bat, Northern long-eared bat, and Gray Bat, as well as Tricolored bat (proposed for Federal listing) and Little brown bat (under consideration for Federal listing) will suffer permanent habitat loss of up to 97 acres of the STS construction project area. In addition, some undetermined amount of habitat adjacent to STS construction project area will be affected by noise, vibration, dust, elevated $CO_2$ emissions, altered hydrology, and cooling tower discharges. Bat species of concern may avoid areas with these latter effects, or the bats may suffer deleterious health effects due to exposure. Short-term stressors could also affect non-volant young more severely than adults, as they would not be able to avoid the impacted areas. The action will affect environments situated within the central portion of the ORR, and the majority of area affected by the action is characterized by trees suitable for roosting by forest-dwelling bats. The spatial clustering of these trees increases their value as maternity roost sites. Thus, the action is likely to impact all age and reproductive classes of each species considered.

- ***PROBABILITY OF ACTION'S EFFECTS:*** Loss of up to 97 acres of habitat will occur. Altered hydrology and cooling tower discharges will occur. Noise, airborne particulates, vibration, and elevated $CO_2$ emissions will be most intense during the site preparation and construction phases of the STS construction project. Most will abate once construction is complete.

- ***LIKELIHOOD OF A RESPONSE:*** All bat species considered in this Biological Assessment will respond to habitat loss by finding other suitable roost and foraging locations. Whether or not noise, dust, vibration, and elevated $CO_2$ will occur at levels that affect bat health or cause bats to avoid the area beyond the 97-acre proposed STS construction project area is unknown. Additional forest removal concurrent with but not associated with this project could reduce success of bats' response by reducing nearby habitat options and increasing energy expenditure and exposure.

- ***SHORT-TERM AND LONG-TERM EFFECTS:*** The STS construction project area will involve the permanent loss of 97 acres of forest, which provide roosting and foraging habitat. Cooling tower discharges, altered hydrology, and increased human activity (noise, vibration) represent permanent but relatively unexplored effects. These could result in increased stress on adults and young as well as altered invertebrate abundance and prey beyond the project footprint. Removal of trees will take place during the winter bat hibernation season; thus, incidental take is presumed low to absent. Site preparation and construction will take place over several years (possibly as much as 5 years), during which time dust, noise, elevated $CO_2$, and vibration may affect roosting bats in additional nearby environments.

- ***SEVERITY OF EFFECTS / TIME TO RECOVERY:*** Although the severity of health effects is unknown, each of the listed short-term stressors will cease when construction is finished. Removal of approximately 97 acres of forest known to be used by the bat species named in this BA will be permanent. Permanent effects on the abundance and quality of sources of invertebrate prey (e.g., Bear Creek and associated wetlands, White Oak Creek, and other wetlands and streams within and outside the project footprint) might also result from cooling tower discharges and altered hydrology. The magnitude of these effects is unknown. These will be exacerbated by recent changes in land use in

Bear Creek Valley, and the project team is exploring methods to reduce them through alternative drainage designs.

- ***NATURE OF THE ACTION'S EFFECTS:*** Indiana bats, Northern long-eared bats, Tricolored bats, and Little brown bats have had negative health and survival effects due to White Nose Syndrome leading to a species decline of >90% in some cases. Additional negative health effects could exacerbate WNS effects in individual bats. Young of the year may have negative health and/or decreased survival from exposure to the listed health effects. The level of these effects is unknown. The action involves permanent loss of roosting and foraging habitat. The action will occur within the central portion of the ORR, and the spatial clustering of suitable roost trees increases their value as maternity roost sites. Thus, the action will lead to permanent reduction of available habitat for foraging and reproduction for multiple species. Cooling tower discharge will result in altered physiochemistry and thus abundance and quality of invertebrate prey from adjacent Bear Creek, White Oak Creek, and/or other aquatic environments within and outside the project footprint. The extent of these effects is not currently known, and the project team is exploring methods to minimize them.

- ***PART OF THE POPULATION TO BE AFFECTED:*** A small portion of the range of each bat species named in this BA will be affected by the STS construction project. All ages and reproductive groups are expected to be affected, but lack of direct counts and no demographic data prevent a thorough analysis of population-level outcomes.

The STS construction project area provides suitable roosting, maternity, and foraging habitat for Federal listed endangered Indiana bat and Northern long-eared bat, Tricolored bat (proposed for Federal listing) and Little brown bat (under consideration for Federal listing), as well as foraging habitat and travel corridors for Federal endangered Gray bat. Consequently, the STS construction project area is considered an important aspect of each species' habitat and life history. Loss of suitable roosting, maternity, and foraging habitat across species ranges continues to impact species survival.

The Oak Ridge Reservation is the largest contiguous forested area within the Ridge and Valley Physiographic Precinct of the eastern United States. The ORR provides miles of riparian habitat, acres of forest edge habitat, interior forest, secondary forest, and miles of flight corridors for Indiana bat, Northern long-eared bat, Gray bat, Tricolored bat and Little brown bat. Some areas of primary forest with patches of trees suitable for Indiana bat and Northern long-eared bat maternity colonies are present. Additionally, caves which can serve as hibernacula for these species and summer roosting/maternity caves for Gray bats are located on the ORR, several within 2 to 5 miles of the action area. Although not designated as critical habitat by USFWS, the ORR areas described here fill a unique position in the overall range of each of the species discussed in this BA. Suitable habitat for each of these species has, and continues to be, destroyed and fragmented by government, public and private developers. The ORR serves in the key position of providing patches of ideal habitat between the Appalachian Mountains and Cumberland Plateau where key hibernacula are known to exist for species such as Indiana bat and Gray bat. Establishing permanent conservation areas on the ORR for all species discussed in this BA will improve each species chances for survival.

**RELATIVE IMPORTANCE OF THE ACTION AREA TO THE SPECIES ADDRESSED**

There is a high a degree of uncertainty in the extent of use of the SNS/STS Project area for maternity and summer roosting by listed bats owing to a lack of direct counts. However, acoustic data suggest a high relative occupancy of the STS construction project area during both fall swarming and summer roosting seasons by multiple species of forest dwelling bats compared to elsewhere on the ORR.

Forest structure and proximity to additional resources (e.g., wetlands with connected flyways and suitable hibernacula such as the > 40 caves on the ORR) indicate high habitat quality for multiple species of listed bat on the ORR (Figure 6.1). Much of the forest within the STS construction project area is dominated by mature white oak with a notably sparse understory and high density of suitable roost trees with a south to southwestern exposure. Dead snags also create several canopy gaps in the forest interior. These forest resources are bordered by several streams and emergent wetlands to the south, a pond to the west, and Bear Creek and its associated tributaries and wetlands to the north, which support among the highest abundance and diversity of invertebrate prey among the aquatic systems monitored by the ORNL Environmental Sciences Division (Matson et al., 2022). The site is also unique in that it is located along Chestnut Ridge near the center of the ORR, and similarly exposed areas with roosting habitat within just meters of aquatic resources are notably absent elsewhere along Chestnut Ridge.

Owing to the distinctive, high-quality roosting and foraging resources provided by the STS construction project area to bats, a consideration for the project has been to set aside habitat elsewhere on the ORR that is both high quality and ecologically similar to that found within the STS construction project area. Thus, data were compiled from recent forest inventory of the ORR, a LiDAR flyover at less than 1-meter resolution, aerial imagery, on-site bat roost tree assessments, and an inventory of all waterbodies and streams on the ORR. Using ArcGIS Pro 2.6.0 (ESRI 2020), all data were previously rasterized at ~1-m resolution, and the following habitat predictors were derived: canopy height and density, roads and infrastructure, Euclidean distance to permanent water bodies, soil saturation, and slope-aspect (see Carter et al., 2020a, 2020b, 2020c). A maximum likelihood classification of these composited raster bands was then performed using the Spatial Analyst extension, with ground-based delineations of habitat within the STS construction project area from Carter (2020a) serving as training samples. All raster cells that overlapped other future development were omitted. The untransformed predictions (minimum-maximum stretch type in ArcGIS Pro) are displayed in Figure 9.1, where the top 95% of predictions appear as white. These areas consisted of 39.25 hectares of the ORR's total 13,034 hectares. This equated to only 0.22% of upland forest roosting habitat on the ORR being at least 95% similar to the highest quality roost habitat found within the STS construction project area. The STS construction project area designated for project laydown is all mature hardwoods with clear understory and midstory and is sited on a south-facing slope. White oaks and other hardwood trees with peeling bark, live trees with crevices, and dead snags exist throughout this area. The STS construction project area in turn contains 97 acres (39.25 ha) of potential roosting habitat, with 7.0 acres (2.83 ha) being considered exceptionally high. That is, the STS construction project area contains 10.1% of the 97 acres () of high-quality upland roost habitat on the ORR (Figure 9.1).

It should be further emphasized that estimates for the broader ORR above reflect a combination of habitat quality and, most importantly, similarity to habitat found within the STS construction project area. Many sites have been surveyed to confirm presence of potential roosting habitat. Additional high-quality habitats, particularly those associated with several beaver impoundments on the ORR were captured in the analysis but would not be ranked high in similarity to the upland forest of the STS construction project area. Bat acoustic surveys have been done within the majority of sites identified in the analysis as a means of obtaining a broad brushstroke picture of where Federal and State listed bat species may be found across the ORR. These surveys, conducted over the past decade, have confirmed that areas identified in this model as preferred roosting and foraging habitat are accurate. Figure 9.1 can thus be described as an assessment of potential capacity and a tool to guide mitigation specifically for the STS construction project area.

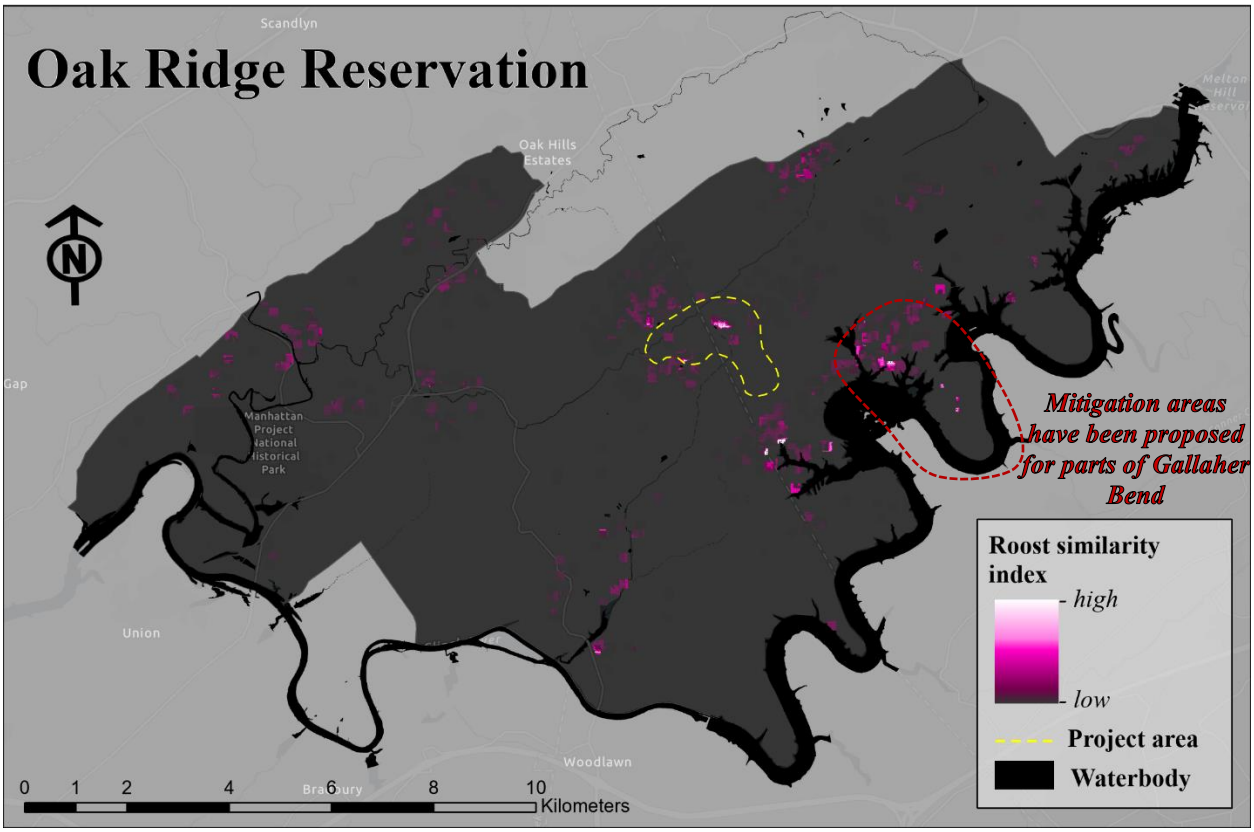


**Figure 9.1. Upland roosting habitat across the ORR.** Upland forest roosting habitat elsewhere on the Oak Ridge Reservation with species composition and structural features similar to that within the SNS/STS Project area.

**BIOLOGICAL RISK:**

Thorough demographic data are not available for the action area or the broader ORR. Direct capture surveys of bat species have occurred on a very limited basis (though listed species are known from historical data and recent service calls for bats in/on buildings), and no attempts to census any bat species have occurred on the ORR. This assessment assumes—based on census of potential roost trees, nearby habitat, their quality in comparison to other areas on the ORR, and acoustic data in comparison to reference sites in other areas on the ORR—that permanent removal of forest within the action area will result in direct loss of habitat and future opportunities for reproduction, foraging, and flight corridors for each species considered herein.

***Cumulative Effects***

Cumulative effects are defined differently under ESA and NEPA. Under ESA, cumulative effects are reasonably foreseeable future state, private and tribal activities only. For ESA cumulative effects, we do not consider the effects of past or future Federal actions. ESA cumulative effects are additive to the environmental baseline (past and ongoing actions and their effects) we described above in Section 7.0 of this BA. Conversely, under NEPA, cumulative effects include all past and ongoing actions and their effects that are additive to the effects from all reasonably foreseeable future actions (Federal and non-Federal) as well. For ESA consultation purposes in this BA, we are using the ESA definition of cumulative effects.

Below in section 10 is a brief discussion of future Federal and non-Federal (private, state, or tribal only) activities that are reasonably likely to occur within the action area that directly and indirectly affect species/critical habitat addressed in this assessment. These are added to the environmental baseline (discussed above).

***Interrelated and Interdependent Actions and Their Effects***

The current landscape that surrounds the SNS, adjacent to Bear Creek Valley, has been subject to forest clearing and fragmentation, leading to loss of suitable habitat for Federal listed threatened and endangered bat species and other protected bat species listed in this BA (although, only the Gray bat was considered during initial SNS consultation). Prior development of the SNS facility involved removal of vegetation from a minimum of 110 acres on the ORR for the SNS facility, support facilities and parking areas. Land cover on this original 110 acres consisted of more than 84.5 acres of mixed hardwood forest composed of red oak, white oak, chestnut oak, poplar, and hickory. Approximately 20 percent of the site was covered in loblolly pines planted in the 1940s and 1950s, with an additional 20 percent of the site logged due to pine beetle kill. The remaining 10 percent of the site was old field scrub. Additional acreage was developed as roads, sewage line, water main, natural gas line, steam line, electrical feeder lines. The FEIS for the SNS facility and support structures, road, etc. identified no State or Federal listed threatened, endangered, or In Need of Management animal species within the original project area. Environmental effects on forested habitats and aquatic resources were expected to be minimal during project development and long term. Although permanent removal of more than 110 acres of mostly forested land for the original SNS Project resulted in forest fragmentation, minimal effects of wildlife were expected because a forested path along Chestnut Ridge was retained.

***Incidental Take***

No incidental take (as defined by ESA) is anticipated for any Federal listed species *or* species under consideration or proposed for Federal listing.

***Effect Determination***

The STS construction project **"<u>may affect, likely to adversely affect"</u>** Indiana bat (*Myotis sodalis),* Northern long-eared bat *(Myotis septentrionalis),* Gray bat *(Myotis grisescens),* Tricolored bat *(Perimyotis subflavus),* and Little brown bat *(Myotis lucifugus).*

## 10. ADDITIONAL CONSERVATION RECOMMENDATIONS

DOE Oak Ridge Site Office agrees to establish a mitigation area to be permanently conserved based on the results of this Biological Assessment. A determination of worst-case scenario for Tennessee forest-dwelling bats listed in Section 5.1 above is the driver behind this determination. The mitigation area described in Section 3 of this BA will be permanently conserved to provide suitable roosting and foraging habitat for Federal listed bat species and species under considerations for Federal listing named in this BA for which a determination of may affect, likely to adversely affect has been made. In addition to a permanently conserved mitigation area, research projects to support species recovery of the bats listed in this BA will be supported by DOE. Research may include creation of an artificial cave, design and testing of artificial tree roosts, support of graduate student projects on the ORR, and other research through collaboration between universities and the ORNL Natural Resources Management Program and the Environmental Sciences Division. Discussions regarding restoration of most of the 97-acres of the STS construction project will take place as part of the formal consultation between USFWS and DOE-ORO.

## 11. NEED FOR RE-ASSESSMENT BASED ON CHANGED CONDITIONS

This BA and findings above are based on the best current data and scientific information available. A new analysis and revised BA must be prepared if one or more of the following occurs: (1) new species information (including but not limited to a newly discovered activity area or other species information) reveals effects to threatened, endangered, proposed species, or designated/proposed critical habitat in a manner or to an extent not considered in this assessment; (2) the action is subsequently modified or it is not fully implemented as described herein which causes an effect that was not considered in this assessment; or (3) a new species is listed or critical habitat is designated which may be affected by the action that was not previously analyzed herein.

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# APPENDIX A.

ORNL/TM-2020/1698

# Natural Resources Assessment for the Spallation Neutron Source Second Target Station, Oak Ridge, Tennessee

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**September 2020**

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE US DEPARTMENT OF ENERGY

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ORNL/TM-2020/1698

Natural Resources Management Program

# NATURAL RESOURCES ASSESSMENT FOR THE SPALLATION NEUTRON SOURCE SECOND TARGET STATION, OAK RIDGE, TENNESSEE

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September 2020

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## ACRONYMS

| | |
|---|---|
| BCC | USFWS bird of conservation concern |
| BMC | USFWS bird of management concern |
| dbh | diameter at breast height (4.5 ft) |
| DOE | US Department of Energy |
| GPS | global positioning system |
| MBTA | Migratory Bird Treaty Act |
| ORNL | Oak Ridge National Laboratory |
| ORR | Oak Ridge Reservation |
| PIF | Partners in Flight |
| SNS | Spallation Neutron Source |
| STS | Second Target Station |
| TDEC | Tennessee Department of Environment and Conservation |
| TWRA | Tennessee Wildlife Resources Agency |
| USFWS | US Fish and Wildlife Service |
| VES | visual encounter survey |

# 1. INTRODUCTION

The US Department of Energy's Oak Ridge National Laboratory (ORNL) is a leading institution in advanced materials, supercomputing, neutrons, and nuclear science. As a research laboratory managed by UT-Battelle, LLC for DOE, ORNL has national priorities in energy, security, and scientific discovery that necessitate facility improvements and expansions. DOE is also committed to environmental stewardship. The laboratory is located on the ~32,000-acre Oak Ridge Reservation (ORR), much of which is categorized as a National Environmental Research Park and a state Wildlife Management Area. DOE works with the Tennessee Wildlife Resources Agency (TWRA), Tennessee Department of Environment and Conservation (TDEC), US Fish and Wildlife Service (USFWS), US Department of Agriculture, and other agencies to serve as an effective steward of the ORR. Accordingly, project managers must conform to environmental regulations, agreements, and policies at the federal, state, and institutional levels. Per 40 CFR (Code of Federal Regulations) 1508.14, potential effects on research and science education on the National Environmental Research Park represent potential impacts of federal actions. Moreover, federal actions that affect the quantity and quality of hunting opportunities and deer reduction harvest on the Oak Ridge Wildlife Management Area must be considered whenever other aspects of the human environment (as defined by NEPA) are affected.

The Spallation Neutron Source (SNS) is a premiere facility at ORNL that provides advanced capabilities in neutron scattering to promote new discoveries and research opportunities in material sciences, physics, chemistry, biological sciences, and others. A conceptual design for a Second Target Station (STS) has been in consideration for several years. The STS is intended to complement and enhance existing ORNL capabilities, notably research and exploration of complex materials. The proposed STS will involve development of existing natural areas on the ORR, which might contain sensitive resources that require mitigation or avoidance in accordance with existing policies and regulation.

This report summarizes current knowledge of natural and cultural resources within the STS project area. At the time of this report, the proposed STS project consisted of an operations area comprising 55.4 acres (22.4 ha) and a total review area for potential construction comprising ~224 acres (90.6 ha). The review area is located primarily within forested natural areas of the ORR with minor development in the form of power-line rights-of-way and secondary/graveled roads (Figure 1). The primary goal was to evaluate potential effects on sensitive resources that might result from development of the STS. In addition to on-the-ground surveys during summer 2009 and fall 2019 to summer 2020 by ORNL Natural Resources Management Program and Aquatic Ecology Group staff, this report makes use of historical (pre-1995) and contemporary (1995 to present) data from additional confirmed sources (e.g., TDEC). Likewise, forest conditions were compiled primarily from a 2013 forest inventory effort for Forest Management Compartment 17 and supplemented with limited ground observations in 2019. The individuals who obtained and compiled the data that are presented here are familiar with and routinely assess sensitive resources on the ORR.

Biological surveys rarely permit a full picture of the resources that will be affected. Additional species are expected to be present at low detection frequency. Moreover, natural area loss within relatively small areas of the ORR can have meaningful effects on ecosystem and human health even beyond the ORR. We attempt to consider these uncertainties herein. Accordingly, this report should facilitate environmentally sound decisions during planning and development of the STS and help project managers address regulatory guidance and DOE policy as it relates to sustainable development in compliance with, for example, the US Endangered Species Act, Migratory Bird Treaty Act (MBTA), Tennessee Rare Plant Protection and Conservation Act of 1985, Tennessee Nongame and Endangered or Threatened Wildlife Species Conservation Act of 1974, several federal and state regulations regarding aquatic resource

protection, and site-specific policies as outlined in various ORR management plans developed by ORNL and TWRA for DOE (e.g., Carter et al. 2020).

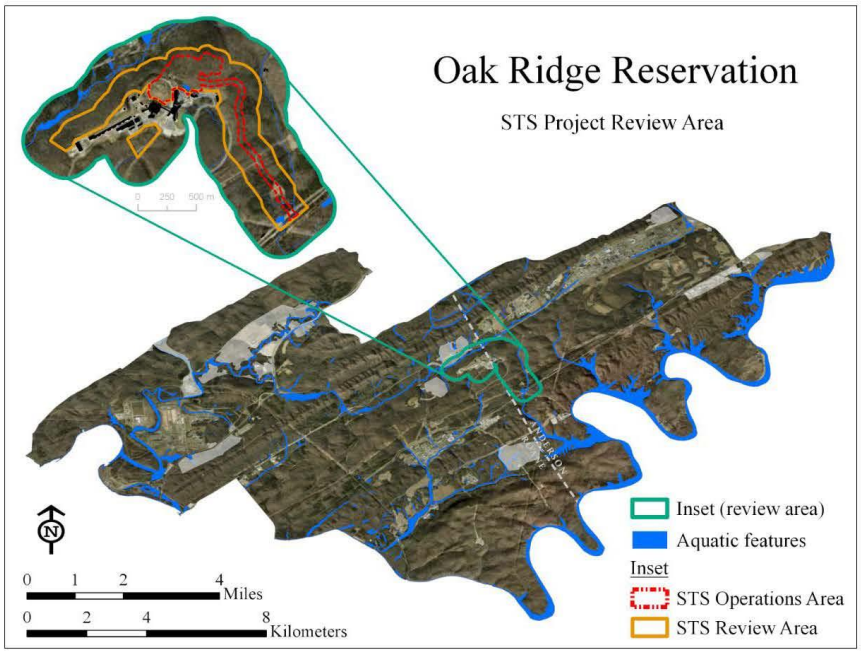


**Figure 1. Review area for the proposed STS on DOE's ORR, Oak Ridge, Tennessee.**

## 2. METHODS

*Overview*—In addition to two on-the-ground surveys in 2009 and 2019 to 2020, the authors compiled historical (pre-1995) and contemporary (1995 to present) data on sensitive resources within the STS review area from (1) previous reports and observations by ORNL Natural Resources, (2) reports made available to ORNL Natural Resources by researchers and contractors on the ORR (e.g., 2013 Forest Inventory), and (3) the TDEC's Natural Heritage Inventory Program. Historical observations (pre-1995) are especially relevant to quantify rare species, which are inherently difficult to detect. Thus, historical observations were presumed valid unless subsequent targeted surveys failed to detect those resources, and/or—in the case of sensitive flora and fauna—other resources that are critical to their persistence were no longer present or adequate.

### 2.1 SENSITIVE RESOURCES SURVEYS

Environmental surveys for much of the STS survey area were first conducted in 2009 for what was then termed the "SNS Target Building #2" (Giffen et al. 2009). The 2009 survey area did not include the planned access road that will link Bethel Valley Road to the STS. Methods and results from the 2009 report are in Appendix I, along with more detailed plant surveys compared with those conducted in 2019. New sensitive resources surveys within the STS project area (Figure 2) occurred from September 17 to October 31, 2019 and March 26 to August 10, 2020.

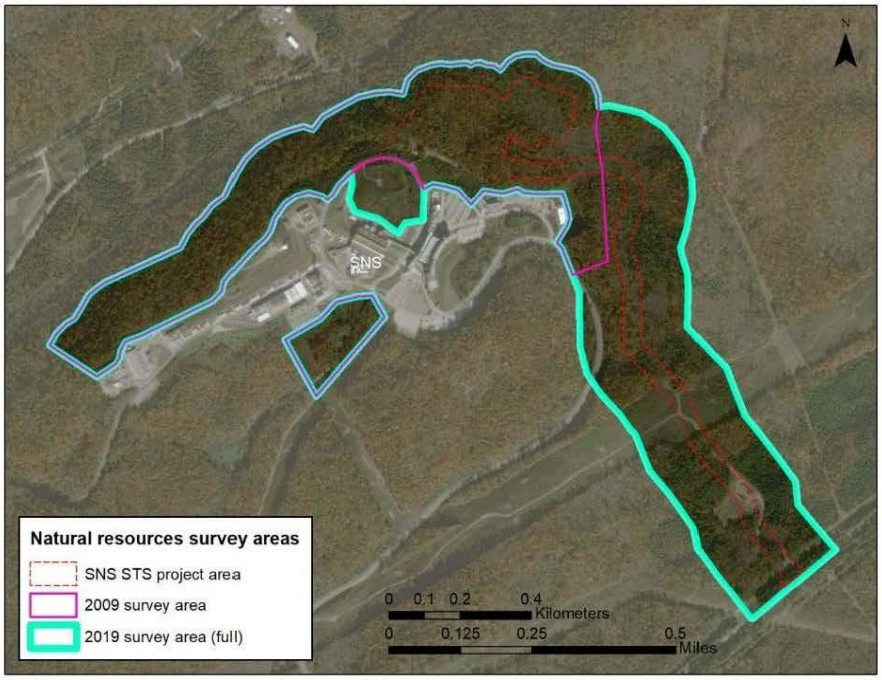


**Figure 2. Natural resources survey areas for the SNS STS project (dashed red border).** The 2009 survey area was expanded in October 2019 to account for the access road that connects to Bethel Valley Road.

### 2.1.1 Wildlife Surveys

*Bat acoustic surveys*—Five bat acoustic monitors (Wildlife Acoustics Song Meter SM4Bat FS Ultrasonic Recorders equipped with SMM-U2) were positioned in likely flyways and foraging zones throughout the survey area from October 15–29 and June 8–16, 2020. Sites for acoustic recording were selected based on likelihood of use by bats as flyways to foraging grounds and/or for foraging. Microphones were mounted on 3-m poles and directed along the likely flyway. Recording began 30 min before sunset and ended 30 min after sunrise each night. All SM4Bat monitors were deployed for 14 consecutive nights, beginning October 15, 2019. Data were collected and analyzed using Kaleidoscope Pro Analysis Software, version 5 with both zero-crossing and full-spectrum analysis methods, as approved by the USFWS.

*Reptiles and amphibian visual encounter surveys (VESs)*—We implemented VESs along two primary transects throughout the extent of the study area and once each along all forest edges and roadsides. Previously installed erosion netting along the northern perimeter of SNS was also surveyed opportunistically throughout the 2019 and 2020 field seasons to detect ensnared reptiles or their carcasses.

*Small mammal trapping*—To quantify small mammal abundance and diversity, 144 (n = 57 in the fall; n = 87 in the spring) Sherman live traps were positioned every 30 to 60 m along a transect that extended north from Bethel Valley Road, along the planned STS access road, and west through the primary impact area. Separate Sherman live trap arrays were also placed around a retention pond (n = 3) and a high grassy field (n = 10) located in the northeast portion of SNS, south of Perimeter Road in the fall of 2019.

Eighty-seven Sherman traps were placed in the southern portion of the project area during the spring. Traps were placed primarily in the southern portion of the project area in the moist forest habitat just north of Old Bethel Valley Road.

*Bird point counts*— Avian point counts were implemented at each of the small mammal trap sites and at 10 additional locations throughout the survey area. All bird species seen or heard within a period of 10 min were recorded. Each site was visited 10 times throughout October 2019, twice from September 17–26, 2019, and 10 times during April 2020.

*Drift fence surveys (small vertebrates)*— A drift fence array was installed to provide a detailed assessment of small vertebrates within the central portion of the survey area, where most new development is being considered. The drift fence array consisted of ~200 in. of silt fence installed in an "x" pattern with a four-way funnel trap at its center (Figure 3). A single funnel trap was also positioned at the terminus of each of the four silt fences. Traps were checked daily when active (Monday through Friday each week), and bird seed, shelter, and a water source were provided within each trap. In total, the trap was active for ~120 days and nights from 17 September–31 October 2019 and 26 March–10 August 2020.

**Figure 3. (left) Measuring and tagging a copperhead after checking drift fence arrays within the northcentral portion of the STS survey area; (right) following installation of a four-way funnel trap in October 2019.**

### 2.1.2 Plant Surveys

Rare plant surveys were conducted primarily to confirm detailed assessment in 2009. Walkdowns were conducted along similar transects to those established in 2009 (Appendix I, Figure 1) as well as the planned access road that will connect the STS facilities to Bethel Valley Road (Figures 1 and 2).

## 2.2 FOREST INVENTORY

Forest conditions were assessed based on a forest inventory conducted in 2013 and on current ground observations. A forest inventory for Forest Management Compartment 17, which contains the SNS STS survey area, was concluded in November 2013 (Johnston, unpublished report to the ORNL Natural Resources Management Program). More than 470 sampling points were taken on a 300 by 300 ft grid covering the 970-acre (393-ha) compartment. A subset of 103 points fell within the STS survey area and were extracted for this review (Appendix II).

# 3. RESULTS AND DISCUSSION

## 3.1 SENSITIVE RESOURCES SURVEYS

### 3.1.1 Wildlife Surveys

All wildlife known from the STS review area are included in Appendix III, alongside their state and federal protection status. In total, 151 vertebrate and invertebrate wildlife taxa are known from the review area (Appendix III). Of all species known from the STS review area, at least 10 are afforded special legal protection under state or federal law, 5 species are considered by USFWS to be both birds of conservation concern (BCC) and birds of management concern (BMC), 2 species are BCC-only, and 2 species are BMC-only (in addition to ≥50 bird species afforded protection under the MBTA [16 U.S.C. §§703-711]). Additionally, at least one species is considered rare by TDEC, and seven species represent ORNL focal species for management and research (imperiled bats and four-toed salamander) (Appendix III).

*Bat acoustic surveys*—Results from five bat acoustic detectors deployed from 15–29 October 2019 (70 survey nights during fall swarming season) are included in Table 1a. Table 1b results are from six bat acoustic detectors deployed from 8-16 June 2020 (63 survey nights during summer roosting season). In total, 15 native bat species were detected. Detection frequencies provide strong evidence for 10 species, reasonable evidence for 4 species, and 1 species was considered unlikely within the STS survey area. Both state and federally listed species—including federally endangered gray bats (*Myotis grisescens*), state threatened little brown bats (*Myotis lucifugus*), and state threatened tricolored bats (*Perimyotis subflavus*) (also under federal review)—were detected at high frequency. Four additional species with state and/or federal listing status were considered probable residents given either moderate detection frequency or incidental observation (Tables 1a and 1b). Habitat suitable to each bat species was abundant throughout the project area but particularly within the open and mature forest in the northcentral portion of the STS project area (Figure 4).

**Table 1a. Results from acoustic bat detectors from 15–29 October 2019.** The number of call detections is included for each detector. A low number of detections, within and between monitors, is considered poor evidence of presence. Shaded rows represent status species. Darker shading indicates greater confidence based on the number of calls, suitable habitat, and nearby location records. (SR: considered rare or regionally important by the state of Tennessee; SD: state deemed in need of management; ST: state threatened; SE: state endangered; FT: federally threatened; FE: federally endangered; FP: federal listing petition currently under review).

| Species | Species code | Bat detector site | | | | | Considered present | Status |
|---|---|---|---|---|---|---|---|---|
| | | 1-19 | 2-19 | 3-19 | 4-19 | 5-19 | | |
| *Corynorhinus rafinesquii* | CORA | 0 | 3 | 4 | 0 | 0 | Probable | SD |
| *Eptesicus fuscus* | EPFU | 5 | 3 | 1 | 0 | 8 | Yes | |
| *Lasiurus borealis* | LABO | 6 | 3 | 51 | 86 | 191 | Yes | |
| *Lasiurus cinereus* | LACI | 77 | 34 | 23 | 0 | 15 | Yes | |
| *Lasionycteris noctivagans* | LANO | 41 | 14 | 15 | 0 | 137 | Yes | |
| *Myotis austroriparius* | MYAU | 0 | 0 | 0 | 0 | 1 | Unlikely | SR |
| *Myotis grisescens* | MYGR | 12 | 28 | 59 | 21 | 394 | Yes | FE, SE |
| *Myotis leibii* | MYLE | 1 | 2 | 1 | 0 | 2 | Probable | SD |
| *Myotis lucifugus* | MYLU | 3 | 9 | 13 | 3 | 58 | Yes | ST |
| *Myotis septentrionalis* | MYSE | 0 | 1 | 2 | 0 | 0 | Probable | FT, ST |
| *Myotis sodalis* | MYSO | 0 | 3 | 3 | 0 | 1 | Probable | FE, SE |
| *Nycticeius humeralis* | NYHU | 2 | 0 | 28 | 13 | 280 | Yes | |
| *Perimyotis subflavus* | PESU | 5 | 0 | 11 | 24 | 378 | Yes | FP, ST |
| *Tadarida brasiliensis* | TABR | 30 | 10 | 3 | 0 | 9 | Yes | |
| *Lasiurus seminolus* | LASE | 0 | 0 | 0 | 0 | 197 | Yes | |

**Table 1b. Results from acoustic bat detectors from 8-16 June 2020.** The number of call detections is included for each detector.

| Species | Species code | Bat detector site | | | | | | Considered present | Status |
|---|---|---|---|---|---|---|---|---|---|
| | | 1-20 | 2-20 | 3-20 | 4-20 | 5-20 | 6-20 | | |
| *Corynorhinus rafinesquii* | CORA | 0 | 0 | 0 | 0 | 0 | 1 | Possible | SD |
| *Eptesicus fuscus* | EPFU | 0 | 1 | 0 | 0 | 0 | 393 | Yes | |
| *Lasiurus borealis* | LABO | 90 | 25 | 109 | 1 | 0 | 692 | Yes | |
| *Lasiurus cinereus* | LACI | 1 | 28 | 0 | 201 | 0 | 0 | Yes | |
| *Lasionycteris noctivagans* | LANO | 2 | 4 | 3 | 1 | 0 | 0 | Yes | |
| *Myotis austroriparius* | MYAU | 0 | 0 | 0 | 0 | 0 | 0 | Unlikely | SR |
| *Myotis grisescens* | MYGR | 184 | 2 | 0 | 1 | 5 | 46 | Yes | FE, SE |
| *Myotis leibii* | MYLE | 0 | 0 | 0 | 0 | 0 | 0 | Possible | SD |
| *Myotis lucifugus* | MYLU | 152 | 89 | 38 | 1 | 0 | 68 | Yes | ST |
| *Myotis septentrionalis* | MYSE | 0 | 0 | 0 | 0 | 0 | 0 | Possible | FT, ST |
| *Myotis sodalis* | MYSO | 18 | 2 | 1 | 0 | 0 | 0 | Probable | FE, SE |
| *Nycticeius humeralis* | NYHU | 0 | 0 | 0 | 1 | 0 | 3 | Possible | |
| *Perimyotis subflavus* | PESU | 0 | 2 | 9 | 3 | 0 | 190 | Yes | FP, ST |
| *Tadarida brasiliensis* | TABR | 2 | 0 | 2 | 2 | 0 | 3 | Yes | |
| *Lasiurus seminolus* | LASE | 0 | 1 | 2 | 2 | 0 | 3 | Yes | |

Note: See Table 1a for status abbreviation definitions.

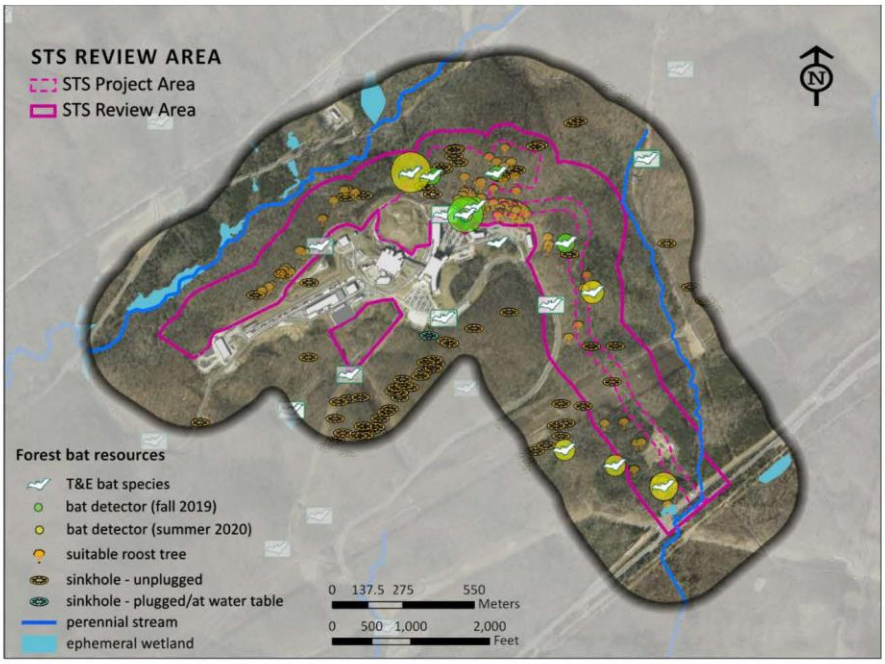


**Figure 4. Contemporary and historical forest bat resources.** All known locations within the vicinity of SNS with records for threatened and endangered bat species are included (see also Table 1a and 1b). Green circles depict bat detector locations from fall 2019 (n = 5); yellow circles represent bat detector locations from summer 2020 (n = 5). Each circle is sized relative to the number of bats detected at that location. Roost trees (orange) are based on 2009 and 2019 to 2020 surveys and are largely represented by white oak.

*Bird point counts (13 person-hours)*—In total, 60 bird species were identified from approximately 22 survey hours (13 h in 2019, 9 h in 2020). This included 59 species protected under the MBTA, including 4 species considered to be BMCs, 4 species considered by Partners in Flight (PIF) to be species in steep decline, and 1 species considered by TDEC to be rare in the state of Tennessee (Table 2). No other state- or federally listed bird species were detected, although TDEC data indicate the historical occurrence of peregrine falcon (*Falco peregrinus*) along the planned access road near Bethel Valley Road. This species is no longer listed by the state of Tennessee but also falls under the protection of the MBTA (Table 2).

*Small mammal trapping (1270 total trap nights)*—No status small mammal species were detected during summer/fall of 2019 or spring/summer of 2020. Common species included deer mice (*Peromyscus* spp), cotton rats (*Sigmodon hispidus*), chipmunks (*Tamias striatus*), house mice (*Mus musculus*), and short-tailed shrews (*Blarina brevicauda*).

Historical data from ORNL and TDEC indicate the presence of southern bog lemmings (*Synaptomys cooperi*) throughout the southernmost portion of the survey area near Bethel Valley Road. This species is listed as "in need of management" by both TWRA and TDEC. Focused trapping efforts in the southern portion of the project area during spring 2020 failed to detect any specimens. Its presence remains possible, but dense invasive plant cover and repeated mowing through the wetland have compromised habitat. Given that prior presence indicates a high potential for bog lemmings in the area, invasive plant

removal and wetland/grassland restoration in this area might serve to offset some impacts of STS construction and qualify as mitigation at the state level.

*Reptile and amphibian surveys (visual encounter and cover boards) (45 person-hours)*—We observed 18 amphibian and reptile species during visual encounter and cover board surveys. These included six species not detected via funnel traps (see *Drift fence surveys* below): ringnecked snake (*Diadophis punctatus*), watersnake (*Nerodia sipedon*), earthsnake (*Virginia valeriae)*, Cope's gray treefrog (*Hyla chrysoscelis),* four-toed salamander (*Hemidactylium scutatum*), and chorus frog (*Pseudacris feriarum*).

Previous surveys indicated the presence of four-toed salamanders (*Hemidactylium scutatum*) within the survey area, north of SNS. Although the atypical habitat in which one individual was found suggested that the salamander was transient (Giffen et al. 2009), potentially suitable breeding habitat for four-toed salamanders was documented in the northeastern portion of the area during 2019 surveys. No specimens were found in this area during the spring 2020 reproductive season, but a large breeding population of four-toed salamander was identified in the wetland and moist forest in the southernmost portion of the STS footprint, where bog lemmings were historically known to occur (Figure 5). Along with the bog lemming, this species is listed as "in need of management" by the state of Tennessee. Detectability is extremely low outside of the spring breeding season, thus additional survey of suitable habitat during spring 2020 was necessary to confirm presence, and the extent of occurrence of this state-listed species within the STS footprint might be larger than is currently known. The ORNL Aquatic Ecology Group and Natural Resources Management have made considerable efforts in identifying four-toed salamander populations and important corridors for movement by this sensitive species on the ORR. Recent field and ecological modeling studies have identified the forest surrounding SNS as important to four-toed salamander movement (Wade and Carter 2020; Wade, DeRolph, and Carter 2020). This would explain why previous surveys recorded this species as likely transient in atypical habitat within the STS review area. The STS project area appears to represent a considerable corridor between populations in Bear Creek Valley and within the Bearden Creek and Melton Branch watersheds (Wade and Carter 2020).

The remains of 17 individual reptiles were identified within erosion netting along Perimeter Road (Figure 6). Of these individuals, four species were identified with confidence, which included ratsnakes (*Pantherophis spiloides*), eastern racers (*Coluber constrictor*), gartersnakes (*Thamnophis sirtalis*) and copperheads (*Agkistrodon contortrix*). The remains of one individual could not be positively identified. However, osteological features of the skull and teeth suggest that it was an eastern slender glass lizard (*Ophisaurus attentuatus*). This species is listed as "in need of management" by the state of Tennessee, but its presence cannot be confirmed without additional survey. Suitable habitat exists along road edges surrounding SNS. However, the extensive erosion netting and previous construction of the SNS facility has likely eliminated the primary useable habitat for this species on the ORR.

Additional species encountered during visual surveys or as incidentals can be found in Appendix III and several representatives are shown in Figure 7 (including drift fence array captures).

**Figure 5. State-listed four-toed salamander and wetland breeding habitat at the southernmost end of the STS review area.**

**Figure 6. Representative images of reptile remains found in erosion netting during surveys along Perimeter Road in the northeastern portion of the survey area.**

**Figure 7. Examples of wildlife encountered during 2019 field surveys.**

*Drift fence surveys (small vertebrates) (120 traps days and nights for a single 5-trap array)*—50 species were captured in drift fence funnel arrays. This included 10 reptiles: copperhead (*Agkistrodon contortrix*), wormsnake (*Carphophis amoenus*), racer (*Coluber constrictor*), milksnake (*Lampropeltis triangulum*), cornsnake (*Pantherophis guttatus*), ratsnake (*Pantherophis spiloides*), five-lined skink (*Plestiodon fasciatus*), little brown skink (*Scincella lateralis*), box turtle (*Terrapene carolina*), and gartersnake (*Thamnophis sirtalis*); 10 amphibians: spotted salamander (*Ambystoma maculatum*), American toad (*Anaxyrus americanus*), narrow-mouthed toad (*Gastrophryne carolinensis*), American bullfrog (*Lithobates catesbeianus*), green frog (*Lithobates clamitans*), pickerel frog (*Lithobates palustris*), southern leopard frog (*Lithobates sphenocephalus*), eastern newt (*Notophthalmus viridescens*), slimy salamander (*Plethodon glutinosus*), and spring peeper (*Pseudacris crucifer*); 4 mammal species: *Peromyscus* spp., chipmunk (*Tamias striatus*), eastern mole (*Scalopus aquaticus*); and northern shot-tailed shrew (*Blarina brevicauda*); and 1 bird species: Carolina wren (*Thryothorus ludovicianus*). At least 35 invertebrate taxa were also identified as trap bycatch.

Compared to other sites on the ORR, the study area contained high richness and abundance of reptiles; average richness with high abundance of pond-breeding amphibians; and average richness and abundance of small mammals. No status species of amphibians or reptiles were documented during drift fence surveys. However, state-listed pine snakes (*Pituophis melanoleucus*) are expected, particularly within the dry, open forest in the northcentral portion of the survey area. Owing to their small population size and secretive nature, pine snakes are inherently difficult to detect, and species accumulation curves suggest that some rare species were not detected within the STS review area (Figure 8).

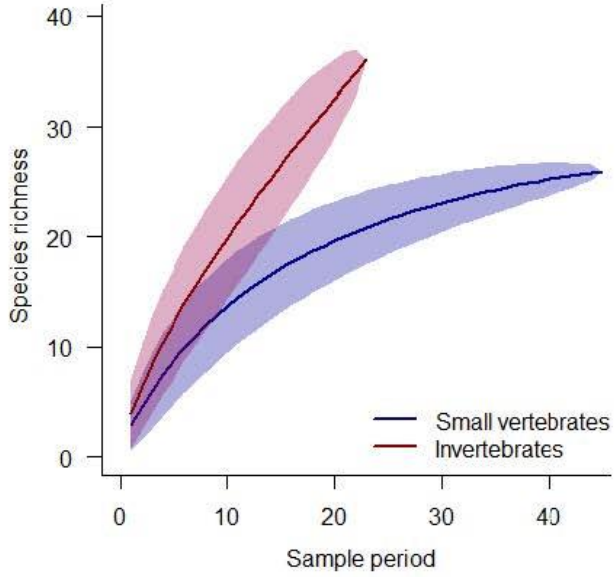


**Figure 8. Species accumulation curves based on funnel trap captures of invertebrates (red) and small vertebrates (blue) from fall 2019 to summer 2020.** Curves indicate the cumulative number of species captured through time and according to sample effort. Lines indicate observed cumulative richness, and shaded regions represent the interquartile range of simulated values. Lack of saturation in accumulation curves indicates likely incomplete sampling and failed detection of rare species for both invertebrates and small vertebrates (amphibians, reptiles, and small mammals). Lack of saturation was more extreme for invertebrate bycatch, as would be expected given the greater number of invertebrate species on the ORR.

### 3.1.2 Plant Surveys

No new listed plant populations were found during 2019 to 2020 plant surveys, and no new significant disturbances of the vegetation were seen in the natural vegetation areas. The mature forest on the northwest side of the SNS appears unchanged. More than 100 whorled horsebalm (*Collinsonia verticillata*) plants and 5 sites for American ginseng (*Panax quinquefolius*) occur in this forest. A small population of pink lady-slipper (*Cypripedium acaule*) occurs in the southern portion of the survey area.

### 3.1.3 Aquatic Resources

The STS review area is primarily upland forest. However, it contains extensive wet weather conveyances, and portions of stream and wetland are intersected by the project area (Figure 9). If this project proceeds, permits and additional assessment will be required. Minimally, these would include wetland delineations (USACE 1987), stream evaluations (TDEC 2019), and hydrologic determinations of currently unclassified channels and wet weather conveyances (TDEC 2020). Owing to the presence of state-listed species, some sites might require additional assessment for the presence of Exceptional Tennessee Waters (TDEC 2015), but current wetland area of <1 acre suggests that avoidance of impacts to these areas is achievable with strategic site designs.

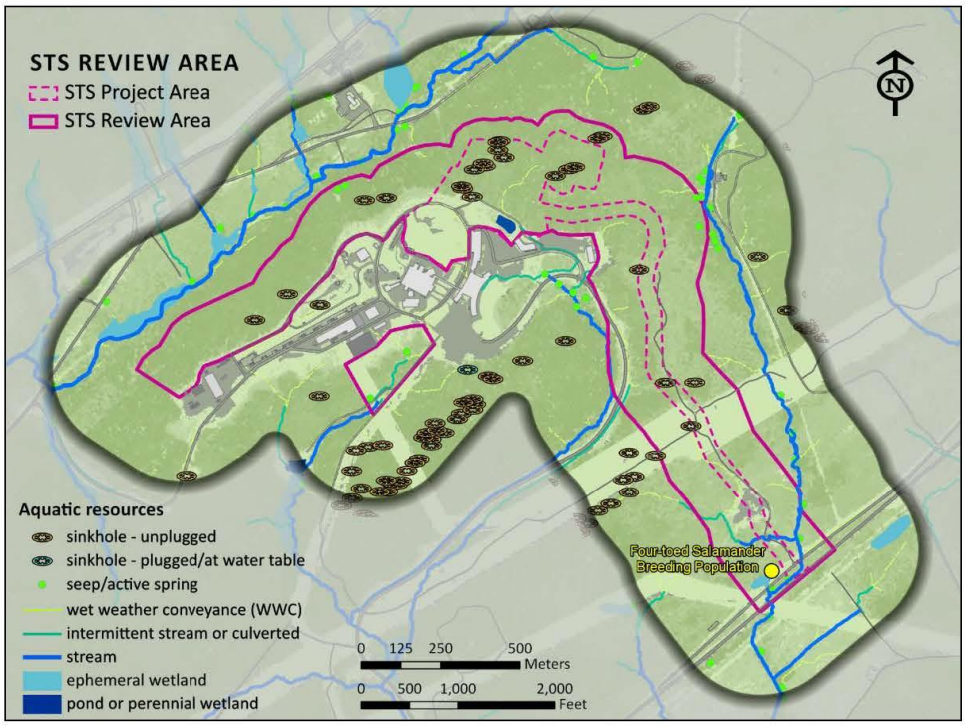


**Figure 9. Aquatic resources within the STS review and project area (solid and dashed magenta line, respectively).** Note the occurrence of streams and breeding population of the state-listed four-toed salamander (yellow circle) in the southeasternmost portion of the review area.

### 3.1.4 Additional Observations

We compiled historical and incidental observations of sensitive resources for the SNS STS survey area from (1) prior observations made by ORNL NR or ESD staff during routine field surveys, (2) external researcher and contractor reports, and (3) TDEC's Natural Heritage Inventory Program, which contains various confirmed sources that date back as far as 1940 for much of the ORR. The STS survey area contained few historical plant and animal records. Among these were southern bog lemmings (*Synaptomys cooperi*), northern long-eared bats (*Myotis septentrionalis*), peregrine falcons (*Falco peregrinus*), slender glass lizards (*Ophisaurus attenuatus*), and American ginsengs (*Panax quinquefolius*).

All status species records, both contemporary and historical, for the STS project area are included in Figure 10 and Table 2 (see also Appendix III). Rare plants are excluded from maps and figures but are abundant in mature mesic forest within the survey area.

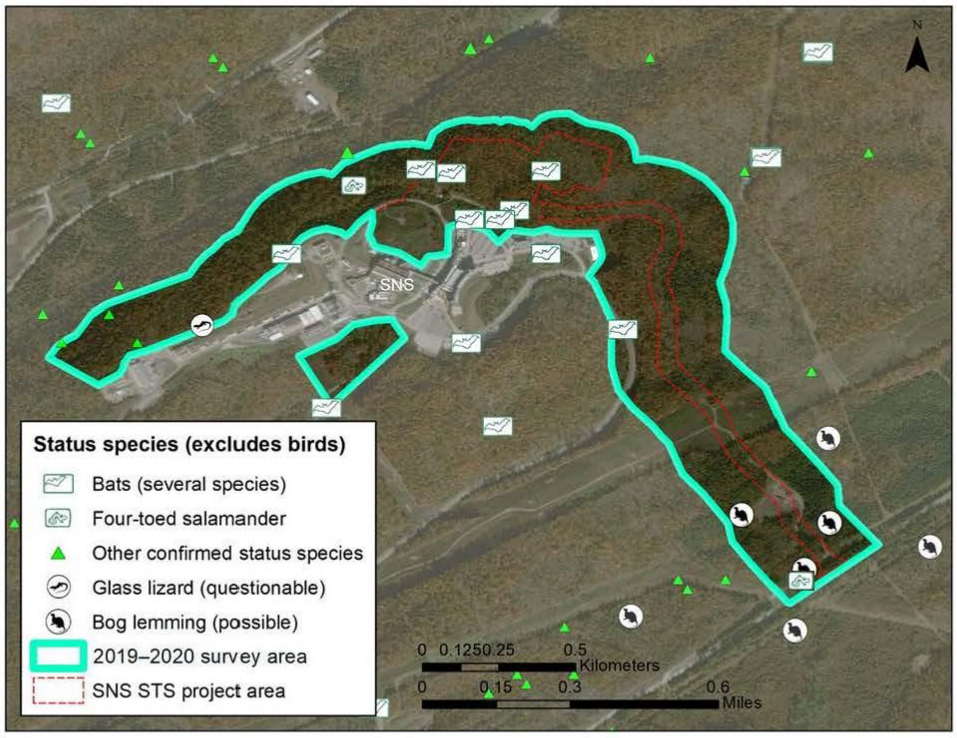


**Figure 10. Status species locations, excluding birds. All bat points represent at least one federally listed species.** The identities of some listed species were omitted (green triangles) because release of that information could compromise sensitive resources.

**Table 2. Status wildlife species present within the SNS STS project area based on historical (pre-1995) and contemporary observation (1995 to present).** Status codes: SR: considered rare or regionally important by TDEC; SD: state deemed in need of management; ST: state threatened; SE: state endangered; FT: federally threatened; FE: federally endangered; FP: federal listing petition currently under review; MBTA: protected under the MBTA; CBSD: PIF species designated as a common bird in steep decline. A complete list of species found in the STS project area can be found in Appendix III.

| Common name | Scientific name | Status | Notes |
|---|---|---|---|
| | ***Birds*** | | |
| Wood duck | *Aix sponsa* | MBTA + BMC | 2019–2020 |
| Ruby-throated hummingbird | *Archilochus colubris* | MBTA | 2009 |
| White-breasted nuthatch | *Baeolophus bicolor* | MBTA | 2009, 2019–2020 |
| Red-shouldered hawk | *Buteo lineatus* | MBTA | 2009 |
| Red-tailed hawk | *Buteo jamaicensus* | MBTA | 2019–2020 |
| Broad-winged hawk | *Buteo platypterus* | MBTA | 2009, 2019–2020 |
| Blue-gray gnatcatcher | *Polioptila caerulea* | MBTA | 2019–2020 |
| American crow | *Corvus brachyrhynchos* | MBTA | 2019–2020 |
| American robin | *Turdus migratorius* | MBTA | 2019–2020<br>Barn swallow |
| Brown-headed cowbird | *Mylothrus ater* | MBTA | 2019–2020 |
| Common grackle | *Quiscalus quiscula* | MBTA + CBSD | 2019–2020 |
| Chipping sparrow | *Spizella passerina* | MBTA | 2019–2020 |
| Common yellowthroat | *Geothylpis trichas* | MBTA | 2019–2020 |
| Northern cardinal | *Cardinalis cardinalis* | MBTA | 2009, 2019–2020 |
| Yellow-billed cuckoo | *Coccyzus americanus* | MBTA + CBSD | 2009 |
| Red-winged blackbird | *Agelaius phoeniceus* | MBTA | 2019–2020 |
| Northern flicker | *Colaptes auratus* | MBTA | |
| Eastern wood-pewee | *Contopus virens* | MBTA | 2009 |
| American crow | *Corvus brachyrhynchos* | MBTA | 2009, 2019–2020 |
| Blue jay | *Cyanocitta cristata* | MBTA | 2009, 2019–2020 |
| Pileated woodpecker | *Dryocopus pileatus* | MBTA | 2009, 2019–2020 |
| Acadian flycatcher | *Empidonax virescens* | MBTA | 2009 |
| Peregrine falcon | *Falco peregrinus* | MBTA + BMC, BCC | Historical, likely transient* |
| Barn swallow | *Hirundo rustica* | MBTA | 2009 |
| Tree swallow | *Tachycineta bicolor* | MBTA | 2019–2020 |
| Red-bellied woodpecker | *Melanerpes carolinus* | MBTA | 2009, 2019–2020 |
| Song sparrow | *Melospiza melodia* | MBTA | 2009, 2019–2020 |
| Northern mockingbird | *Mimus polyglottos* | MBTA | 2019–2020 |
| Blue grosbeak | *Passerina caerulea* | MBTA | 2009 |
| Northern parula | *Setophaga americana* | MBTA | 2019–2020 |
| Prairie warbler | *Setophaga discolor* | MBTA | 2019–2020 |
| Indigo bunting | *Passerina cyanea* | MBTA | 2009 |
| Savannah sparrow | *Passerculus sandwichensis* | MBTA + SR | 2019–2020 |
| Downy woodpecker | *Picoides pubescens* | MBTA | 2009, 2019–2020 |
| Eastern towhee | *Pipilo erythrophthalmus* | MBTA | 2009, 2019–2020 |
| Scarlet tanager | *Piranga olivacea* | MBTA | 2009, 2019–2020 |
| Summer tanager | *Piranga rubra* | MBTA | 2009, 2019–2020 |

**Table 2. Status wildlife species present within the SNS STS project area based on historical (pre-1995) and contemporary observation (1995–present).**

| Common name | Scientific name | Status | Notes |
|---|---|---|---|
| | ***Birds (continued)*** | | |
| Scarlet Tanager | *Catharus ustslatus* | MBTA | 2019–2020 |
| Carolina Chickadee | *Poecile carolinensis* | MBTA | 2009, 2019–2020 |
| Eastern Phoebe | *Sayornis phoebe* | MBTA | 2009, 2019–2020 |
| Hooded Warbler | *Setophaga citrina* | MBTA | 2019–2020 |
| Yellow Warbler | *Setophaga petechia* | MBTA | 2019–2020 |
| Chestnut-Sided Warbler | *Setophaga pensylvanica* | MBTA | 2019–2020 |
| Pine Warbler | *Setophaga pinus* | MBTA | 2009–2020 |
| Yellow-breasted Chat | *Icteria virens* | MBTA | 2019–2020 |
| Eastern Bluebird | *Sialia sialis* | MBTA | 2009, 2019–2020 |
| Yellow-Bellied Sapsucker | *Sphyrapicus varius* | MBTA + BMC, BCC | 2009 |
| American Goldfinch | *Spinus tristis* | MBTA | 2009, 2019–2020 |
| White-Breasted Nuthatch | *Sitta carolinensis* | MBTA | 2009, 2019–2020 |
| Field Sparrow | *Spizella pusilla* | MBTA + CBSD | 2009, 2019–2020 |
| Eastern Meadowlark | *Sturnella magna* | MBTA + CBSD | 2019–2020 |
| Carolina Wren | *Thryothorus ludovicianus* | MBTA | 2009, 2019–2020 |
| Red-Eyed Vireo | *Vireo olivaceus* | MBTA | 2009, 2019–2020 |
| White-eyed Vireo | *Vireo griseus* | MBTA | 2019–2020 |
| Yellow-Throated Vireo | *Vireo flavifrons* | MBTA | 2009 |
| White-throated sparrow | *Zonotrichia albicollis* | MBTA | 2019–2020 |
| House Finch | *Haemorhous mexicanus* | MBTA | 2019–2020 |
| European Starling | *Sturnus vulgaris* | | 2019–2020 |
| Mourning Dove | *Zenaida macroura* | MBTA + BMC | 2009, 2019–2020 |
| Wild Turkey | *Meteagris gallopava silvestris* | MBTA | 2019–2020 |
| | ***Mammals*** | | |
| Rafinesque's big-eared bat | *Corynorhinus rafinesquii* | SD | 2019, probable[†] |
| Southeastern myotis | *Myotis austroriparius* | SR | 2019, unlikely[‡] |
| Grey bat | *Myotis grisescens* | SE + FE | 2019–2020 |
| Eastern small-footed bat | *Myotis leibii* | SD | 2019–2020 |
| Little brown bat | *Myotis lucifugus* | ST | 2019 |
| Northern long-eared bat | *Myotis septentrionalis* | ST + FT | Historical, probable[†] |
| Indiana bat | *Myotis sodalis* | SE + FE | 2019–2020, probable[†] |
| Tricolored bat | *Perimyotis subflavus* | FP + ST | 2019–2020 |
| Southern bog lemming | *Synaptomys cooperi* | SD | Historical[§] |
| | ***Amphibians*** | | |
| Four-toed salamander | *Hemidactylium scutatum* | SD, ORNL FP | 2009–2020 |
| | ***Reptiles*** | | |
| Eastern slender glass lizard | *Ophisaurus attenuatus* | SD | Historical, questionable[|] |

[*] Record is historical and confirmed, but nesting habitat is not apparent within site.
[†] Record based on few acoustic monitor detections, but presence is assumed given habitat and nearby records.
[‡] Record based on only one or two acoustic monitor detections; presence is unlikely.
[§] Records predate ORNL Natural Resources Program. Targeted surveys in 2020 failed to detect this species.
[|] Questionable contemporary (2019) record based on skeletal remains of recently deceased individual.

### 3.2 FOREST INVENTORY

*Forest cover and land use*—Land use categories in the STS survey area include forest, rights-of-way, developed areas, and edge. Forest comprises approximately 75.6% (169.40 acres) of the area, followed by developed areas (12.3%, 27.39 acres) and rights-of-way (11.1%, 24.75 acres) (Figure 11). Less than 1% (1.44 acres, located between Bethel Valley and Old Bethel Valley Roads) would be considered edge (Figure 11). Thirty-six tree species from 23 genera were documented within the STS survey area (Table 3). Spatial distributions of selected dominant species (>20% basal area at sample points) and additional details regarding forest conditions can be found in Appendix II.

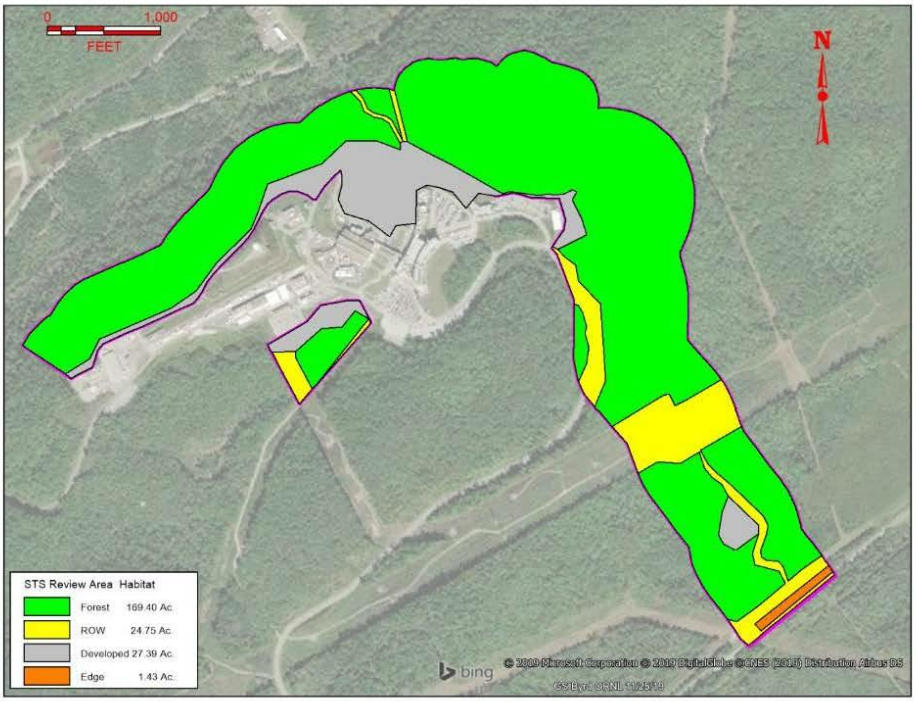


**Figure 11. Forest cover and land use within the STS project area based on 2013 forest inventory data.**

**Table 3. List of 36 tree species inventoried within the STS survey area.**

| Species | Common name | Status |
|---|---|---|
| *Acer rubrum* | Red maple | Native |
| *Acer saccharum* | Sugar maple | Native |
| *Aralia spinosa* | Devil's walking stick | Native |
| *Carya cordiformis* | Bitternut hickory | Native |
| *Carya glabra* | Pignut hickory | Native |
| *Carya tomentosa* | Mockernut hickory | Native |
| *Celtis occidentalis* | Hackberry | Native |
| *Cercis canadensis* | Eastern redbud | Native |
| *Cornus florida* | Flowering dogwood | Native |
| *Fagus grandifolia* | American beech | Native |
| *Fraxinus americana* | White ash | Native |
| *Juglans nigra* | Black walnut | Native |
| *Juniperus virginiana* | Eastern redcedar | Native |
| *Liquidambar styraciflua* | Sweetgum | Native |
| *Liriodendron tulipifera* | Tulip poplar | Native |
| *Morus rubra* | Red mulberry | Native |
| *Nyssa sylvatica* | Black gum | Native |
| *Oxydendron arboreum* | Sourwood | Native |
| *Paulownia tomentosa* | Princess tree | Non-native, invasive |
| *Pinus echinata* | Shortleaf pine | Native |
| *Pinus strobus* | White pine | Native |
| *Pinus taeda* | Loblolly pine | Native |
| *Pinus virginiana* | Virginia pine | Native |
| *Plantanus occidentalis* | American sycamore | Native |
| *Prunus serotina* | Black cherry | Native |
| *Pyrus calleryana* | Callery pear | Non-native, invasive |
| *Quercus alba* | White oak | Native |
| *Quercus coccinea* | Scarlet oak | Native |
| *Quercus falcata* | Southern red oak | Native |
| *Quercus montana* | Chestnut oak | Native |
| *Quercus rubra* | Northern red oak | Native |
| *Quercus stellata* | Post oak | Native |
| *Quercus velutina* | Black oak | Native |
| *Sassafras albidum* | Sassafras | Native |
| *Ulmus alata* | Winged elm | Native |
| *Ulmus rubra* | Slippery elm | Native |

*Land use history and cultural resources*—Figure 12 depicts a topographic map of the STS survey area as it appeared in 1941, immediately prior to acquisition by the federal government during the Manhattan Project. Forested areas at that time are highlighted and occupied 48.3% of the site (107.8 acres), and the balance (41.7%, 115.2 acres) was open fields.

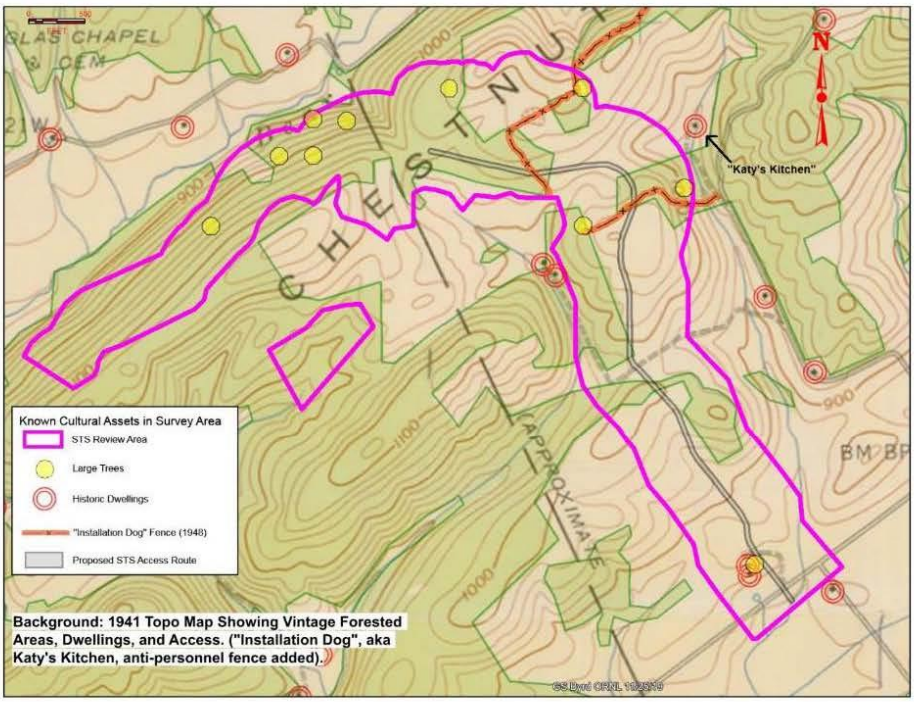


**Figure 12. Historic and cultural resources within the survey area.**

The STS survey area comprises lands from 12 acquisition parcels but contains the remnants of dwellings of only 1 of these parcels (Tract G-601, from "Hiram P. Carter and wife"). The survey area also contains a segment of a driveway connecting a nearby homeplace (Tract B143, Charles E. Brennan) to what is now known as 0907 Access Road. No other preconstruction era features appear within the survey area.

The review era contains a significant portion of an artifact of the cold war era, namely the remains of a double apron anti-personnel fence, surrounding Building 0907 (Katy's Kitchen). Originally referred to as "Installation Dog" in 1948, the 0907 site was a discrete repository for plutonium and the area surrounding it protected by a "GI combat-type barbed wire fence, and rigged with a very elaborate alarm system" (Ruby A. Miller, Union Carbide Nuclear Division News, 1973, as reprinted in ORNL Publication ORNL/M-2732, 2008). An example of this type of obstacle is represented in Figure 13. Remains of the fence include its iron pickets (4 in. posts and shorter stakes, barbed wire [on ground and embedded in trees], and metal warning postings [no longer legible]). Whatever the historical significance of the fence may be, the barbed wire and several dozens of rebar posts and stakes, some difficult to discern among the deep leaf litter, may present hazards to STS construction personnel and equipment during site development.

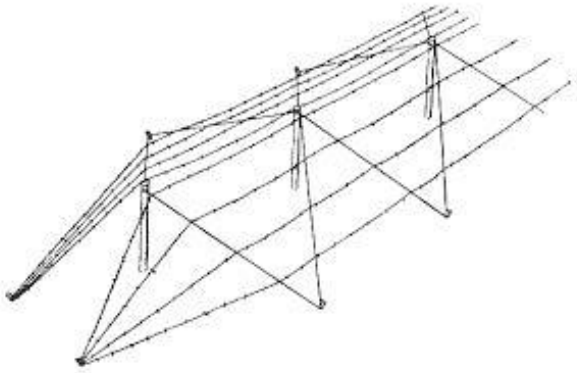

**Figure 13. Example of the type of double apron obstacle found within the survey area near Building 0907 (Katy's Kitchen).**

A review of ORNL Forest Management records indicates that open areas outside the Installation Dog fence were planted with loblolly pine in 1955. The pine was thinned in 1970, 1971, and 1985, and finally harvested in 2000 during the most recent southern pine beetle epidemic and land clearing for the SNS project.

Selective harvesting of most of the survey area's hardwood timber took place in 1972 in the areas east of Chestnut Ridge Drive and in 1977 for the areas to the west. Additionally, clear-cutting occurred among these hardwoods in 1999 and 2000 ahead of SNS site development.

## 4. CONCLUSIONS

This report includes a compilation of new and existing data regarding sensitive flora and fauna, forest condition, and cultural and historical resources that might be impacted by the proposed STS project. In total, 111 species of wildlife were documented within the survey area (Appendix III). Of these, at least 10 species are afforded special legal protection under state or federal law (USFWS), in addition to 59 bird species that are afforded protection under the MBTA (16 U.S.C. §§ 703-711). Few special status plant species occur within the STS project area.

The highest richness and diversity of sensitive resources in the STS survey area appears to occur where the primary development of the STS facilities is proposed (in the northeastern to central portion of the survey area). This area contains a large number of sinks and macropores that provide a high degree of heterogeneity at the landscape and microhabitat levels. Such heterogeneity is simultaneously expected to support a greater number of rare species while reducing detectability (greater niche space while reducing the efficacy of generalized survey methods). The holding pond along the perimeter road also adds considerable value in an otherwise well-drained landscape, as evidenced by the presence of several pond-breeding amphibians. A borderline ephemeral wetland also exists nearby in what appears to be suitable habitat for state-listed four-toed salamanders.

The northeastern to central portions of the survey area also produced the greatest number of reptiles during VESs. These areas contain some of the most suitable habitat for pine snakes on the ORR. Although not detected during surveys, pine snakes might occur given historical records in nearby areas and the suitably dry forest and infertile soils that characterize the area. Eastern slender glass lizards

should not be considered present until additional specimens are discovered. However, likely habitat exists along edges and open canopy habitats with infertile soils surrounding SNS.

The only federally listed species within the STS project area are bats. At least three status bat species were considered present, with four additional status species expected with very high confidence (Tables 1a and 1b). The northeastern to central portion of the study area is likewise expected to harbor unusually high bat richness and abundance owing to a high density of potential roost trees. Acoustic monitors also detected a high number of calls within this area later than what existing guidance suggests for reliable detection (USFWS 2017).

The southern portion of the STS project area, from Bethel Valley Road to the primary facility expansion area, contains the widest range of habitat types. However, the thick understory (within forest and rights-of-way) deemed much of this area difficult to survey. State-listed southern bog lemmings were once abundant within the lower, moist habitats nearest Bethel Valley Road. This species represents another questionable occurrence within the STS project area. Suitable habitat was largely eliminated during construction of much of the ORNL campus, and targeted surveys during summer 2020 failed to detect this species.

### 4.1 MITIGATION

TDEC and TWRA must be notified immediately concerning known impacts to state-listed fauna if the STS project proceeds. Moreover, acceptable mitigation measures for many species, notably bats, depend on the type of habitat (e.g., foraging, roosting, hibernacula). Given that the primary planned construction area of the STS site contains extensive roost habitat for federally listed bats, and federally listed bats were detected via acoustic survey, at least informal consultation with USFWS should be initiated immediately (USFWS 2017). Minimally, informal consultation between DOE and USFWS will also be required for migratory birds under existing agreements between USFWS and DOE (66 FR 3853; for additional details of the responsibilities of DOE under the MBTA, see Carter et al. 2020).

Avoidance of sensitive resources is the preferred first approach. Consultation between USFWS and DOE will determine avoidance and mitigation measures for bats and migratory birds. At the state level, the wetland and small number of streams might be avoided via minimal changes to site design. This would reduce or eliminate necessary permitting and potential mitigation of aquatic resources, as required at the state and federal levels (TDEC 2015, 2019, 2020). Furthermore, two major mitigation strategies might be proposed to offset impacts of STS construction and operation at the state (but not federal) level. These include (1) removal of the synthetic erosion netting that surrounds the SNS facility and SNS Access Road and (2) invasive plant control and restoration of the wetland and moist forest at the southern end of the project area.

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# APPENDIX I. METHODS AND RESULTS FOR 2009 SURVEYS

Giffen, N., S. Reasor, G. Byrd, L. Pounds, C. Waggoner, and C. Campbell. 2009. *Environmental Survey Report for SNS: Target Building #2*. Unpublished technical report. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

## I.1 METHODS

Figure I.1 depicts the surveys conducted on the SNS site for the evaluation of alternatives. The following is a brief description of the methods used during the study.

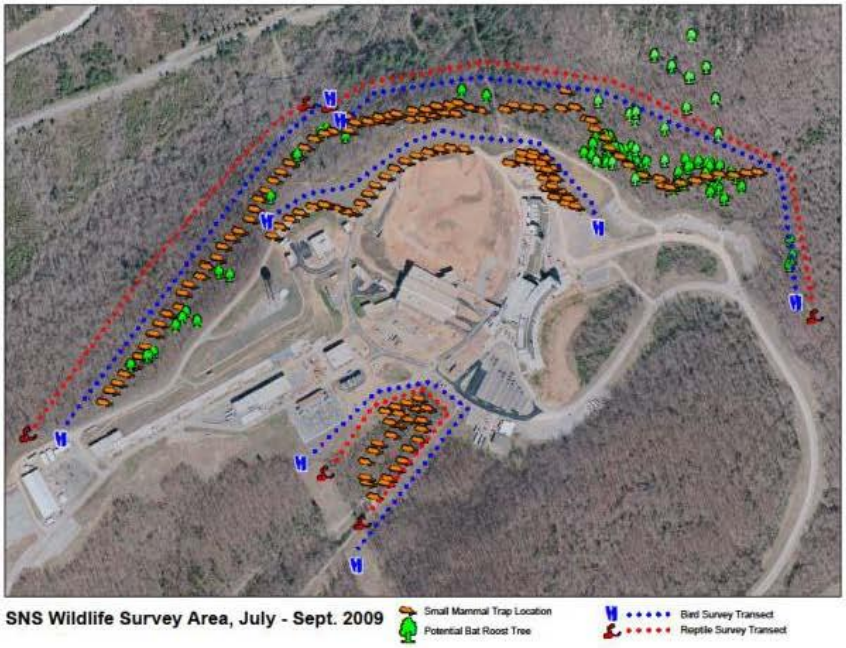



**Figure I.1. Natural resources survey map.**

*Bird survey*—A series of transect surveys of site habitats were conducted during the morning hours. During that time, all birds either heard or seen were recorded. Incidental encounters with birds were also recorded during surveys of other natural resources. Additionally, any sign (e.g., woodpecker drillings) was noted where it could be identified to the species.

*Small mammal survey*—Small mammal surveys were conducted at the site using Sherman live traps. A total of 145 traps were set out on the site covering all habitats. Small mammals were trapped for 7 nights during a 2-week period for a total of 1,015 trap nights (7 nights × 145 traps). All captured small mammals were identified and released at the location of capture. Incidental encounters with mammals were also recorded during surveys of other natural resources.

*Reptile and amphibian survey*—One-day VESs were conducted in all site habitats. This involved searching under logs, rocks, bark, leaf litter, and other debris. All reptiles and amphibians encountered were identified and recorded. Incidental encounters with reptiles and amphibians were also recorded during surveys of other natural resources.

*Vegetation survey*—Walk-through surveys of each habitat were conducted at which time all vascular plant species that could be identified were recorded. Additional surveys were conducted with a professional plant ecologist to specifically identify rare plants. The ORNL forester also surveyed the site to evaluate trees for potential significance and marketability.

*Survey of potential bat roosting habitat*—A visual survey of trees was conducted on the site to determine the presence of potential bat roosting habitat. All trees containing potential bat habitat were flagged for mapping at a later date.

*Global positioning system (GPS) survey point locations*—GPS locations were recorded for all natural resource survey transects and points. GPS locations for potential bat roosting trees at the site were also recorded. A Trimble unit was used to record all locations.

## I.2 RESULTS

The results of the natural resources surveys are presented by habitat type and associated with each alternative as appropriate because each alternative spans more than one habitat type. Alternatives #1 and #3, in particular, are associated with the same habitat types on the north side of the facility. Alternative #2 is associated with a separate area on the west side of the facility.

### I.2.1 Habitats in the Area of Alternatives #1 and #3

#### I.2.1.1 Dry Upland Forest

This dry upland forest is characterized by rolling hills, swales, and moderate slopes. The area slopes upward and eastward on the site from the moister, more steeply sloping forested area to the west. Chestnut Ridge Road is a defining boundary between the drier and moister forested areas at the site. This forest is bordered on the south by a relatively sharp edge in most locations that is characterized by grassy fields, scattered shrubs, and disturbed areas.

*Bird survey results*—A total of 15 bird species were identified in this habitat by either sight or song. Sign was noted for two additional species.

There was sign (tree drillings) noted for one species, the yellow-bellied sapsucker (*Sphyrapicus varius*), which is on the federal "species of management concern" and state "in need of management" list. This species is a fairly common winter visitor on the ORR but is not present during the breeding season. Wild turkey (*Meleagris gallopavo*) scrapes were also noted in the leaf litter on the site.

Five species were recorded at the site that are on the PIF list as being of regional importance in the ridge and valley. PIF monitors population trends based on data gathered throughout the region and lists species that are in apparent decline. Of greatest concern are species that are considered to be impacted by forest fragmentation (i.e., interior forest species). Species in this category that were noted in this habitat on and adjacent to the project site are broad-winged hawk (*Buteo platypterus*), downy woodpecker (*Picoides pubescens*), eastern-wood pewee (*Contopus virens*), scarlet tanager (*Piranga olivacea*) and summer tanager (*Piranga rubra*). Two other notable forest birds recorded on the site are the red-shouldered hawk (*Buteo lineatus*) and pileated woodpecker (*Dryocopus pileatus*). The two hawk species (broad-winged

and red-shouldered) were flyovers. (Ovenbird [*Seiurus aurocapillus*] has been recorded in this area during previous surveys. The ovenbird is an interior forest bird.) A complete bird list for the dry forest is provided in Table I.1.

**Table I.1. Bird species list for the dry forest.**

| Scientific name | Common name | Status | | |
|---|---|---|---|---|
| | | Federal | State | PIF |
| ***Kites, hawks, eagles, and allies*** | | | | |
| *Buteo lineatus* | Red-shouldered hawk | | | |
| *Buteo platypterus* | Broad-winged hawk | | | RI |
| ***Pheasants and turkeys*** | | | | |
| *Meleagris gallopavo* | Wild turkey | | | |
| ***Cuckoos, roadrunners, and anis*** | | | | |
| *Coccyzus americanus* | Yellow-billed cuckoo | | | |
| ***Woodpeckers*** | | | | |
| *Sphyrapicus varius* | Yellow-bellied sapsucker | MC | NM | |
| *Melanerpes carolinus* | Red-bellied woodpecker | | | |
| *Picoides pubescens* | Downy woodpecker | | | RI |
| *Dryocopus pileatus* | Pileated woodpecker | | | |
| ***Tyrant flycatchers*** | | | | |
| *Sayornis phoebe* | Eastern phoebe | | | |
| *Contopus virens* | Eastern wood-pewee | | | RI |
| ***Nuthatches*** | | | | |
| *Sitta carolinensis* | White-breasted nuthatch | | | |
| ***Wrens*** | | | | |
| *Thryothorus ludovicianus* | Carolina wren | | | |
| ***Vireos*** | | | | |
| *Vireo olivaceus* | Red-eyed vireo | | | |
| ***Crows and jays*** | | | | |
| *Cyanocitta cristata* | Blue jay | | | |
| *Corvus brachyrhynchos* | American crow | | | |
| ***Tanagers*** | | | | |
| *Piranga olivacea* | Scarlet tanager | | | RI |
| *Piranga rubra* | Summer tanager | | | RI |

MC = species of management concern, NM = in need of management, RI = regional importance

*Small mammal survey results*—A total of 25 Sherman live traps were set out in the dry upland forest habitat. Small mammals were trapped for 7 nights during a 2-week period for a total of 175 trap nights (7 nights × 25 traps).

The white-footed mouse (*Peromyscus leucopus*) was the only species of small mammal captured in traps in this habitat. Eastern chipmunks (*Tamias striatus*) and gray squirrels (*Sciurus carolinensis*) were also recorded incidentally while conducting other surveys. Sign of coyote (*Canis latrans*) (scat) and white-tailed deer (*Odocoileus virginianus*) (scat and tracks) were also noted.

*Reptile and amphibian survey*—A one-day VES was conducted in the dry upland forest habitat. This involved searching under logs, rocks, bark, leaf litter, and other debris. All reptiles and amphibians found were recorded. Incidental encounters with reptiles and amphibians were also recorded during surveys of other natural resources.

All reptiles and amphibians recorded for this habitat are considered to be common on the ORR. Species recorded included the eastern box turtle (*Terrapene carolina carolina*), gray treefrog (*Hyla versicolor*), Cope's gray treefrog (*Hyla chrysoscelis*), five-lined skink (*Eumeces fasciatus*), and American toad (*Bufo americanus americanus*).

*Vegetation survey*—A one-day walk-through was conducted at which time all vascular plant species that could be identified were recorded. An additional survey was conducted with a professional plant ecologist to specifically identify rare plants. The ORNL forester also surveyed the site to evaluate trees for potential significance and marketability.

This habitat is characterized by an overstory of white oak (*Quercus alba*), scarlet oak (*Quercus coccinea*), southern red oak (*Quercus falcata*), tulip poplar (*Liriodendron tulipifera*), and pignut hickory (*Carya glabra*). There is also a scattering of chestnut oak (*Quercus montana*) and red maple (*Acer rubrum*) in the overstory in this area. The understory is relatively open and contains saplings of several different species, including American beech (*Fagus grandifolia*), black cherry (*Prunus serotina*), sourwood (*Oxydendrum arboreum*), sweetgum (*Liquidambar styraciflua*), and common pawpaw (*Asimina triloba*). Groundcover in the area is also scattered and includes Virginia creeper (*Parthenocissus quinquefolia*), Christmas fern (*Polystichum acrostichoides*), catbriar (*Smilax sp.*), poison ivy (*Toxicodendron radicans*), muscadine (*Vitis rotundifolia*), and striped pipsissewa (*Chimaphila maculata*).

In this dry upland forest, the prevalence of white oaks with exfoliating bark is notable. These trees provide potential roosting habitat for the federally endangered Indiana bat. Indiana bats use these trees for maternity roosts from approximately mid-May through mid-September (Harvey et. al.). Potential roost trees are depicted in Figure I.1. A complete plant list for this habitat is provided in Table I.2.

**Table I.2. Plant species list for the dry upland forest.**

| Scientific name | Common name |
|---|---|
| *Liriodendron tulipifera* | Tulip poplar |
| *Carya glabra* | Pignut hickory |
| *Nyssa sylvatica* | Black gum |
| *Quercus falcata* | Southern red oak |
| *Quercus coccinea* | Scarlet oak |
| *Quercus alba* | White oak |
| *Quercus montana* | Chestnut oak |
| *Acer rubrum* | Red maple |
| *Sassafras albidum* | Sassafras |
| *Fagus grandifolia* | American beech |
| *Prunus serotina* | Black cherry |
| *Asimina triloba* | Common pawpaw |
| *Vaccinium pallidum* | Lowbush blueberry |
| *Oxydendrum arboreum* | Sourwood |
| *Liquidambar styraciflua* | Sweetgum |
| *Juniperus virginiana* | Eastern red cedar |
| *Parthenocissus quinquefolia* | Virginia creeper |
| *Polystichum acrostichoides* | Christmas fern |
| *Smilax sp.* | Catbriar |
| *Toxicodendron radicans* | Poison ivy |
| *Vitis rotundifolia* | Muscadine |
| *Chimaphila maculata* | Striped pipsissewa |
| *Microstegium vimineum* | Nepal grass |
| *Lespedeza cuneata* | Sericea lespedeza |
| *Coronilla varia* | Crown-vetch |
| *Cirsium sp.* | Thistle |
| *Festuca sp.* | Fescue |

### I.2.1.2 Moist Forest

The moister forest is characterized by a northward facing slope that grades down into the Bear Creek watershed. Signs of overland flow in the direction of the watershed are noticeable in certain areas of this forest. This forest is bordered on the south by a sharp edge in certain locations and by a relatively gradual edge in other locations. Edges are characterized by grassy fields, scattered shrubs, and disturbed areas.

*Bird survey results*—A total of 14 bird species were identified in this habitat by either sight or song. Sign was noted for one additional species.

There was sign (tree drillings) noted for the federal- and state-listed yellow-bellied sapsucker. Five species were recorded at the site that are on the PIF list as being of regional importance in the ridge and valley. Interior forest species in this category that were noted in this habitat on and adjacent to the project site are the downy woodpecker, Acadian flycatcher (*Empidonax virescens*), yellow-throated vireo (*Vireo flavifrons*), and scarlet tanager (*Piranga olivacea*). Acadian flycatchers are particularly good indicators of moist forests. This flycatcher species has relatively specialized habitat requirements, being found in

moist, predominantly deciduous woodlands. In most of the state, they are found along wooded streams and in moist ravines (Nicholson 1997). One other notable forest bird recorded on the site is the pileated woodpecker. A complete bird list for this habitat is provided in Table I.3.

**Table I.3. Bird species list for the moist forest.**

| Scientific name | Common name | Status | | |
|---|---|---|---|---|
| | | Federal | State | PIF |
| ***Pigeons and doves*** | | | | |
| *Zenaida macroura* | Mourning dove | | | |
| ***Woodpeckers*** | | | | |
| *Sphyrapicus varius* | Yellow-bellied sapsucker | MC | NM | |
| *Dryocopus pileatus* | Pileated woodpecker | | | |
| *Melanerpes carolinus* | Red-bellied woodpecker | | | |
| *Picoides pubescens* | Downy woodpecker | | | RI |
| ***Tyrant flycatchers*** | | | | |
| *Empidonax virescens* | Acadian flycatcher | | | RI |
| *Swallows* | | | | |
| *Hirundo rustica* | Barn swallow | | | |
| ***Titmice and chickadees*** | | | | |
| *Poecile carolinensis* | Carolina chickadee | | | RI |
| *Baeolophus bicolor* | Tufted titmouse | | | |
| ***Nuthatches*** | | | | |
| *Sitta carolinensis* | White-breasted nuthatch | | | |
| ***Vireos*** | | | | |
| *Vireo flavifrons* | Yellow-throated vireo | | | RI |
| *Vireo olivaceus* | Red-eyed vireo | | | |
| ***Crows and jays*** | | | | |
| *Corvus brachyrhynchos* | American crow | | | |
| ***Wood warblers*** | | | | |
| *Vermivora pinus* | Pine warbler | | | |
| ***Tanagers*** | | | | |
| *Piranga olivacea* | Scarlet tanager | | | RI |

MC = species of management concern, NM = in need of management, RI = regional importance

*Small mammal survey results*—A total of 55 Sherman live traps were set out in the moist forest habitat. Small mammals were trapped for 7 nights during a 2-week period for a total of 385 trap nights (7 nights × 55 traps).

The white-footed mouse was by far the most common species captured in the small mammal traps in this habitat. Only two other species were trapped: the eastern chipmunk (*Tamias striatus*) and long-tailed weasel (*Mustela frenata*). Capturing a long-tailed weasel in a small mammal trap is highly unusual, and they are very difficult to capture at all, even when specifically targeted. Although seldom seen, the long-tailed weasel is thought to be fairly common in Tennessee, especially in rural areas. They are active day or night and frequent a variety of habitats, including forest, meadows, and fields. They feed on a variety of small mammals, including mice (Reid 2006). As evidenced by trapping conducted on the SNS site,

mouse populations in the area appear to be thriving, providing a reliable prey source for weasels. The location of the long-tailed weasel capture is shown on Figure I.2. Signs of coyote (scat) and white-tailed deer (scat and tracks) were also noted incidentally while conducting other surveys.

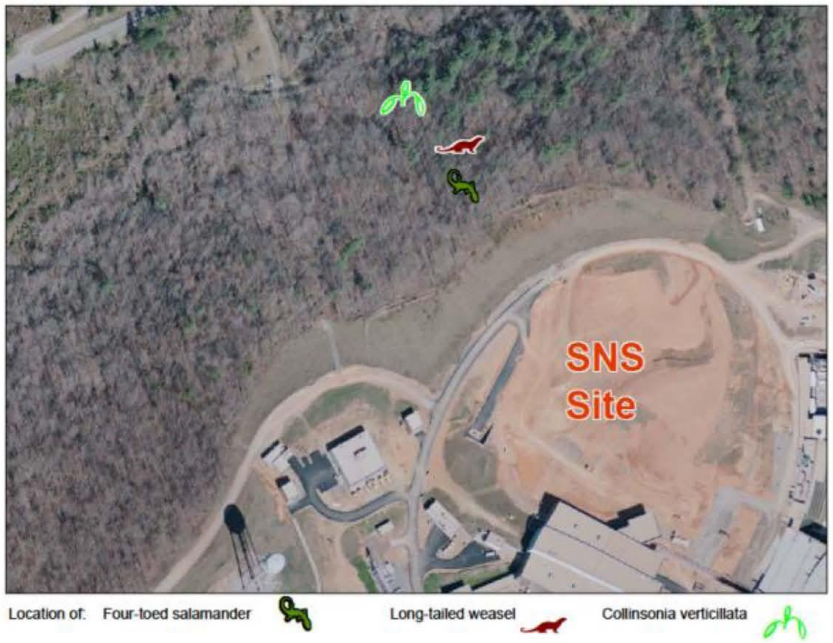



**Figure I.2. Sensitive species locations.**

*Reptile and amphibian survey*—A one-day VES was conducted on the site. This involved searching under logs, rocks, bark, leaf litter, and other debris. All reptiles and amphibians found were recorded. Incidental encounters with reptiles and amphibians were also recorded during surveys of other natural resources.

The majority of the reptiles and amphibians recorded for the site are considered to be common on the ORR. Species recorded included the eastern garter snake (*Thamnophis sirtalis sirtalis*), worm snake (*Carphophis amoenus amoenus*), northern ringneck snake (*Diadophis punctatus edwardsii*), northern slimy salamander (*Plethodon glutinosus*), long-tailed salamander (*Eurycea longicauda longicauda*) and four-toed salamander (*Hemidactylium scutatum*). The four-toed salamander has only been recorded on the ORR one other time (1996). This species is listed by the state of Tennessee as being "in need of management." This designation is given to any species or subspecies of nongame wildlife that the TWRA believes should be investigated to develop information relating to populations, distribution, habitat needs, limiting factors, and other biological and ecological data to determine management measures necessary for their continued ability to sustain themselves successfully. The four-toed salamander is normally associated with shallow pools of standing water, often in the vicinity of sphagnum and other mosses. They commonly nest adjacent to beaver ponds, seasonal pools, and streams. After the breeding season, they lead a fossorial existence in adjacent woodlands (Jensen, et. al. 2008). The breeding season for this species is September through December. The four-toed salamander found on the SNS site likely breeds downslope in the Bear Creek watershed wetlands, and traveled upslope during its nonbreeding season wanderings. There is no actual breeding habitat for this species on the proposed project site. The location

at which the four-toed salamander was captured is depicted in Figure I.2. The capture of three species of salamanders on this site is evidence of the moister character of this area of the forest.

*Vegetation survey*—A one-day walk-through was conducted at which time all vascular plant species that could be identified were recorded. An additional survey was conducted with a professional plant ecologist to specifically identify rare plants. The ORNL forester also surveyed the site to evaluate trees for potential significance and marketability.

This area of the forest on the north side of the SNS facility is noticeably moister than the upland forested areas to the east. It is also a noticeably richer forest with more plant diversity. The overstory includes tulip poplar, pignut hickory, chestnut oak, southern red oak, white oak, sweetgum, scrub pine (*Pinus virginiana*) and white pine (*Pinus strobus*). A few very large chestnut oaks and white pines and one very large sweetgum are notable. The diverse understory includes black gum (*Nyssa sylvatica*), hemlock (*Tsuga canadensis*), sassafras (*Sassafras albidum*), American beech, flowering dogwood (*Cornus florida*), ironwood (*Carpinus caroliniana*), black cherry, sugar maple (*Acer saccharum*), redbud (*Cercis canadensis*), common pawpaw, umbrella magnolia (*Magnolia tripetala*), lowbush blueberry (*Vaccinium pallidum*), sourwood, sweetgum, Carolina buckthorn (*Rhamnus caroliniana*), yellow buckeye (*Aesculus octandra*) and devils-walkingstick (*Aralia spinosa*). Muscadine is also prevalent in the area.

The groundcover in this forest is extremely diverse, with the presence of a variety of ferns and herbaceous species. Ferns recorded in the area include Christmas fern, maidenhair fern (*Adiantum pedatum*), common grape fern (*Botrychium dissectum*), rattlesnake fern (*Botrychium virginianum*) and broad beech fern (*Thelypteris hexagonoptera*). Other groundcover plants in the area include striped pipsissewa, little brown jug (*Hexastylis arifolia*), prostrate tick-trefoil (*Desmodium rotundifolium*), downy rattlesnake plantain (*Goodyera pubescens*), false Solomon's-seal (*Smilacina racemosa*), lopseed (*Phyrma leptostachya*), wild yam (*Dioscorea villosa*), doll's eyes (*Actaea pachypoda*), black snakeroot (*Sanicula odorata*), Virginia-snakeroot (*Aristolochia serpentaria*), yellow passionflower (*Passiflora lutea*), tickseed (*Coreopsis sp.*), crested dwarf iris (*Iris cristata*), wood anemone (*Anemone quinquefolia*), may-apple (*Podophyllum peltatum*), yellow forest violet (*Viola pubescens*), and jack-in-the-pulpit (*Arisaema triphyllum*).

Of particular significance on this slope is the presence of whorled stoneroot (*Collinsonia verticillata*). Whorled stoneroot has a global rank of G3, as determined by NatureServe (nongovernmental organization of national, state, and provincial heritage programs). A rank of G3 means that the species is very rare and local throughout its range, or, because of other factors, vulnerable to extinction throughout its range. Plants in this category generally have between 21 and 100 occurrences and fewer than 10,000 individuals. Although it has a global ranking, whorled stoneroot is not a listed plant in the state of Tennessee. The location of whorled stoneroot on the site is shown in Figure I.2.

Ginseng (*Panax quinquefolius*) was recorded on this same slope. Ginseng is listed as a special concern and commercially exploited (CE) species by the state of Tennessee. The state special concern status is given to plant species that are uncommon in Tennessee or have unique or highly specific habitat requirements or scientific value and, therefore, require careful monitoring of their status. The CE designation is given to plants being taken from the wild in large numbers and propagation or cultivation is insufficient to meet market demand. These plants are of long-term conservation concern. Ginseng is also ranked by the state Division of Natural Areas as an S3S4 species, meaning that it is rare to uncommon to widespread and secure in different areas of the state. NatureServe also gives it a G4 global ranking, meaning that it is globally secure. A complete plant list for this habitat is provided in Table I.4.

**Table I.4. Plant species list for the moist forest.**

| Scientific name | Common name |
|---|---|
| *Lireodendron tulipifera* | Tulip poplar |
| *Carya glabra* | Pignut hickory |
| *Nyssa sylvatica* | Black gum |
| *Quercus falcata* | Southern red oak |
| *Quercus alba* | White oak |
| *Quercus montana* | Chestnut oak |
| *Pinus virginiana* | Scrub pine |
| *Pinus strobus* | White pine |
| *Acer rubrum* | Red maple |
| *Tsuga canadensis* | Hemlock |
| *Aesculus octandra* | Yellow buckeye |
| *Sassafras albidum* | Sassafras |
| *Fagus grandifolia* | American beech |
| *Cornus florida* | Flowering dogwood |
| *Carpinus caroliniana* | Ironwood |
| *Prunus serotina* | Black cherry |
| *Acer saccharum* | Sugar maple |
| *Ilex opaca* | American holly |
| *Cercis canadensis* | Redbud |
| *Asimina triloba* | Common pawpaw |
| *Magnolia tripetala* | Umbrella magnolia |
| *Vaccinium pallidum* | Lowbush blueberry |
| *Oxydendrum arboretum* | Sourwood |
| *Liquidambar styraciflua* | Sweetgum |
| *Rhamnus caroliniana* | Carolina buckthorn |
| *Aralia spinosa* | Devil's walkingstick |
| *Lonicera japonica* | Japanese honeysuckle |
| *Lonicera maackii* | Bush honeysuckle |
| *Morus sp.* | Mulberry |
| *Euonymus* | Euonymus |
| *Rhus copallina* | Winged sumac |
| *Rhus glabra* | Smooth sumac |
| *Rubus sp.* | Blackberry |
| *Parthenocissus quinquefolia* | Virginia creeper |
| *Polystichum acrostichoides* | Christmas fern |
| *Adiantum pedatum* | Maidenhair fern |
| *Botrychium dissectum* | Common grape fern |
| *Thelypteris hexagonoptera* | Broad beech fern |
| *Botrychium virginianum* | Rattlesnake fern |
| *Panax quinuefolius* | Ginseng |
| *Smilax sp.* | Catbriar |
| *Toxicodendron radicans* | Poison ivy |

**Table I.4. Plant species list for the moist forest (continued).**

| *Scientific name* | **Common name** |
|---|---|
| *Bignonia capreolata* | Cross-vine |
| *Vitis rotundifolia* | Muscadine |
| *Chimaphila maculata* | Striped pipsissewa |
| *Pycnanthemum pilosum* | Mountain-mint |
| *Microstegium vimineum* | Nepal grass |
| *Hexastylis arifolia* | Little brown jug |
| *Desmodium rotundifolium* | Prostrate tick-trefoil |
| *Desmodium nudiflorum* | Naked-flowered tick-trefoil |
| *Goodyera pubescens* | Downy rattlesnake plantain |
| *Smilacina racemosa* | False Solomon's seal |
| *Phryma leptostachya* | Lopseed |
| *Dioscorea villosa* | Wild yam |
| *Actaea pachypoda* | Doll's eyes |
| *Sanicula odorata* | Black snakeroot |
| *Aristolochia serpentaria* | Virginia-snakeroot |
| *Passiflora lutea* | Yellow passion flower |
| *Coreopsis sp.* | Tickseed |
| *Viola pubescens* | Yellow forest violet |
| *Arisaema triphyllum* | Jack-in-the-pulpit |
| *Iris cristata* | Crested dwarf iris |
| *Anemone quinquefolia* | Wood anemone |
| *Podophyllum peltatum* | May-apple |
| *Collinsonia verticillata* | Whorled stoneroot |

### I.2.1.3 Fields and Disturbed Areas

This habitat that borders the forested areas includes steeply sloping areas characterized by grassy fields, scattered shrubs, and disturbed areas.

*Bird survey results*—A total of six bird species were identified in this habitat by either sight or song. One additional species, the wild turkey, was identified by signs (i.e., tracks).

Two species were recorded at the site that are on the PIF list as being of regional importance in the ridge and valley. Species in this category that were noted in this habitat were the indigo bunting (*Passerina cyanea*) and eastern towhee (*Pipilo erythrophthalmus*). A complete bird list for the fields and disturbed areas is provided in Table I.5.

**Table I.5. Bird species list for fields and disturbed areas.**

| **Scientific name** | **Common name** | **Status** | | |
|---|---|---|---|---|
| | | **Federal** | **State** | **PIF** |
| ***Pheasants and turkeys*** | | | | |
| *Meleagris gallopavo* | Wild turkey | | | |
| ***Towhees, sparrows, and allies*** | | | | |

| Scientific name | Common name | Status | | |
|---|---|---|---|---|
| | | Federal | State | PIF |
| *Melospiza melodia* | Song sparrow | | | |
| ***Finches*** | | | | |
| *Pipilo erythrophthalmus* | Eastern towhee | | | RI |
| *Carduelis tristis* | American goldfinch | | | |
| ***Cardinals, grosbeaks, and allies*** | | | | |
| *Passerina cyanea* | Indigo bunting | | | RI |
| *Cardinalis cardinalis* | Northern cardinal | | | |
| *Passerina caerulea* | Blue grosbeak | | | |

RI = regional importance

*Small mammal survey results*—A total of 40 Sherman live traps were set out in the fields and disturbed areas. Small mammals were trapped for 7 nights during a 2-week period for a total of 280 trap nights (7 nights × 40 traps).

Hispid cotton rats (*Sigmodon hispidis*) were captured in large numbers in this habitat. The only other species captured in this habitat was the white-footed mouse. Raccoon (*Procyon lotor*) sign (tracks) was also noted incidentally.

*Reptile and amphibian survey*—A one-day VES was conducted in this habitat. No reptile or amphibian species were noted in this habitat during the survey.

*Vegetation survey*—A one-day walk-through was conducted at which time all vascular plant species that could be identified were recorded. An additional survey was conducted with a professional plant ecologist to specifically identify rare plants. The ORNL forester also surveyed the site to evaluate trees for potential significance and marketability.

The majority of this habitat is characterized by fescue (*Festuca sp.*), with a few other herbaceous species and scattered shrubs. Other herbaceous species noted included Sericea lespedeza (*Lespedeza cuneata*), Korean lespedeza (*Kummerowia stipulacea*), crown vetch (*Coronilla varia*), thistle (*Cirsium sp.*), Canada goldenrod (*Solidago canadensis*), Queen Anne's lace (*Daucus carota*), aster (*Aster* sp.), and big bluestem (*Andropogon gerardii*). Scattered shrubs in this habitat included autumn olive (*Elaeagnus umbellate*), smooth sumac (*Rhus glabra*), winged sumac (*Rhus copallina*), sycamore (*Platanus occidentalis*), tulip poplar, boxelder (*Acer negundo*), redbud, and blackberry (*Rubus sp.*). A small area of cattails (*Typha latifolia*) and willows (*Salix sp.*) is present around the northern recharge basin. A complete plant list for this habitat is provided in Table I.6.

**Table I.6. Plant species list for fields and disturbed areas.**

| Scientific name | Common name |
|---|---|
| *Cercis canadensis* | Redbud |
| *Elaeagnus umbellata* | Autumn olive |
| *Rubus sp.* | Blackberry |
| *Platanus occidentalis* | Sycamore |
| *Salix sp.* | Willow |

| | |
|---|---|
| *Lireodendron tulipifera* | Tulip poplar |
| *Acer negundo* | Boxelder |
| *Rhus copallina* | Winged sumac |
| *Rhus glabra* | Smooth sumac |
| *Typha latifolia* | Wideleaf cattail |
| *Cirsium sp.* | Thistle |
| *Aster sp.* | Aster |
| *Daucus carota* | Queen Anne's lace |
| *Solidago canadensis* | Canada goldenrod |
| *Lespedeza cuneata* | Sericea lespedeza |
| *Kummerowia stipulacea* | Korean lespedeza |
| *Coronilla varia* | Crown-vetch |
| *Microstegium vimineum* | Nepal grass |
| *Andropogon gerardii* | Big bluestem |
| *Festuca sp.* | Fescue |

#### I.2.1.4 Alternative #2 Site Characteristics

The Alternative #2 site, located on the southwestern side of the SNS facility, is characterized by disturbed areas, a steeply sloping area of field habitat, other brushy areas, and a small wooded area. The wooded area is fragmented from the adjacent forest by roads and power-line corridors. Overland flow to an off-site settling pond is evident through the forested area, with the main flow coming through a culvert near the edge of the forest. A network of silt fencing is present downstream of the culvert. Deep gullies have been carved through the forest from runoff.

*Bird survey results*—A total of five bird species were identified in this habitat by either sight or song. All species sighted except for one are common species found in fields or along forest edges. The one forest species sighted was the ruby-throated hummingbird (*Archilochus colubris*).

One species recorded at the site, field sparrow (*Spizella pusilla*), is on the PIF list as being of regional importance in the ridge and valley. Table I.7 provides a list of bird species recorded on the site.

**Table I.7. Bird species list for Alternative #2 habitats.**

| Scientific name | Common name | Status | | |
|---|---|---|---|---|
| | | Federal | State | PIF |
| ***Hummingbirds*** | | | | |
| *Archilochus colubris* | Ruby-throated hummingbird | | | |
| ***Wrens*** | | | | |
| *Thryothorus ludovicianus* | Carolina wren | | | |
| ***Thrushes*** | | | | |
| *Sialia sialis* | Eastern bluebird | | | |
| ***Towhees, sparrows, and allies*** | | | | |
| *Spizella pusilla* | Field sparrow | | | RI |
| ***Finches*** | | | | |
| *Carduelis tristis* | American goldfinch | | | |

RI = regional importance

*Small mammal survey results*—A total of 25 Sherman live traps were set out at the Alternative #2 site. Small mammals were trapped for 7 nights during a 2-week period for a total of 175 trap nights (7 nights × 25 traps).

The hispid cotton rat was the only species captured in the fields at this site. White-footed mice and chipmunks were captured in the forested area.

*Reptile and amphibian survey*—A one-day VES was conducted in this habitat. The only species identified on the site was the pickerel frog (*Rana palustris*), which was seen adjacent to the culvert. One snake was seen, but it escaped before it could be identified.

*Vegetation survey*—A one-day walk-through was conducted at which time all vascular plant species that could be identified were recorded. An additional survey was conducted with a professional plant ecologist to specifically identify rare plants. The ORNL forester also surveyed the site to evaluate trees for potential significance and marketability.

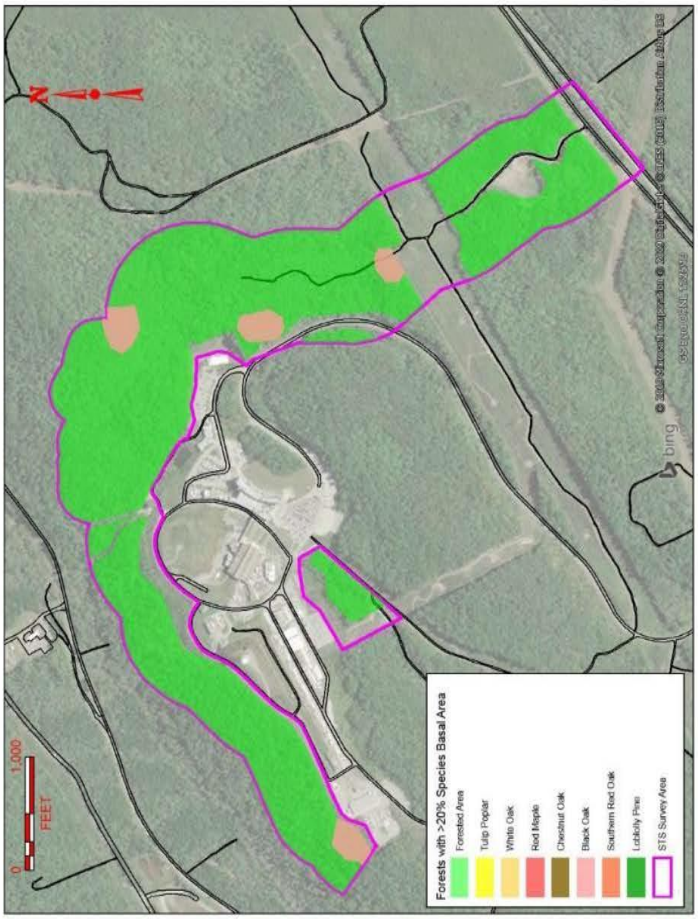
The majority of the field habitat is characterized by fescue and Sericea lespedeza, with a few other herbaceous species and scattered shrubs. Other herbaceous species noted include the thistle, Canada goldenrod, yarrow (*Achillea millefolium*), aster (*Aster* sp.), rose pink (*Sabatia angularis*), and Joe-Pye weed (*Eupatorium fistulosum*). Scattered shrubs in this habitat include winged sumac, redbud, and blackberry.

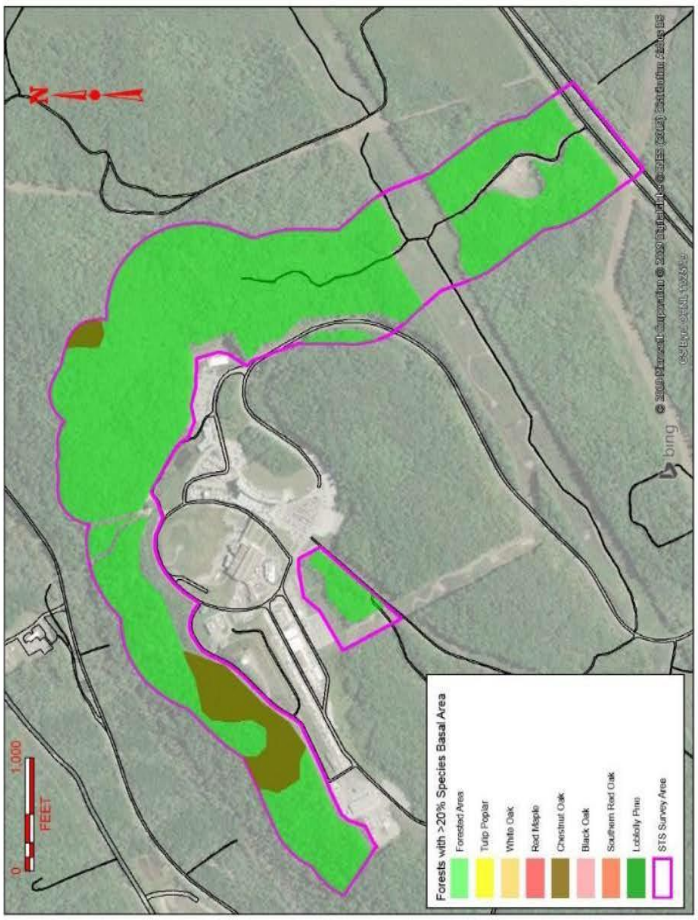
The overstory in the wooded area includes mockernut hickory (*Carya tomentosa*), scrub pine, tulip poplar, red maple, southern red oak, and black gum. The understory includes sourwood, sassafras, sweetgum, American beech, southern red oak, white oak, flowering dogwood, black cherry, deerberry (*Vaccinium stamineum*), and common privet (*Ligustrum vulgare*). Muscadine is also prevalent in this area. Groundcover species include Christmas fern, striped pipsissewa, little brown jug, prostrate tick-trefoil, naked-flowered tick-trefoil (*Desmodium nudiflorum*), downy rattlesnake plantain, heal-all (*Prunella vulgaris*), and false Solomon's seal. Orange jewelweed (*Impatiens capensis*) is also prevalent in the washes. A complete plant list for this habitat is provided in Table I.8.

**Table I.8. Plant species list for Alternative #2 habitats.**

| Scientific name | Common name |
|---|---|
| *Lireodendron tulipifera* | Tulip poplar |
| *Carya tomentosa* | Mockernut hickory |
| *Nyssa sylvatica* | Black gum |
| *Quercus falcata* | Southern red oak |
| *Quercus alba* | White oak |
| *Quercus montana* | Chestnut oak |
| *Pinus virginiana* | Scrub pine |
| *Acer rubrum* | Red maple |
| *Fagus grandifolia* | American beech |
| *Cornus florida* | Flowering dogwood |
| *Prunus serotina* | Black cherry |
| *Cercis Canadensis* | Redbud |
| *Oxydendrum arboretum* | Sourwood |
| *Vaccinium stamineum* | Deerberry |
| *Lonicera japonica* | Japanese honeysuckle |
| *Rhus copallina* | Winged sumac |
| *Rhus glabra* | Smooth sumac |
| *Ligustrum vulgare* | Common privet |
| *Rubus sp.* | Blackberry |
| *Polystichum acrostichoides* | Christmas fern |
| *Toxicodendron radicans* | Poison ivy |
| *Vitis rotundifolia* | Muscadine |
| *Hexastylis arifolia* | Little brown jug |
| *Desmodium rotundifolium* | Prostrate tick-trefoil |
| *Desmodium nudiflorum* | Naked-flowered tick-foil |
| *Goodyera pubescens* | Downy rattlesnake plantain |
| *Chimaphila maculatA* | Striped pipsissewa |
| *Prunella vulgaris* | Heal-all |
| *Smilacina racemosa* | False Solomon's seal |
| *Elephantopus* | Elephant's foot |
| *Impatiens capensis* | Orange jewelweed |
| *Cirsium sp.* | Thistle |
| *Aster sp.* | Aster |
| *Lespedeza sp.* | Clover |
| *Solidago canadensis* | Canada goldenrod |
| *Achillea millefolium* | Yarrow |
| *Sabatia angularis* | Rose-pink |
| *Eupatorium fistulosum* | Joe-Pye weed |
| *Lespedeza cuneata* | Sericea lespedeza |
| *Microstegium vimineum* | Nepal grass |
| *Festuca sp.* | Fescue |

## APPENDIX II. ADDITIONAL DETAILS FROM 2013 FOREST INVENTORY

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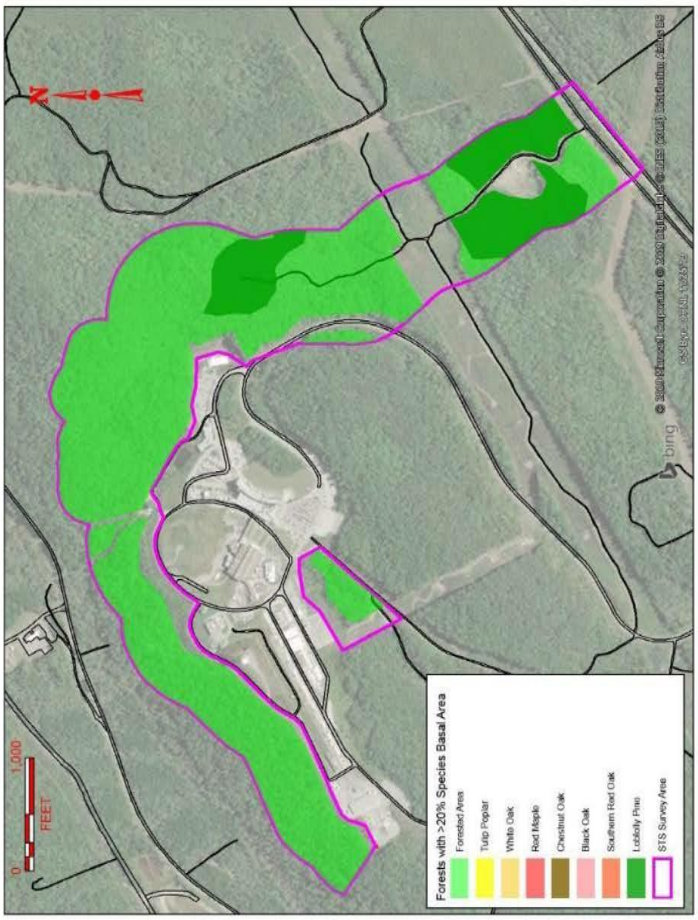
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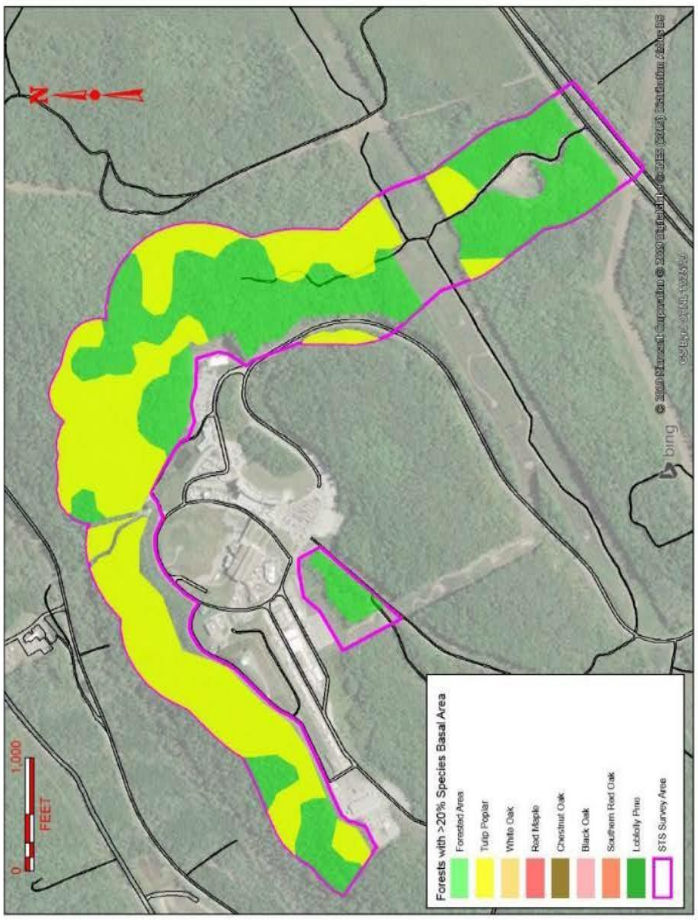
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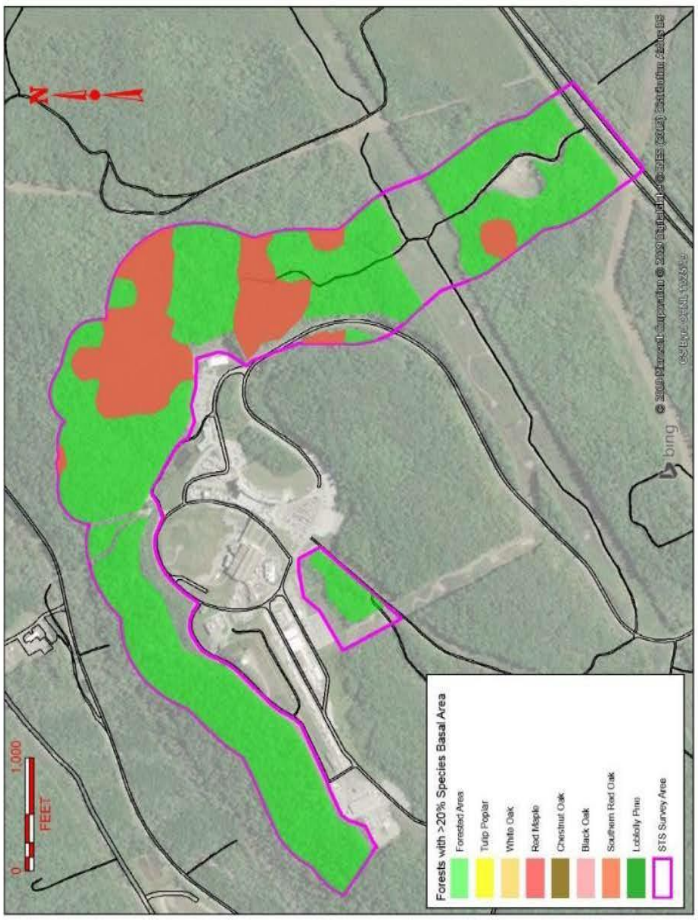
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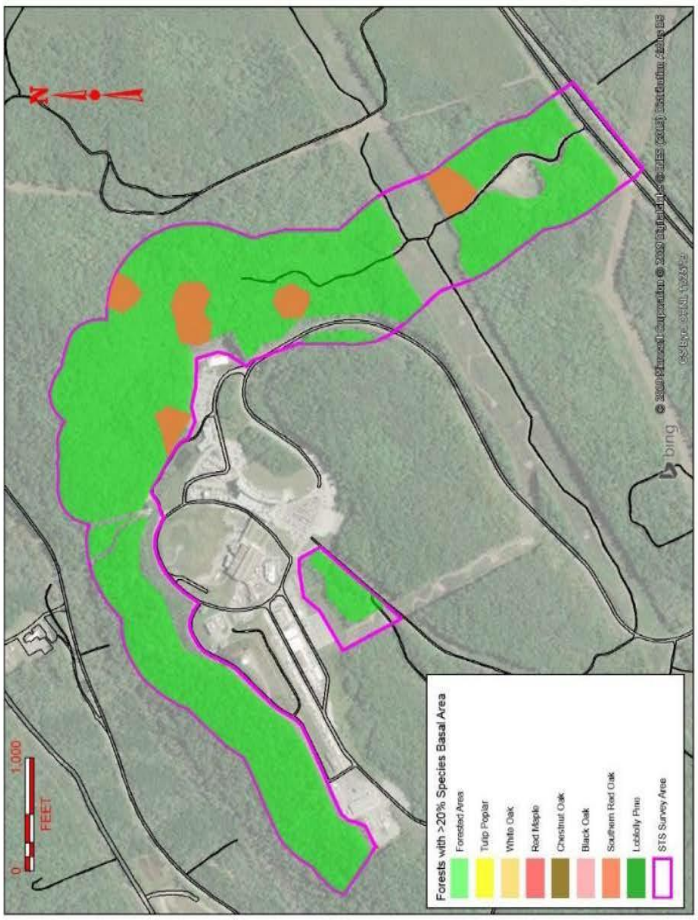
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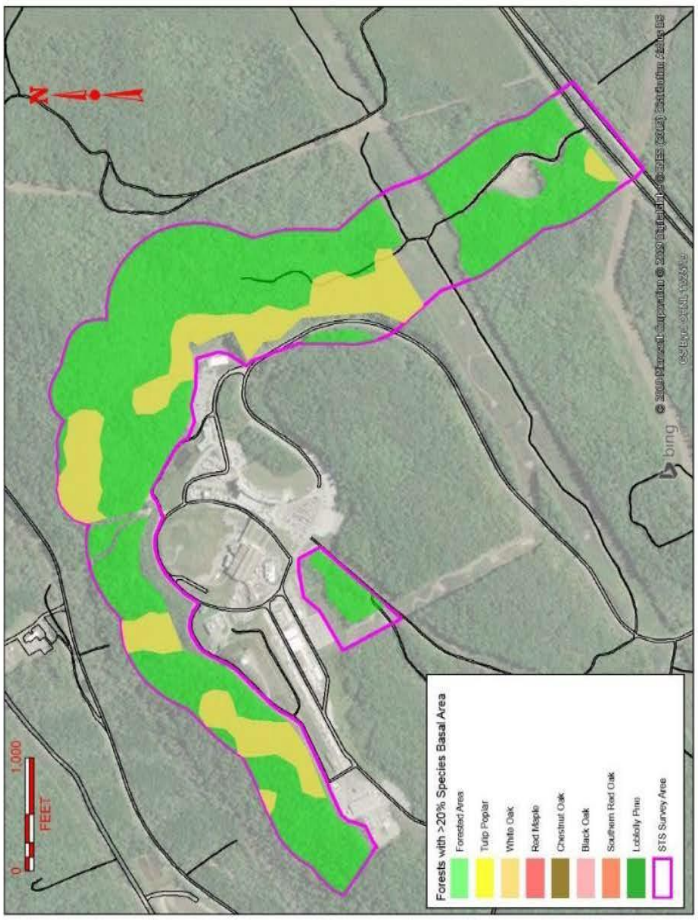
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Forests with >20% Species Basal Area
Forested Area
Tulip Poplar
White Oak
Red Maple
Chestnut Oak
Black Oak
Southern Red Oak
Loblolly Pine
STS Survey Area
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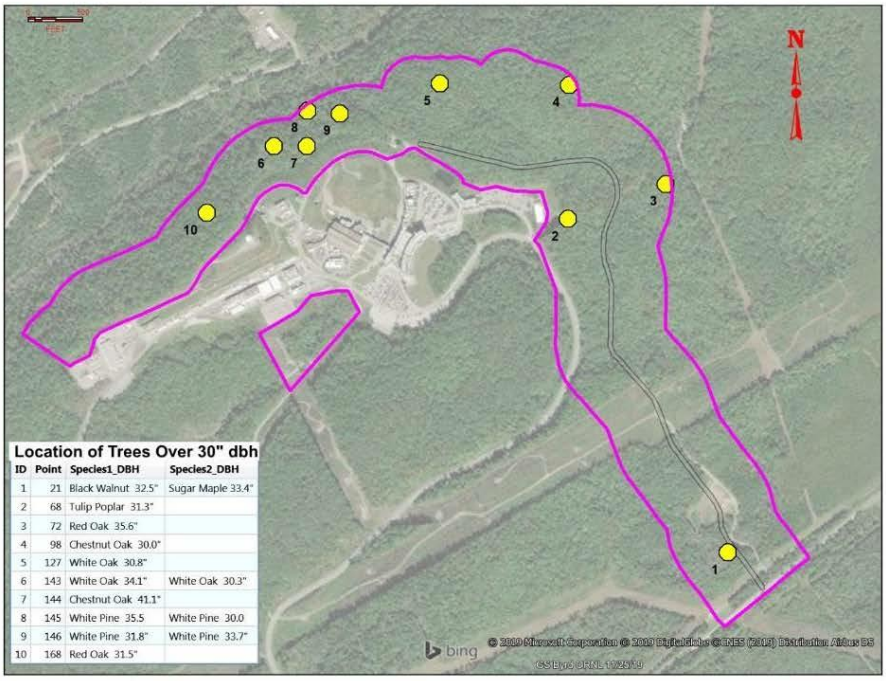
**Largest diameter of live trees by species and number of trees tallied with diameter at breast height (dbh) greater than 30.0 in.**

| Species | Common name | Largest dbh recorded (in.) | Number of trees with dbh > 30.0 in. |
|---|---|---|---|
| *Acer rubrum* | Red maple | 24.3 | |
| *Acer saccharum* | Sugar maple | 33.4 | 1 |
| *Aralia spinosa* | Devil's walking stick | 2.8 | |
| *Carya cordiformis* | Bitternut hickory | 17.7 | |
| *Carya glabra* | Pignut hickory | 28.3 | |
| *Carya tomentosa* | Mockernut hickory | 23.8 | |
| *Celtis occidentalis* | Hackberry | 16.2 | |
| *Cercis canadensis* | Eastern redbud | 9 | |
| *Cornus florida* | Flowering dogwood | 6.3 | |
| *Fagus grandifolia* | American beech | 22.7 | |
| *Fraxinus americana* | White ash | 11.5 | |
| *Juglans nigra* | Black walnut | 32.5 | 1 |
| *Juniperus virginiana* | Eastern redcedar | 23.5 | |
| *Liquidambar styraciflua* | Sweetgum | 23.2 | |
| *Liriodendron tulipifera* | Tulip poplar | 31.6 | 1 |
| *Morus rubra* | Red mulberry | 16.8 | |
| *Nyssa sylvatica* | Black gum | 14.5 | |
| *Oxydendron arboreum* | Sourwood | 18 | |
| *Paulownia tomentosa* | Princess tree | 11.4 | |
| *Pinus echinata* | Shortleaf pine | 17.4 | |
| *Pinus strobus* | White pine | 35.5 | 4 |
| *Pinus taeda* | Loblolly pine | 18 | |
| *Pinus virginiana* | Virginia pine | 18.3 | |
| *Plantanus occidentalis* | American sycamore | 23.9 | |
| *Prunus serotina* | Black cherry | 26 | |
| *Pyrus calleryana* | Callery pear | 3.1 | |
| *Quercus alba* | White oak | 34.1 | 3 |
| *Quercus coccinea* | Scarlet oak | 22.5 | |
| *Quercus falcata* | Southern red oak | 27.3 | |
| *Quercus montana* | Chestnut oak | 41.1 | 2 |
| *Quercus rubra* | Northern red oak | 35.6 | 2 |
| *Quercus stellata* | Post oak | 21 | |
| *Quercus velutina* | Black oak | 29.0 | |
| *Sassafras albidum* | Sassafras | 10.8 | |
| *Ulmus alata* | Winged elm | 12.9 | |
| *Ulmus rubra* | Slippery elm | 10.3 | |
| | | **Total ≥30.0 in.** | **14** |




**Location of Trees Over 30" dbh**

| ID | Point | Species1_DBH | Species2_DBH |
|---|---|---|---|
| 1 | 21 | Black Walnut 32.5" | Sugar Maple 33.4" |
| 2 | 68 | Tulip Poplar 31.3" | |
| 3 | 72 | Red Oak 35.6" | |
| 4 | 98 | Chestnut Oak 30.0" | |
| 5 | 127 | White Oak 30.8" | |
| 6 | 143 | White Oak 34.1" | White Oak 30.3" |
| 7 | 144 | Chestnut Oak 41.1" | |
| 8 | 145 | White Pine 35.5 | White Pine 30.0 |
| 9 | 146 | White Pine 31.8" | White Pine 33.7" |
| 10 | 168 | Red Oak 31.5" | |

## APPENDIX III. COMPLETE LIST OF VERTEBRATE SPECIES DOCUMENTED WITHIN THE SNS STS PROJECT AREA

| Type | Scientific name | Common name | Global rank | State rank | Federal status | State status |
|---|---|---|---|---|---|---|
| Amphibian | *Ambystoma maculatum* | Spotted salamander | | | | |
| Amphibian | *Anaxyrus americanus* | American toad | | | | |
| Amphibian | *Eurycea bislineata/wilderae* | Two-lined salamander | | | | |
| Amphibian | *Gastrophryne carolinensis* | Eastern narrow-mouthed toad | | | | |
| Amphibian | *Hemidactylium scutatum* | Four-toed salamander | G5 | S3 | | D |
| Amphibian | *Hyla chrysoscelis* | Cope's gray treefrog | | | | |
| Amphibian | *Lithobates catesbeianus* | American bullfrog | | | | |
| Amphibian | *Lithobates clamitans* | Green frog | | | | |
| Amphibian | *Lithobates palustris* | Pickerel frog | | | | |
| Amphibian | *Notphthalmus viridescens* | Eastern newt | | | | |
| Amphibian | *Plethodon glutinosis* | Slimy salamander | | | | |
| Amphibian | *Pseudacris crucifer* | Spring peeper | | | | |
| Bat | *Corynorhinus rafinesquii* | Rafinesque's big-eared bat | G3G4 | S3 | | D |
| Bat | *Eptesicus fuscus* | Big brown bat | | | | |
| Bat | *Lasionycteris noctivagans* | Silver-haired bat | | | | |
| Bat | *Lasiurus borealis* | Eastern red bat | | | | |
| Bat | *Lasiurus cinereus* | Hoary bat | | | | |
| Bat | *Lasiurus seminolus* | Seminole bat | | | | |
| Bat | *Myotis grisescens* | Gray bat | G4 | S2 | E | E |
| Bat | *Myotis leibii* | Eastern small-footed bat | G4 | S2S3 | | D |
| Bird | *Myotis septentrionalis* | Northern long-eared bat | G1G2 | S1S2 | T | T |
| Bat | *Myotis lucifugus* | Little brown bat | G3 | S3 | UR | T |
| Bat | *Myotis sodalis* | Indiana bat | G2 | S1 | E | E |
| Bat | *Nycticeius humeralis* | Evening bat | | | | |
| Bat | *Perimyotis subflavus* | Tricolored bat | G2G3 | S2S3 | UR | T |
| Bat | *Tadarida brasiliensis* | Brazilian free-tailed bat | | | | |

III-1

| Type | Scientific name | Common name | Global rank | State rank | Federal status | State status |
|---|---|---|---|---|---|---|
| Bird | *Aix sponsa* | Wood duck | | | | |
| Bird | *Archilochus colubris* | Ruby-throated hummingbird | | | | |
| Bird | *Baeolophus bicolor* | Tufted titmouse | | | | |
| Bird | *Buteo lineatus* | Red-shouldered hawk | | | | |
| Bird | *Buteo jamaicensus* | Red-tailed hawk | | | | |
| Bird | *Cathartes aura* | Turkey vulture | | | | |
| Bird | *Coragyps atratus* | Black vulture | | | | |
| Bird | *Cardinalis cardinalis* | Northern cardinal | | | | |
| Bird | *Coccyzus americanus* | Yellow-billed cuckoo | | | | |
| Bird | *Colaptes auratus* | Northern flicker | | | | |
| Bird | *Contopus virens* | Eastern wood-pewee | | | | |
| Bird | *Catharus ustslatus* | Swainson's thrush | | | | |
| Bird | *Tachycineta bicolor* | Tree swallow | | | | |
| Bird | *Setophaga discolor* | Prairie warbler | | | | |
| Bird | *Corvus brachyrhynchos* | American crow | | | | |
| Bird | *Turdus migratorius* | American robin | | | | |
| Bird | *Cyanocitta cristata* | Blue jay | | | | |
| Bird | *Dryocopus pileatus* | Pileated woodpecker | | | | |
| Bird | *Empidonax virescens* | Acadian flycatcher | | | | |
| Bird | *Hirundo rustica* | Barn swallow | | | | |
| Bird | *Molothrus ater* | Brown-headed cowbird | | | | |
| Bird | *Setophaga americana* | Northern parula | | | | |
| Bird | *Polioptila caerulea* | Blue-gray gnatcatcher | | | | |
| Bird | *Haemorhous mexicanus* | House finch | | | | |
| Bird | *Melanerpes carolinus* | Red-bellied woodpecker | | | | |
| Bird | *Melospiza melodia* | Song sparrow | | | | |
| Bird | *Meteagris gallopava silvestris* | Wild turkey | | | | |
| Bird | *Mimus polyglottos* | Northern mockingbird | | | | |
| Bird | *Quiscalus guiscula* | Common grackle | | | | |
| Bird | *Passerculus sandwichensis* | Savannah sparrow | G5 | S1B,S4N | | Rare |
| Bird | *Passerina caerulea* | Blue grosbeak | | | | |

III-2

| Type | Scientific name | Common name | Global rank | State rank | Federal status | State status |
|---|---|---|---|---|---|---|
| Bird | *Passerina cyanea* | Indigo bunting | | | | |
| Bird | *Picoides pubescens* | Downy woodpecker | | | | |
| Bird | *Pipilo erythrophthalmus* | Eastern towhee | | | | |
| Bird | *Piranga olivacea* | Scarlet tanager | | | | |
| Bird | *Piranga rubra* | Summer tanager | | | | |
| Bird | *Poecile carolinensis* | Carolina chickadee | | | | |
| Bird | *Sayornis phoebe* | Eastern phoebe | | | | |
| Bird | *Setophaga citrina* | Hooded warbler | | | | |
| Bird | *Setophaga pensylvanica* | Chestnut-sided warbler | | | | |
| Bird | *Setophaga pinus* | Pine warbler | | | | |
| Bird | *Geothylpis trichas* | Common yellowthroat | | | | |
| Bird | *Sialia sialis* | Eastern bluebird | | | | |
| Bird | *Sitta carolinensis* | White-breasted nuthatch | | | | |
| Bird | *Sphyrapicus varius* | Yellow-bellied sapsucker | | | | |
| Bird | *Spinus tristis* | American goldfinch | | | | |
| Bird | *Spizella pusilla* | Field sparrow | | | | |
| Bird | *Spizella passerina* | Chipping sparrow | | | | |
| Bird | *Sturnella magna* | Eastern meadowlark | | | | |
| Bird | *Sturnus vulgaris* | European starling | | | | |
| Bird | *Thryothorus ludovicianus* | Carolina wren | | | | |
| Bird | *Vireo flavifrons* | Yellow-throated vireo | | | | |
| Bird | *Setophaga petechia* | Yellow warbler | | | | |
| Bird | *Icteria virens* | Yellow-breasted chat | | | | |
| Bird | *Buteo platypterus* | Broad-winged hawk | | | | |
| Bird | *Agelaius phoeniceus* | Red-winged blackbird | | | | |
| Bird | *Vireo olivaceus* | Red-eyed vireo | | | | |
| Bird | *Vireo griseus* | White-eyed vireo | | | | |
| Bird | *Vireo flavifrons* | Yellow-throated vireo | | | | |
| Bird | *Zenaida macroura* | Mourning dove | | | | |
| Bird | *Zonotrichia albicollis* | White-throated sparrow | | | | |
| Mammal | *Blarina brevicauda* | Short-tailed shrew | | | | |

| Type | Scientific name | Common name | Global rank | State rank | Federal status | State status |
|---|---|---|---|---|---|---|
| Mammal | *Canis latrans* | Coyote | | | | |
| Mammal | *Mustela frenata* | Long-tail weasel | | | | |
| Mammal | *Odocoileus virginianus* | Deer | | | | |
| Mammal | *Peromyscus leucopus* | White-footed mouse | | | | |
| Mammal | *Peromyscus sp* | Peromyscus | | | | |
| Mammal | *Procyon lotor* | Raccoon | | | | |
| Mammal | *Sigmodon hispidus* | Cotton rat | | | | |
| Mammal | *Synaptomys cooperi* | Southern bog lemming | G5 | S4 | | D |
| Mammal | *Tamias striatus* | Eastern chipmunk | | | | |
| Reptile | *Agkistrodon contortrix* | Copperhead | | | | |
| Reptile | *Carphophis amoenus* | Wormsnake | | | | |
| Reptile | *Coluber constrictor* | Racer | | | | |
| Reptile | *Diadophis punctatus* | Ring-necked snake | | | | |
| Reptile | *Ophisaurus attenuatus* | Eastern slender glass lizard | G5T5 | S3 | | D |
| Reptile | *Pantherophis guttatus* | Corn Snake | | | | |
| Reptile | *Lampropeltis triangulum* | Milksnake | | | | |
| Reptile | *Nerodia sipedon* | Watersnake | | | | |
| Reptile | *Pantherophis spiloides* | Rat snake | | | | |
| Reptile | *Scincella lateralis* | Little brown skink | | | | |
| Reptile | *Plestiodon fasciatus* | Five-lined skink | | | | |
| Reptile | *Terrapene carolina* | Eastern box turtle | | | | |
| Reptile | *Thamnophis sirtalis* | Gartersnake | | | | |
| Reptile | *Virginia valeriae* | Earthsnake | | | | |

III-4