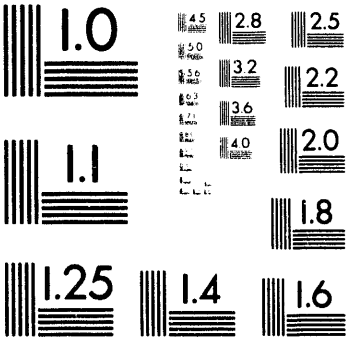
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ORNL/NERP-8

ENVIRONMENTAL SCIENCES DIVISION

RESOURCE MANAGEMENT PLAN FOR THE OAK RIDGE RESERVATION VOLUME 30: OAK RIDGE NATIONAL ENVIRONMENTAL RESEARCH PARK NATURAL AREAS AND REFERENCE AREAS – OAK RIDGE RESERVATION ENVIRONMENTALLY SENSITIVE SITES CONTAINING SPECIAL PLANTS, ANIMALS, AND COMMUNITIES

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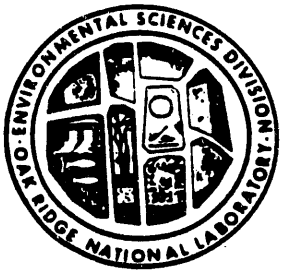

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

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ACRONYMS

3C	No longer a federal candidate (see Table 2)
ANA	Aquatic Natural Area
ARA	Aquatic Reference Area
BCK	code for study sites on Bear Creek
BMAP	Biological Monitoring and Abatement Program
C1	federal candidate higher priority (see Table 2)
C2	federal candidate lower priority (See Table 2)
DOE	U.S. Department of Energy
E	endangered (see Table 2)
EFK	code for study sites on the east fork of Poplar Creek
EFPC	East Fork Poplar Creek
ESD	Environmental Sciences Division
FCK	code for study sites on First Creek
FFK	code for study sites on Fifth Creek
GCK	code for study sites on Grassy Creek
GHK	code for study sites on Gum Hollow Branch
GIS	Geographic Information System
MBK	code for study sites on Mill Branch
MEK	code for study sites on Melton Branch
MIK	code for study sites on Mitchell Branch
NA	Natural Area
NPDES	National Pollutant Discharge Elimination System
NTK	code for study sites on the Northwest Tributary
OREIS	Oak Ridge Environmental Information System
ORR	Oak Ridge Reservation
PHK	code for study sites on Pinhook Branch
RA	Reference Area
RCRA	Resource Conservation and Recovery Act
S	special concern (see Table 2)
SCK	code for study sites on Scarboro Creek
T	threatened (see Table 2)
TVA	Tennessee Valley Authority
WCK	code for study sites on White Oak Creek

ABSTRACT

Areas on the Oak Ridge Reservation (ORR) that contain rare plant or animal species or are special habitats are protected through National Environmental Research Park Natural Area (NA) or Reference Area (RA) designations. The U.S. Department of Energy's Oak Ridge National Environmental Research Park program is responsible for identifying species of vascular plants that are endangered, threatened, or rare and, as much as possible, for conserving those areas in which such species grow. This report includes a listing of Research Park NAs and RAs with general habitat descriptions and a computer-generated map with the areas identified. These are the locations of rare plant or animal species or special habitats that are known at this time. As the Reservation continues to be surveyed, it is expected that additional sites will be designated as Research Park NAs or RAs.

This document is a component of a larger effort to identify environmentally sensitive areas on ORR. This report identifies the currently known locations of rare plant species, rare animal species, and special biological communities. Floodplains, wetlands (except those in RAs or NAs), and cultural resources are not included in this report.

1. INTRODUCTION

The Oak Ridge National Environmental Research Park is located in the 35,300-acre U.S. Department of Energy Oak Ridge Reservation (DOE-ORR) and consists of 13,600 acres (5,500 ha). The Reservation is within the Ridge and Valley physiographic province and is rich in biological diversity. The Department of Energy has made the commitment to preserve biological diversity through the protection of special habitats on the Reservation such as those of rare plants or animals, vegetational communities representative of the Southern Appalachians, and vegetational communities uncommon in this area (Marquess, P. T., Assistant Manager for Administration, U.S. Department of Energy Oak Ridge Operations, Oak Ridge, personal communication, Oct. 3, 1985). Special habitats on the Reservation are protected through National Environmental Research Park Natural Area (NA) or Reference Area (RA) designations (Parr and Pounds 1987). These designations protect state-listed or federally listed species, species under consideration for listing, and special habitats. The NAs or RAs also serve as reference or control areas for biological monitoring, environmental remediation, characterization, and other ecological research activities.

The Oak Ridge National Environmental Research Park program is responsible for both federal and state regulations with respect to rare plant species for the Reservation (Marquess, P. T., Assistant Manager for Administration, U.S. Department of Energy Oak Ridge Operations, Oak Ridge, personal communication, Oct. 3, 1985), and the program works closely with the Tennessee Department of Environment and Conservation in the area of rare species and special habitats in the state. Sites on ORR containing rare plant populations or special habitats are designated Research Park NAs or Research Park RAs regardless of whether the site is actually located within the Research Park boundaries.

In 1987 the first document describing ORR NAs and RAs (Parr and Pounds) was published. Since that time, additional areas have been designated as NAs and RAs as the result of the findings of specific site surveys conducted for National Environmental Policy Act compliance. The purpose of this document is to provide updated information on the location and description of the Research Park NAs and RAs. Two new designations, Aquatic Natural Areas (ANAs) and Aquatic Reference Areas (ARAs), have been added to identify and protect special aquatic resources. Research Park NAs and RAs are summarized in Table 1. Some of these sites have also been designated state Natural Areas as part of a 1986 agreement between DOE and the Tennessee Department of Conservation (Howell, C., Commissioner, Tennessee Department of Conservation, Nashville, personal communication, Jan. 3, 1986). These are identified in the general habitat descriptions of the site.

It is important to note that there has not been a comprehensive, systematic survey of the Reservation for the occurrence of rare plant species or special habitats. This document reports only sites in which rare plants or special habitats are currently <u>known</u> to occur. <u>This does not mean that they do not also occur in other areas</u>. As ORR surveys continue for various projects, the number of known locations of rare

plants and special habitats will probably increase, and additional NAs or RAs will be designated.

Table 1. Summary of Oak Ridge National Research Park Natural Areas and Reference Areas

Area type	Number of sites
Natural area (NA)	33[a]
Aquatic natural area (ANA)	8
Reference area (RA)	30
Aquatic reference area (ARA)	9
Total	80

[a]Two of the NAs are on former U.S. Department of Energy property that is now under Tennessee Valley Authority ownership (the Clinch River Breeder Reactor site).

The mapping information has been computerized on the Geographic Information System (GIS), Oak Ridge Environmental Information System (OREIS).

The objectives of this report are to do the following:

1. Update information on National Environmental Research Park Natural Areas and Reference Areas published in Parr and Pounds (1987).

2. Provide current information on the locations and general descriptions of National Environmental Research Park Natural Areas and Reference Areas.

3. Add locations and descriptions of Aquatic Natural Areas and Aquatic Reference Areas.

4. Computerize locations of Research Park areas using the Geographic Information System.

5. Provide information for the ORR project to identify environmentally sensitive areas.

2. RESEARCH PARK NATURAL AREAS AND AQUATIC NATURAL AREAS

The Research Park Natural Areas (NAs) have been established to protect state-listed or federally listed rare species and species under status review for federal listing that occur on ORR. There are 33 NAs on ORR representing 33 areas of major rare plant habitats (up from 18 known in 1987). The NAs consist of a core area (actual location of the plants) and a buffer area for habitat protection. Seventeen different rare plant species (up from 11 in 1987) occur in more than 33 sites on ORR. Rare plant species occurring on ORR and their state and federal status are presented in Table 2. The NA locations are identified on Fig. 1 as NA# with brief habitat descriptions in Sects. 2.1 and 2.2. Further information on rare plants can be found in *Resource Management Plan for the Oak Ridge Reservation Volume 29: Rare Plants on the Oak Ridge Reservation* (Cunningham et al. in preparation).

Some of the species listed by Tennessee that are threatened (T) or endangered (E) due to commercial exploitation or are of special concern may be widely scattered as individuals or small groups across ORR. In these cases, not every individual plant and its habitat are designated an NA. These decisions are made in light of a number of factors and are made on a case-by-case basis. All species with state or federal status, including candidate and proposed species, whether in a designated NA or not, are given special consideration in land-use planning.

Eight Research Park ANAs were added since 1987 and are identified on the map as ANA#. The ANAs are used for study and reference areas as part of the Biological Monitoring and Abatement Programs (BMAPs) or environmental remediation efforts at the DOE facilities in Oak Ridge. The BMAPs are included as part of the National Pollutant Discharge Elimination System (NPDES) permits for the Oak Ridge K-25 Site, the Oak Ridge Y-12 Plant, and the Oak Ridge National Laboratory (ORNL) (Loar et al. 1989; Loar et al. 1991; Loar et al. 1992). Many ANAs represent nonimpacted streams or reaches of streams that are comparable in terms of size and potential fauna to streams or reaches that are monitored for impacts through the BMAPs. Others encompass study sites that reflect varying degrees of impact from the DOE facilities. As such, a considerable amount of baseline data are available and are continually being accumulated for these areas. Tennessee Dace (*Phoxinus tennesseensis*) are found in many of the ANAs. This species is deemed in need of management by the state of Tennessee and is being considered for elevation to threatened status.

Table 2. Status of rare and endangered plants on the Oak Ridge Reservation (as of August 1992)

Scientific name	Common name	State status	Federal status
Aureolaria patula	spreading false-foxglove	T	C1
Carex gravida	heavy sedge	S	
Cimicifuga rubifolia	Appalachian bugbane	T	C2
Cypripedium acaule	pink lady-slipper	E*	
Delphinium exaltatum	tall larkspur	E	C2
Diervilla lonicera	northern bush-honeysuckle	T	
Elodea nuttallii	Nutall waterweed	S	
Fothergilla major	mountain witch-alder	T	
Hydrastis canadensis	golden seal	T	3C
Juglans cinerea	butternut	T	C2
Lilium canadense	Canada lily	T	
Lilium michiganense[a]	Michigan lily	T	
Liparis loeselii	fen orchid	E	
Panax quinquefolius	ginseng	T	3C
Platanthera flava var. *herbiola*	tubercled rein-orchid	T	
Platanthera peramoena	purple fringeless orchid	T	3C
Saxifraga careyana	Carey saxifrage	S	3C
Solidago ptarmicoides[b]	prairie goldenrod	E	
Spiranthes ovalis	lesser ladies'-tresses	S	

[a]*Lilium michiganense* may have been extirpated from ORR by the impoundment at Melton Hill.

[b]*Solidago ptarmicoides* is only in cultivation in the Barren Research Garden of the National Environmental Research Park.

Explanation of status codes used (adapted from the Tennessee Department of Conservation, Ecological Services Division, Rare and Endangered Plant Listing, January 17, 1991)

State

E - Endangered. Species now in danger of becoming extinct in Tennessee because of (a) their rarity throughout their range, or (b) their rarity in Tennessee as a result of sensitive habitat destruction or restricted area of distribution.

E* - Taxa considered to be endangered in Tennessee due to evidence of large numbers being taken from the wild and lack of commercial success with propagation or transplantation.

T - Threatened. Species likely to become endangered in the immediately foreseeable future as a result of rapid habitat destruction or commercial exploitation.

S - Special concern. Species requiring special concern because of (a) their rarity in Tennessee because the state represents the limit or near-limit of their geographic range, or (b) their status is undetermined because of insufficient information.

Federal (Determined by the U.S. Fish and Wildlife Service)

C1 - Taxa for which the U.S. Fish and Wildlife Service has on file substantial information on biological vulnerability and threats to support the appropriateness to list them as endangered or threatened species. Included are those taxa whose status in recent past is known, but may have already become extinct.

C2 - Taxa for which information now in possession of the Service indicated that proposing to list them as endangered or threatened is appropriate, but for which substantial data on biological vulnerability and threat(s) are not currently known or on file to support a proposed rule.

3C - Taxa that have proven to be more abundant or widespread than was previously believed and/or those that are not subject to any identifiable threat.

Note: The taxa listed in Categories 1 and 2 may be considered candidates for addition to the list of endangered and threatened plants and, as such, consideration should be given them in environmental planning.

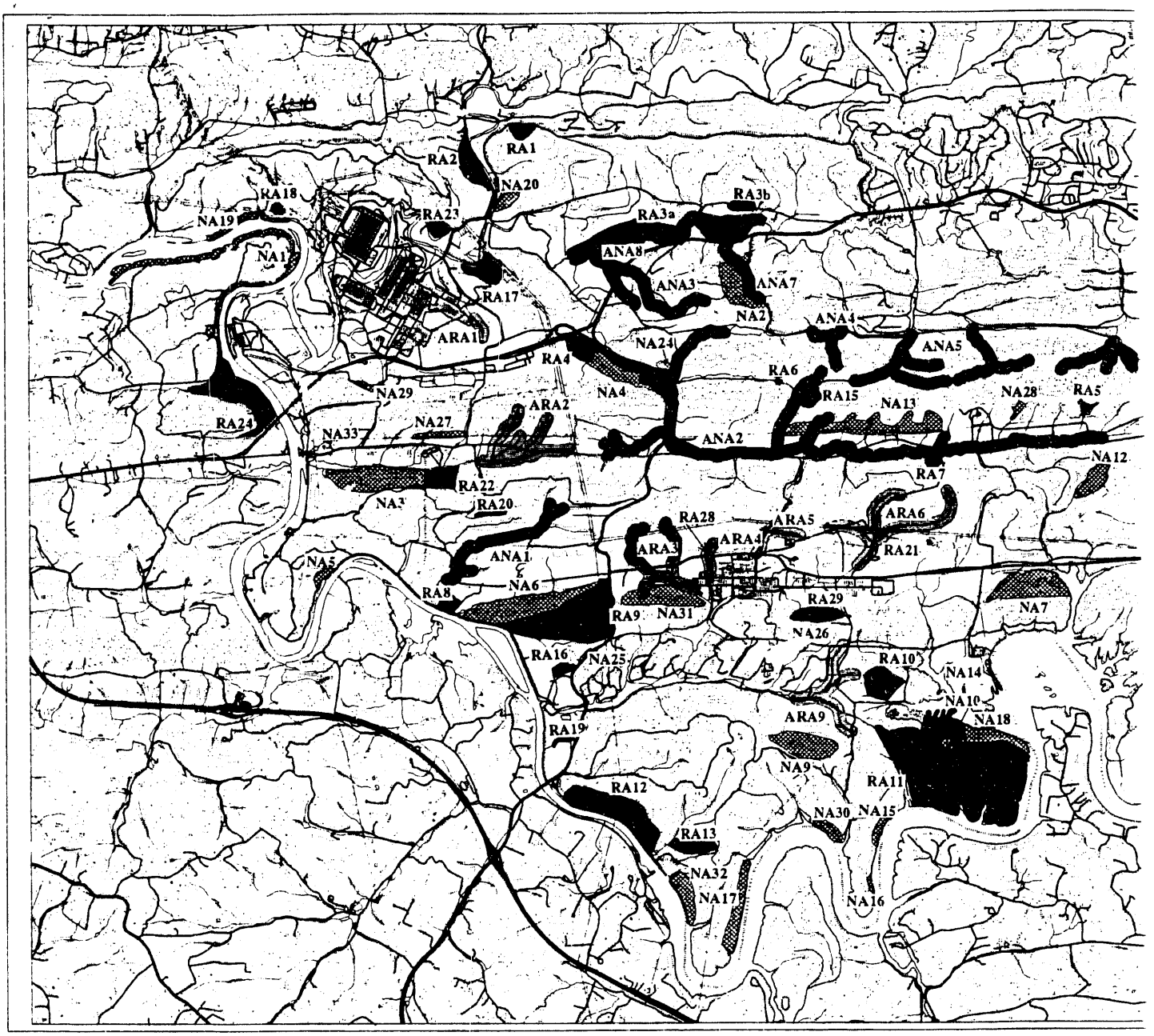

Fig. 1. Natural Areas and Reference Areas for the Oak Ridge Reservation. Env

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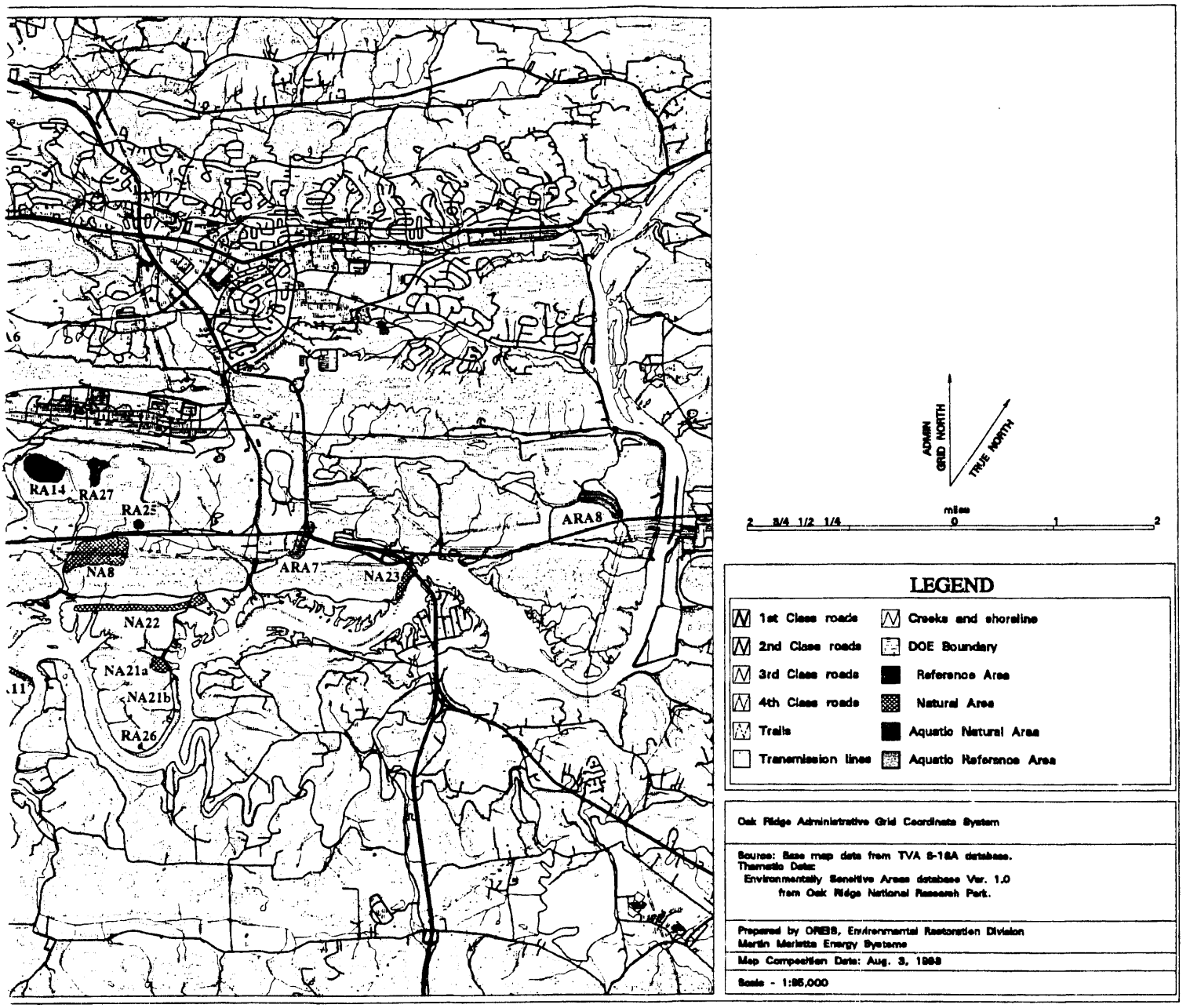

ronmentally sensitive sites containing special plants, animals, and communities.

2.1 RESEARCH PARK NATURAL AREAS

Below are the names and codes for Research Park Natural Areas. The status of rare species is indicated by status codes, which are explained in Table 2. The NAs are shown on Fig. 1.

NA1 CAMPBELL BEND BLUFFS AND FOREST. The river bluffs and adjacent forests provide habitat for two species under consideration for federal listing: spreading false-foxglove (*Aureolaria patula*, T, C1) and Appalachian bugbane (*Cimicifuga rubifolia*, T, C2). Both of these species are also listed as endangered on the Tennessee list of rare plants. Boeing, Inc., now owns much of the area that was part of this NA, but the two rare species mentioned above are present on the remainder of the NA.

NA2 EAST FORK RIDGE MESIC FOREST. This forested area consists of a moist, maturing woodland of many species, including beech, maple, and basswood on north- and east-facing slopes. A small unnamed creek runs through the site. The area is notable for a variety of woodland sedges and spring wildflowers. A large population of golden seal (*Hydrastis canadensis*, T, 3C), which is on the state list as threatened in Tennessee because of commercial exploitation, occurs in this area. Canada lily (*Lilium canadense*, T) has been seen here in the past ten years but has not been seen recently.

NA3 GRASSY CREEK MESIC SLOPES. This area, once a part of DOE-ORR, is now owned by the Tennessee Valley Authority (TVA). It is a forested area with north-facing slopes and limestone outcrops along the grassy creek embayment of the Clinch River. It contains a population of Appalachian bugbane (*Cimicifuga rubifolia*, T, C2), a population of spreading false-foxglove (*Aureolaria patula*, T, C1), and scattered plants of Carey saxifrage (*Saxifraga careyana*, S, 3C), all of which are state listed. Bugbane and false-foxglove are under status review for federal listing.

NA4 REIN-ORCHID SWAMP. This is a forested wetland area that contains old stream or flood channels and numerous seeps. The tubercled rein-orchid (*Plantanthera flava* var. *herbiola*, T), which is state listed, is found here. An uncommon wetland plant, golden club (*Orontium aquaticum*), occurs here. This site has been registered as a state Natural Area.

NA5 BREEDER BLUFFS. This area, once part of DOE-ORR, is now TVA land. Carey saxifrage (*Saxifraga careyana*, S, 3C) occurs on the bluffs over the river. Carey saxifrage is state listed as a species of special concern. The authors have not seen this site.

NA6 RACCOON CREEK GOLDEN SEAL AREA. This is a north-facing lower slope forest area with limestone outcrops. Golden seal (*Hydrastis canadensis*, T, 3C) occurs throughout this area. It is a state-listed species in part because of commercial exploitation. Other species uncommon to ORR that grow here are monk's hood (*Aconitum uncinatum*) and fly poison

(*Amianthium muscaetoxicum*). This area also includes an interesting embayment wetland.

NA7 WALKER BRANCH EMBAYMENT "BARREN." This is a large area with a variety of forest types and mowed sections along a pipeline and a power line. The slopes are mostly north-facing with some limestone outcropping. Tall larkspur (*Delphinium exaltatum*, E, C2) is scattered throughout this site. It is a state-listed plant and a candidate for federal listing. This site has also been registered as a state Natural Area.

NA8 McCOY BRANCH EMBAYMENT "BARREN." This area is similar to NA7. There is a large population of tall larkspur (*Delphinium exaltatum*, E, C2) here. This species is state listed as endangered and a federal candidate. This site has been registered as a state Natural Area.

NA9 CESIUM FOREST ORCHID AREA. This is an immature, mesic forest of mainly tulip poplar (*Liriodendron tulipifera*). Several shallow limestone sinkholes are scattered through the valley. A very small population of the lesser ladies'-tresses orchid (*Spiranthes ovalis*, S) occurs in one of the sinks. The state lists that orchid as a species of special concern.

NA10 LAZY BEAVER FOREST. This area is an immature mesic forest of tulip poplar (*Liriodendron tulipifera*). Evidence of a former homesite is nearby. The largest known population of the lesser ladies'-tresses orchid (*Spiranthes ovalis*, S) on ORR occurs here. It is state listed as a species of special concern. What seem to be dwarfed golden seal plants (*Hydrastis canadensis*, T, 3C) are also found here. The small size may be due to the drier-than-normal habitat for golden seal. Golden seal is listed as threatened in Tennessee.

NA11 BULL BLUFF. This steep, north-facing limestone bluff overlooks Melton Hill Lake. The bluff is wooded except for cliff areas. Rare plants occurring on this bluff include Appalachian bugbane (*Cimicifuga rubifolia*, T, C2), northern bush-honeysuckle (*Diervilla lonicera*, T), and Carey saxifrage (*Saxifraga careyana*, S, 3C). All of these species are on the Tennessee list of rare plants. Bugbane is under status review for federal listing. This site is registered as a state Natural Area.

NA12 WALKER BRANCH FOTHERGILLA SITE. The only colony of mountain witch-adler (*Fothergilla major*, T) known to occur on ORR grows on a west-facing slope in the Walker Branch Watershed. This population of the shrub is probably one clone. The site is near the top of a lower slope with heath family members (azalea and blueberry) and halfway to the top of the ridge. *Fothergilla* is state listed as threatened in Tennessee.

NA13 PINE RIDGE WETLANDS (IN PART, FORMERLY PINE RIDGE LILY AREA). This area includes wetlands in Bear Creek tributary bottoms and surrounding upland areas. The area encompasses part of a power-line

right-of-way and forested areas to the north of the power line. The wetlands are along Bear Creek tributaries and include open areas in the right-of-way and forested areas north of the right-of-way. The Canada lily (*Lilium canadense*, T), Tennessee listed, occurred in this area in the past. Purple fringeless orchid (*Platanthera peramoena*, T, 3C) is found in two of the wet meadows under the power lines. Tubercled rein-orchid (*Platanthera flava* var. *herbiola*, T) is found in three of the forested wetlands.

NA14 WHITE CEDAR AREA. White cedar (*Thuja occidentalis*) occurs here on a small, shaley cliff that slopes steeply into Melton Hill Lake. This species normally occurs at more northern latitudes. Also found here is northern bush-honeysuckle (*Diervilla lonicera*, T), which is state listed and also normally found farther north. Finally, spreading false-foxglove (*Aureolaria patula*, T, C1), another state-listed species, is found here.

NA15 NORTH HICKORY CREEK BEND BLUFFS. This is a steep, east-facing slope above Melton Hill Lake with an overstory of pines and various hardwoods. Two rare plants, both state listed, occur here: Appalachian bugbane (*Cimicifuga rubifolia*, T, C2) and Carey saxifrage (*Saxifraga careyana*, S, 3C). *Cimicifuga rubifolia* is a federal candidate.

NA16 SOUTH HICKORY CREEK BEND BLUFFS. This habitat is similar to that of NA15. The state-listed Carey saxifrage (*Saxifraga careyana*, S, 3C) occurs here also.

NA17 TOWER SHIELDING BLUFFS. This is a steep east-facing slope above Melton Hill Lake. The overstory consists of oaks and hickories with some mesic species such as sugar maple. The spreading false-foxglove (*Aureolaria patula*, T, C1) and Carey saxifrage (*Saxifraga careyana*, S, 3C), which occur on these bluffs, are both state listed. *Aureolaria patula* is under status review for federal listing.

NA18 COPPER RIDGE OUTCROP. The ridge area is extremely rocky and has numerous rocky sinks and cave entrances. The slopes are forested and north-facing. Carey saxifrage (*Saxifraga careyana*, S, 3C) occurs here. Tennessee lists it as a species of special concern.

NA19 BLACKOAK RIDGE RIVER BLUFFS. The slopes are southeast-facing and forested with some limestone rock outcrop. This area is the habitat for two species that are under review for federal listing: spreading false-foxglove (*Aureolaria patula*, T, C1) and Appalachian bugbane (*Cimicifuga rubifolia*, T, C2). They are both also state listed.

NA20 POPLAR CREEK CLIFFS. This site is on a west-facing slope of the Poplar Creek gap in Blackoak Ridge. Small limestone cliffs occur near the stream. Many species that are unusual for ORR occur here, including hemlock (*Tsuga canadensis*), rhododendron (*Rhododendron maximum*), fringe tree (*Chionanthus virginicus*), spider lily (*Hymenocallis fulva*), and mock orange (*Philadelphis hirsutus*). This site is registered as a state

Natural Area. The state-listed and federal-candidate species spreading false-foxglove (*Aureolaria patula*, T, C1 occurs here.

NA21 RAINY KNOB BLUFF, FREELS BEND. NA21 is composed of two parts. NA21a is the main area. A scenic, rocky limestone sinkhole with a cave entrance is here. This forested, north-facing bluff provides habitat for Carey saxifrage (*Saxifraga careyana*, S, 3C), a state-listed species. A small population of the state-listed species golden seal (*Hydrastis canadensis*) is also found here. NA21b is a small, rocky area directly adjacent to Melton Lake. A population of *Saxifraga careyana* is here also.

NA22 BULL BLUFF ROAD AREA. Several individuals of the state-listed species, *Lilium canadense* (T) or *Lilium michiganense* (T), are scattered throughout this area. The drainages and streams are the prime sites within this area for protection.

NA23 SOLWAY BEND BLUFFS. This is an east-facing, rocky slope. It provides habitat for Carey saxifrage (*Saxifraga careyana*, S, 3C), which is state listed. Other uncommon species occur here including cancer root (*Orobanche uniflora*).

NA24 HEMBREE MARSH. This unique area is one of perhaps two marshes on ORR not subject to the changing water levels of TVA's dams. Sweet flag (*Acorus calamus*) is one of the dominant species in the open wet area. This site is registered as a state Natural Area. Fen orchid (*Liparis loeselii*, E), Tennessee endangered, is found here.

NA25 HIGHWAY 95 LILY AREA. Canada lily (*Lilium canadense*, T) or Michigan lily (*Lilium michiganense*, T), each listed by Tennessee as threatened, is found in a moist area along a wooded stream. No flowering lilies have been seen here. Flowering plants will be needed to determine which species is present. Quillwort (*Isoetes* sp.) is also present.

NA26 MELTON VALLEY LILY AREA. This is a forested wetland with a couple of small pools. These may be important amphibian breeding sites. Two immature Canada lily (*Lilium canadense*, T) or Michigan lily (*Lilium michiganense*, T) plants were found here. Tennessee lists both species as threatened.

NA27 FRINGELESS ORCHID WETLANDS. This is a series of small wetlands under the Bear Creek power-line right-of-way west of Highway 95. A great diversity of wet meadow species occurs in these sites including purple fringeless orchid (*Platanthera peramoena*, T, 3C), which is listed as threatened in Tennessee. This site is identified as B-13 in the wetlands survey (Cunningham and Pounds 1991).

NA28 EASTERN BEAR CREEK REIN-ORCHID WETLAND. This is a small wetland along a stream shaded with overarching red maple branches. The dominant herbs are *Microstegium vimineum* and *Leersia* sp. A small population of

Platanthera flava var. *herbiola* (T), which is considered threatened in Tennessee, is also there.

NA29 NORTHWEST PINE RIDGE FRINGELESS ORCHID SITE. A population of purple fringeless orchid (*Platanthera peramoena*, T, 3C) is found here in a wet area in a power-line right-of-way.

NA30 HEALTH PHYSICS RESEARCH REACTOR (HPRR) LAKE BLUFFS. This is an area of steep and often rocky, limestone bluffs along Melton Lake south of HPRR. Spreading false-foxglove (*Aureolaria patula*, T, C1) is found here.

NA31 ENVIRONMENTAL SCIENCES DIVISION (ESD) LILY SITE. This area is on Haw Ridge south of the ESD complex. This is a moist limestone woods with a wide variety of trees. Lily plants presumed to be Canada lily (*Lilium canadense*, T) or possibly Michigan lily (*L. michiganense*, T) were found in three wet spots. Flowering plants are needed for accurate identification.

NA32 MELTON DAM BLUFFS. This is an area of limestone rock outcrops along Melton Lake just upstream from the dam. Butternut (*Juglans cinerea*, T, C2) and spreading false-foxglove (*Aureolaria patula*, T, C1) are found here.

NA33 K-25 FILTRATION PLANT WETLAND. This area is a wetland near the K1515 lagoon. There are two spreading false-foxglove (*Aureolaria patula*, T, C1) plants.

2.2 AQUATIC NATURAL AREAS

Below are the names and codes for Research Park Aquatic Natural Areas (ANAs). The ANAs are shown on Fig. 1. Study sites are indicated by a stream code with a number. For example, BCK 3.25 is a study site on Bear Creek.

ANA1 ISH CREEK. This second-order, spring-fed stream flows through a mixed hardwood forest before entering the Clinch River. The fish species richness is high for a second-order stream and includes a Tennessee-listed species, the Tennessee Dace. Ish Creek is also the site for many ecological studies.

ANA2 BEAR CREEK. This third-order, spring-fed stream flows out of the Y-12 Plant into East Fork Poplar Creek (EFPC). The downstream sections are bordered by a mature deciduous forest, but the degree of disturbance increases dramatically upstream. The benthic invertebrate fauna is rich and diverse at the downstream sections but shows considerably less diversity near the headwaters. The fish species richness is appropriate for a third-order stream and includes a Tennessee-listed species, the Tennessee Dace. The population of Tennessee Dace in Bear Creek may represent one with the greatest density in the state (Ryon and Loar 1988). The stream contains study sites (BCK 3.25 to BCK 12.36) for the

benthic invertebrate and fish community tasks of the remedial activities for Bear Creek and is used for life history studies of the Tennessee Dace.

ANA3 UNNAMED TRIBUTARY TO EFPC. This second-order stream flows through a pine plantation before entering lower EFPC. The fish species richness is high for a second-order stream and includes a Tennessee-listed species, the Tennessee Dace.

ANA4 FINHOOK BRANCH. This second-order, spring-fed stream flows through a young, managed loblolly pine forest before entering EFPC. The benthic invertebrate fauna is rich and diverse. The fish species richness is appropriate for a second-order stream and includes a Tennessee-listed species, the Tennessee Dace. The stream is a reference (PHK 1.4) for the benthic invertebrate task of the remedial activities for Bear Creek and is a fish community reference for investigations on stream recovery and life history studies of the Tennessee Dace.

ANA5 GUM HOLLOW BRANCH. This third-order, spring-fed stream flows through an oak-hickory forest with some disturbance areas before entering EFPC. The benthic invertebrate fauna is rich and diverse. The fish species richness is appropriate for a small third-order stream and includes a Tennessee-listed species, the Tennessee Dace. The stream is a reference (GHK 1.6 and 2.9) for the benthic invertebrate task of the remedial activities for Bear Creek.

ANA6 MILL BRANCH. This third-order, spring-fed stream flows through an oak-hickory forest with some disturbance areas before entering EFPC. The benthic invertebrate fauna is rich and diverse. The fish species richness is high for a small third-order stream and includes a Tennessee-listed species, the Tennessee Dace. The stream is a reference (MBK 1.6) for the benthic invertebrate and fish community tasks of the remedial activities for Bear Creek.

ANA7 UNNAMED TRIBUTARY TO EFPC. This small first-order stream flows through a mixed hardwood-pine forest before entering lower EFPC. The stream includes a Tennessee-listed fish species, the Tennessee Dace.

ANA8 LOWER EFPC. This fourth-order stream flows through a young-to-mature floodplain forest. The benthic invertebrate fauna is diverse in this area of East Fork but is limited by impacts from the Y-12 Plant and the city of Oak Ridge. The fish species richness is fair for a stream this size, but it lacks some pollution-sensitive species. Some improvements in benthic and fish communities have been noted over the past 5 years. The stream includes study sites (EFK 10.0, 10.6, 6.3, and 2.0) for the benthic invertebrate, periphyton, fish community, fish bioindicator, and fish bioaccumulation tasks of the Y-12 Plant BMAP.

3. RESEARCH PARK REFERENCE AREAS AND AQUATIC REFERENCE AREAS

Areas on DOE-ORR that are representative of the vegetational communities of the southern Appalachian region or that possess unique biotic features have been designated Research Park Reference Areas (RAs). These 38 areas are important as sources of baseline information for long-term observations and monitoring. They are set aside for the exclusive use of nonmanipulative environmental research for definite or indefinite periods of time as stated in DOE Order 4300.1B (DOE 1986). Baseline information has been collected in some of the areas, and other areas have provided important baseline data for ORR Biological Monitoring and Abatement Programs (BMAPs). Many of the Reference Areas originally described (Parr and Pounds 1987) have been redesignated as Research Park Natural Areas because rare plants have been found in them. Currently 29 Research Park Reference Areas exist (up from 23 in 1987). Many of the new additions are wetland areas found during the 1990 ORR Wetland Survey (Cunningham and Pounds 1991). The Research Park Reference Areas are identified on the map as RA#.

Nine sites on DOE-ORR are designated as Research Park Aquatic Reference Areas (ARAs). These sites are identified on the map as ARA#. These ARAs are used primarily for reference areas for the BMAPs or environmental remediation efforts at the DOE facilities in Oak Ridge. The BMAPs are included as part of the National Pollutant Discharge Elimination System (NPDES) permits for the K-25 Site, the Y-12 Plant, and ORNL. The ARAs represent nonimpacted streams or reaches of streams that are comparable in terms of size and potential fauna to streams or reaches that are monitored for impacts through the BMAPs. As such, a considerable amount of baseline data are available and are continually being accumulated for these areas.

3.1 RESEARCH PARK REFERENCE AREAS

Below are the names and codes for Research Park RAs. The status of rare species is indicated by status codes, which are explained in Table 2. The RAs are shown on Fig. 1, except that RA30 is <u>not</u> shown on the map.

RA1 BLACKOAK RIDGE HEMLOCK BLUFFS. This forested area is composed of hemlocks and white pine overlooking Poplar Creek.

RA2 LEATHERWOOD BLUFFS. These moist, east-facing slopes occur where Poplar Creek cuts through Blackoak Ridge. A great diversity of species grow here (many of them uncommon on ORR), including hemlock and rhododendron.

RA3 EAST FORK FLOODPLAIN. This is a typical eastern U.S. floodplain forest of sycamore, ash, and boxelder. This plant community is uncommon on ORR; most of the floodplains have been planted in pine. The main area is mapped as RA3a. A nearby abandoned limestone quarry is mapped as RA3b.

RA4 BEAR CREEK WETLANDS. This is an unusual area in a nearly flat basin where springs, seeps, and old streambeds create a variety of wet habitats. This area surrounds on three sides the southern rein-orchid swamp, Research Park NA4. Part of this site is also registered as a state Natural Area.

RA5 QUILLWORT TEMPORARY POND. This is a wooded wetland that appears to be flooded for part of the year. The quillworts growing here have been determined to be *Isoetes carolinia*, a recently described species. This species may be found to be rare enough for listing by the state. This site may be an important amphibian breeding site.

RA6 PINK LADY SLIPPER COMMUNITY. An unusually large population of the pink lady slipper (*Cypripedium acaule*, E) occurs in a Virginia pine (*Pinus virginiana*) forest. Pink lady slipper, although not rare, is subject to commercial exploitation and is considered to be endangered in Tennessee.

RA7 BEAR CREEK MESIC FOREST. This area contains mature white pine trees (*Pinus strobus*), both on the north-facing slope and in a low area with holly (*Ilex opaca*). The uncommon *Aesculus parviflora*, a shrubby buckeye, is found along Bear Creek. A large spring flows ~20 m (66 ft) into Bear Creek.

RA8 RACCOON CREEK BARREN. This is a cedar barren area with few trees over a shallow limestone soil. Many interesting plants occur here: prickly pear cactus (*Opuntia humifusa*), side-oats grama (*Bouteloua curtipendula*), an adder's tongue fern (*Ophioglossum engelmannii*), a milk vetch (*Astragalus canadensis*), and ironwood (*Bumelia lycoides*). The common name ironwood is also used for the common species *Carpinus caroliniana*.

RA9 HAW RIDGE UPLAND HARDWOODS. This is a representative upland hardwoods area with primarily oaks and hickories. It is adjacent to NA6.

RA10 MOSS AND LICHEN PINE COMMUNITY. This area demonstrates succession following serious soil erosion damage. The area is abundant in mosses and lichens under pine trees, typical of early successional stages. The dominant ground cover here is reindeer moss (*Cladonia subtenuis*), which is actually a lichen.

RA11 COPPER RIDGE AREA. The Copper Ridge RA is a large and relatively undisturbed area that includes communities in various stages of succession. Some of the major community types include oak-hickory, pine, and cedar. The ridge section is extremely rocky, and there are numerous limestone rocky sinks and several caves.

RA12 DRY RIVER BLUFFS. This is a wooded limestone cliff area along the Clinch River. A mature oak forest is at the southern end of the area, where the slope is much less rocky.

RA13 WHITE PINE FOREST. This area contains a mesic forest with white pine and numerous small sinkholes. The upper half of the valley in the center of the area is a chain of sinkholes.

RA14 FANNY KNOB WHITE OAK AREA. This area contains a white oak community along the west and south slopes of the knob. Large numbers of ginseng plants (*Panax quinquefolius*, T, 3C) occur scattered throughout the site. This plant is state listed as threatened in Tennessee because of commercial exploitation.

RA15 BEECH-MOUNTAIN LAUREL COMMUNITY. This community is an unusual mixture of dry forest species and mesic species. Dry forest species include mountain laurel (*Kalmia latifolia*), Virginia pine (*Pinus virginiana*), blueberries (*Vaccinium* sp.), trailing arbutus (*Arbutus repens*), azalea (*Rhododendron* sp.), and various oaks (*Quercus* sp.). Mesic species, found along the stream, include beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), hydrangea (*Hydrangea arborescens*), and magnolia (*Magnolia tripetala*). The beech extends well up the slope into the xeric forest, and the mountain laurel reaches down to the stream.

RA16 CLINCH FLOOD PLAIN SWAMP. This is a forested wetland along a stream that enters the floodplain of the Clinch River near the 0800 area. *Carex louisianica*, a coastal plain species rare in East Tennessee, is found here.

RA17 MCKINNEY RIDGE HEMLOCKS. This is the most extensive area of hemlocks and rhododendrons on the reservation. There are two small cave entrances near Poplar Creek. This site is also a registered state Natural Area.

RA18 BLACKOAK RIDGE WHITE PINES. This is a native white pine forest that has been disturbed by recent logging. Several white pines remain that could reestablish the stand.

RA19 SWEET FLAG MARSH. This is a large, open wetland dominated by sweet flag, *Acorus calamus*. Large (greater than an acre), open, unforested wetlands are rare on ORR, particularly those not controlled by the lake water level.

RA20 NEW ZION BOGGY. A forested wetland near New Zion Cemetery. A unique community on ORR; cool water emerges steadily from the ground in several places. Sphagnum moss and ferns are dominant species. Pooled water occurs during some of the year in part of the area. Heavy sedge (*Carex gravidais*) is found here. New Zion Boggy Area is identified as B-12 in the wetlands survey (Cunningham and Pounds 1991).

RA21 CHESTNUT RIDGE SPRINGS AREA. This area consists of immature woods with spring-, seep-, and stream-associated wetlands. Screw-stem (*Bartonia paniculata*), an uncommon species in East Tennessee, is found here. This site is identified as B-14 in the wetlands survey (Cunningham and Pounds 1991).

RA22 GRASSY CREEK SECURITY SITE. This area contains limestone outcrops near the stream. Two of the species found here are uncommon on ORR. These are wild ginger (*Asarum canadensis*) and Jacob's ladder (*Polemonium reptans*). This site is adjacent to NA3.

RA23 UPPER POPLAR CREEK ROOKERY. This site contains a great blue heron rookery—one of two known to occur on ORR. Herons occupied about a dozen nests in the pine stands in the summer of 1986. The site is between a borrow pit pond and Poplar Creek.

RA24 ROBERTS BRANCH WETLANDS COMPLEX. This area of open water and wetlands along Watts Bar Reservoir northwest of Gallaher Bridge includes the wetlands coded as E-PFOIA-96, E-L2OWHh-6, and E-POWHh-97 in the wetlands survey by Cunningham and Pounds (1991).

RA25 LARGE POND. This is one of two artificial ponds chosen for reference areas because of the diversity of aquatic and emergent species. *Sagittaria* sp. and *Wolffia* sp. are among the aquatic species present. This area is identified as L-POWHh-8 in the wetlands survey (Cunningham and Pounds 1991).

RA26 SMALL POND. This is one of two artificial ponds chosen for reference areas because of the diversity of aquatic and emergent species. Several *Potamogeton* species, as well as emergent species, are present. This pond is identified in the wetlands survey as L-POWHh-33 (Cunningham and Pounds 1991).

RA27 OLD ASH DISPOSAL AREA. This area was created by the flow of fly ash slurry. The flow has been discontinued, and the area has become drier, but much of the area is still wetland. This area provides good research possibilities because the history of the site is well known. Interesting plant species are present, including four species of willow (*Salix*) and two species of horsetail (*Equisetum*). A Tennessee special concern species, lesser ladies'-tresses (*Spiranthes ovalis*, S) is found here. Two areas of open water exist, one of which dries up in the late summer. Both areas of open water have aquatic species. A number of unusual plant communities for ORR are here, including areas with scattered willows and a cottonwood grove. This area, though having special plant communities, is different from all other RAs in that the habitat is of recent, human-controlled origin. It is identified in the wetlands survey as B-8 (Cunningham and Pounds 1991).

RA28 SPRING POND. This is a small spring-fed pond with unusually clear water for ponds on ORR. The pond is dominated by Nutall waterweed (*Elodea nuttallii*, S). The RA includes the spring and a short stream that feeds the pond. This spring is identified as B-21 in the wetlands survey (Cunningham and Pounds 1991).

RA29 ORNL ROCKY LIMESTONE FOREST. This area is on Haw Ridge south of the main ORNL complex. Much of this area is dry, rocky woods dominated by oaks and cedars. It is potential habitat for tall larkspur *Delphinium exaltatum*, E, C2).

RA30 LOWER POPLAR CREEK ROOKERY. This site contains a great blue heron rookery—one of two known to occur on ORR. The heron nests are in a forested wetland. This rookery is the focus of a research project. RA30 is not shown on the map (Fig. 1); RA30 is on the north bank of Poplar Creek inside the K-25 Site.

3.2 AQUATIC REFERENCE AREAS

Below are the names and codes for Research Park Aquatic Reference Areas (ARAs). The ARAs are shown on Fig. 1. Study sites are indicated by a code. For example, MIK 1.43 is a study site on Mitchell Branch.

ARA1 UPPER MITCHELL BRANCH (OUTSIDE THE K-25 SITE). This first-order, spring-fed stream flows through a mixed hardwood-pine forest. The stream has a rich and diverse assemblage of benthic invertebrates but only a limited fish fauna. The stream is the primary reference (MIK 1.43) for the benthic invertebrate task of the K-25 Site BMAP.

ARA2 GRASSY CREEK. This second-order, frequently intermittent stream flows through a second-growth, mixed forest dominated by redbud and red cedar. The stream has a diverse benthic invertebrate fauna and fish species richness appropriate for a stream of its size. Grassy Creek is a reference (GCK 2.4) for the benthic invertebrate and fish community tasks of the remedial activity for Bear Creek and is the primary reference for the fish community task of the K-25 Site BMAP.

ARA3 NORTHWEST TRIBUTARY. This second-order, frequently intermittent stream flows along the base of wooded Haw Ridge, but with mowed fields, parking lots, and experimental ponds on the opposite bank. The benthic invertebrate assemblage is diverse, especially in comparison with downstream impacted sites, and the fish fauna is appropriate, considering stream size and intermittent flows. Northwest Tributary is a reference (NTK 1.0) for the periphyton, benthic invertebrate, and fish community tasks of the ORNL BMAP.

ARA4 FIRST CREEK. This first-order, spring-fed stream flows out of a mixed forest on Chestnut Ridge through disturbed habitats of mowed fields and parking lots. Bank canopy is limited to small shrubs and grasses, but the stream contains substantial amounts of watercress, elodea, and peppermint. A rich and diverse assemblage of benthic invertebrates occurs in upper First Creek, but fish species richness has been limited by downstream activities. The stream is a reference (FCK 0.8) for the benthic invertebrate community and fish community tasks, as well as a reference (FCK 1.0) for the periphyton community and toxicity monitoring tasks of the ORNL BMAP.

ARA5 FIFTH CREEK. This first-order, spring-fed stream flows off Chestnut Ridge and is surrounded by upland forest on one bank and mowed fields and small trees on the opposite bank. The benthic invertebrate fauna is rich and diverse. The fish fauna is restricted to two headwater species, but the community is very productive. Upper Fifth

Creek is a reference (FFK 1.0) for the benthic invertebrate and fish community tasks and is a reference (FFK 1.1) for the toxicity monitoring and periphyton community tasks of the ORNL BMAP.

ARA6 UPPER WHITE OAK CREEK. This second-order stream has a watershed area of 2.2 km^2 and is bordered by a young-to-mature forest as well as disturbance vegetation. The stream contains substantial aquatic vegetation, primarily watercress and peppermint. A rich and diverse assemblage of benthic invertebrates and an extremely stable fish community occur in this area. Upper White Oak Creek is a reference (WCK 6.8) for the ORNL BMAP tasks of benthic invertebrate community, fish community, toxicity monitoring, and periphyton community. It is also frequently used as a reference for experimental studies, including many snail-periphyton interaction studies.

ARA7 SCARBORO CREEK. This third-order stream flows from The University of Tennessee Arboretum through open fields and is bordered by small trees and shrubs. The benthic invertebrate fauna is rich and diverse, and the fish community is representative of a smaller third-order stream. The stream is a reference (SCK 2.2) for the fish community task of the McCoy Branch RCRA Facilities Investigation by the Y-12 Plant.

ARA8 UT FARMS CREEK. This second-order spring-fed stream flows through an oak-hickory forest. It has a rich and diverse benthic invertebrate fauna and a typical headwater stream fish community. The stream is used as a reference for the benthic invertebrate community task of the remedial activities for Bear Creek.

ARA9 MELTON BRANCH. This second-order, occasionally intermittent stream flows through a young forest that progresses from mesic lowland to a drier more upland character. Bank vegetation includes jack-in-the-pulpit and green dragon. The benthic invertebrate fauna is rich and diverse, but the fish fauna is limited by the stream size and intermittent nature. Upper Melton Branch is used as a reference (MEK 1.8 and 2.1) for the periphyton, benthic invertebrate, and fish community tasks of the ORNL BMAP.

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