APPENDIX K

THREATENED AND ENDANGERED SPECIES LISTS

APPENDIX K

Species of Special Concern and Inventories of Floral and Faunal Species at Ravenna Army Ammunition Plant

The information contained in this appendix, unless otherwise noted, was obtained from SPECIES AND PLANT COMMUNITIES INVENTORY (1993), RAVENNA ARMY AMMUNITION PLANT, prepared by the Ohio Department of Natural Resources, Division of Natural Areas & Preserves in cooperation with The Nature Conservancy, Ohio Chapter.

The following categories of species lists presented in this appendix are as follows:

Appendix Table K-1. Species of Special Concern (3 pages)

Appendix Table K-2. Rare Plant Species of Portage and Trumbull Counties (5 pages)

Appendix Table K-3. Vascular Plant Flora (32 pages)

Appendix Table K-4. Mammals (15 pages)

Appendix Table K-5. Annotated List of the Birds of the RVAAP (12 pages)

Appendix Table K-6. Amphibians and Reptiles found at the RVAAP (6 pages)

Appendix Table K-7. Species and Numbers of Fish Collected on the RVAAP (1page)

TABLE K-1

APPENDIX TABLE K-1. SPECIES OF SPECIAL CONCERN

I. The following information and lists of species were taken from the unpublished paper "Natural Resources and Environmental Overview" of the Ravenna Army Ammunition Plant with Thoughts on the Future by Tim Morgan, RVAAP Natural Resources Manager, April 1996. There are no known federally-listed threatened or endangered species on the RVAAP, but the federally-listed endangered Indiana bat (*Myotis sodalis*) is a possible inhabitant. Below is a listing of the rare species found at the RVAAP.

A. Species under Federal Observation (former Federal Candidate Species, Category 2)

1. Cerulean Warbler (*Dendroica cerulea*)
2. Butternut (*Juglans cinerea*)
3. Henslow's Sparrow (*Ammodramus henslowii*)

B. State Endangered (1993 Inventory)

1. Northern Harrier (*Circus cyaneus*)
2. Common Barn Owl (*Tyto alba*)
3. Yellow-bellied Sapsucker (*Sphyrapicus varius*)
4. Mountain Brook Lamprey (*Ichthyomyzon greeleyi*)
5. Graceful Underwing (*Catocala gracilis*)

D. State Potentially Threatened

1. Gray birch (*Betula populifolia*)
2. Round-leaved sundew (*Drosera rotundifolia*)
3. Closed gentian (*Gentiana clausa*)
4. Butternut (*Juglans cinerea*)
5. Blunt mountain-mint (*Pychanthemum muticum*)
6. Northern rose azalea (*Rhododendron nudiflorum* var. *roseum*)
7. Large cranberry (*Vaccinium macrocarpon*)
8. Hobblebush (*Viburnum alnifolium*)
9. Fox grape (*Vitus labrusca*)
10. Woodland horsetail (*Equisetum sylvaticum*)
11. Long bech fern (*Phegopteris connectilis*) (*Thelypteris phegopteris*) (suspected)
12. Eel-grass (*Vallisneria americana*) (suspected)

E. State Special Concern [Ohio Department of Wildlife (ODOW) or Heritage Program listing]

1. Woodland Jumping Mouse (*Napaeozapus insignis*) (ODOW)
2. Solitary Vireo (*Vireo solitarius*) (Heritage)
3. Sharp-shinned Hawk (*Accipiter striatus*) (ODOW)
4. Sora (*Porzana carolina*) (ODOW)
5. Virginia Rail (*Rallus limicola*) (ODOW)
6. Four-toed Salamander (*Hemidactylium scutatum*) (ODOW)
7. Smooth Green Snake (*Opheodrys vernalis*) (Heritage)

The category "C" was omitted from the original paper.

II. Species documented by the U.S. Fish and Wildlife Service or the Ohio Department of Natural Areas and Parks within the vicinity of the RVAAP, but not known to be on the RVAAP property. (*from* RVAAP Rare Species List, 2 May, 1995)

A. Federal Endangered

1. Indiana Bat (*Myotis sodalis*)

B. Federal Threatened

1. Northern Monkshood (*Aconitum noveboracense*)
2. Bald Eagle (*Haliaetus leucocephalus*)

C. State Endangered

1. White-stemmed Pondweed
2. Bald Eagle (*Haliaetus leucocephalus*)
3. Northern Monkshood (*Aconitum noveboracense*)
4. Indiana Bat (*Myotis sodalis*)

D. State Threatened

1. Spiral Pondweed (*Potamogeton spirillus*)
2. Pale Sedge (*Carex pallescens*)
3. Upland Sandpiper (*Bartamia longicauda*)

E. State Potentially Threatened

1. Richardson's Pondweed (*Potamogeton richardsonii*)
2. Flat-stem Pondweed (*Potamogeton zosteriformis*)
3. American Water-pennywort (*Hydrocotyle americana*)
4. Large Round-leaved Orchid (*Platanthera orbiculata*)

F. State Special Interest (ODOW)

1. Iowa Darter (*Etheostoma exile*)

Note: Portage County has more rare species than any other county in Ohio. This listing is for consideration of off-site impacts for major projects. These are also potential future species of concern on the RVAAP property.

from: Inservice Note 718
September 1997
Division of Wildlife
Ohio Department of Natural Resources

DEFINITIONS OF CATEGORIES OF STATE-LISTED SPECIES

ENDANGERED - A native species or subspecies threatened with extirpation from the state. The danger may result from one or more causes, such as habitat loss, pollution, predation, interspecific competition, or disease.

THREATENED - A species or subspecies whose survival in Ohio is not in immediate jeopardy, but to which a threat exists. Continued or increased stress will result in its becoming endangered.

SPECIAL INTEREST - A species or subspecies which might become threatened in Ohio under continued or increased stress. Also, a species or subspecies for which there is some concern but for which information is insufficient to permit an adequate status evaluation.

EXTIRPATED - A species or subspecies that occurred in Ohio at the time of European settlement and that has since disappeared from the state.

EXTINCT - A species or subspecies that occurred in Ohio at the time of European settlement and that has since disappeared from its entire range.

TABLE K-2

APPENDIX TABLE K-2. RARE PLANT SPECIES OF PORTAGE AND TRUMBULL COUNTIES

from Ohio Department of Natural Resources, Division of Natural Areas and Parks, Heritage Program

OHIO NATURAL HERITAGE DATA BASE
PORTAGE COUNTY
RARE PLANT SPECIES (1996-97 STATUS LIST)
(YEAR=MOST RECENT RECORD)

STATUS: ENDANGERED (E)
1988 ACONITUM NOVEBORACENSE - NORTHERN MONKSHOOD
1997 ARETHUSA BULBOSA - DRAGON'S-MOUTH
1960 CAREX ARCTATA - DROOPING WOOD SEDGE
1989 CAREX DISPERMA - TWO-SEEDED SEDGE
1983 CAREX ECHINATA - LITTLE PRICKLY SEDGE
1988 CORALLORHIZA TRIFIDA - EARLY CORAL-ROOT
1980 CYPRIPEDIUM CALCEOLUS VAR. PARVIFLORUM - SMALL YELLOW LADY'S-SLIPPER
1993 GALIUM LABRADORICUM - BOG BEDSTRAW
1988 HYDROCOTYLE UMBELLATA - NAVELWORT
1996 HYPERICUM BOREALE - NORTHERN ST. JOHN'S-WORT
1995 LEDUM GROENLANDICUM - LABRADOR-TEA
1990 MYRICA PENSYLVANICA - BAYBERRY
1988 NAJAS GRACILLIMA - THREAD-LIKE NAIAD
1993 PLAGIOTHECIUM LATEBRICOLA - LURKING LESKEA
1990 PLATANTHERA BLEPHARIGLOTTIS - WHITE FRINGED ORCHID
1978 PLATANTHERA PSYCODES - SMALL PURPLE FRINGED ORCHID
1991 POLYGONUM SETACEUM VAR. INTERJECTUM - BRISTLY SMARTWEED
1988 POTAMOGETON FRIESII - FRIES' PONDWEED
1988 POTAMOGETON PRAELONGUS - WHITE-STEM PONDWEED
1988 POTAMOGETON ROBBINSII - ROBBINS' PONDWEED
1974 POTAMOGETON SPIRILLUS - SPIRAL PONDWEED
1979 POTENTILLA ARGUTA - TALL CINQUEFOIL
1985 SALIX PEDICELLARIS - BOG WILLOW
1993 SCHIZACHNE PURPURASCENS - FALSE MELIC
1978 SELAGINELLA RUPESTRIS - ROCK SPIKEMOSS
1972 SISYRINCHIUM MUCRONATUM - NARROW-LEAVED BLUE-EYED-GRASS
1993 UTRICULARIA GEMINISCAPA - TWO-SCAPED BLADDERWORT
1996 XYRIS DIFFORMIS - CAROLINA YELLOW-EYED-GRASS

STATUS: THREATENED (T)
1980 ADLUMIA FUNGOSA - MOUNTAIN-FRINGE
1981 BETULA PUMILA - SWAMP BIRCH
1966 BOTRYCHIUM MULTIFIDUM - LEATHERY GRAPE-FERN
1991 CAREX ALBICANS VAR. EMMONSII - EMMONS' SEDGE
1985 CAREX BRUNNESCENS - BROWNISH SEDGE
1995 CAREX OLIGOSPERMA - FEW-SEEDED SEDGE
1984 CAREX PALLESCENS - PALE SEDGE
1980 CORNUS CANADENSIS - BUNCHBERRY
1976 CYPRIPEDIUM CANDIDUM - WHITE LADY'S-SLIPPER
1995 CYPRIPEDIUM REGINAE - SHOWY LADY'S-SLIPPER
1993 ELYMUS TRACHYCAULUS - BEARDED WHEAT GRASS
1997 EPILOBIUM STRICTUM - SIMPLE WILLOW-HERB
1978 LECHEA INTERMEDIA - ROUND-FRUITED PINWEED
1960 LILIUM PHILADELPHICUM - WOOD-LILY
1960 LUZULA BULBOSA - SOUTHERN WOODRUSH
1993 MELANTHIUM VIRGINICUM - BUNCHFLOWER
1980 MENYANTHES TRIFOLIATA - BUCKBEAN
1980 MYRIOPHYLLUM SIBIRICUM - AMERICAN WATER-MILFOIL

1990 PANICUM BOREALE - NORTHERN PANIC-GRASS
1950 PANICUM PHILADELPHICUM - PHILADELPHIA PANIC-GRASS
1990 POA PALUDIGENA - MARSH SPEAR-GRASS
1991 POGONIA OPHIOGLOSSOIDES - ROSE POGONIA
1985 POLYGONUM CILINODE - MOUNTAIN BINDWEED
1984 TOFIELDIA GLUTINOSA - FALSE ASPHODEL
1966 UTRICULARIA INTERMEDIA - FLAT-LEAVED BLADDERWORT
1996 VACCINIUM OXYCOCCOS - SMALL CRANBERRY
1985 VIBURNUM OPULUS VAR. AMERICANUM - HIGHBUSH-CRANBERRY
1988 WOLFFIELLA FLORIDANA - WOLFFIELLA

STATUS: POTENTIALLY THREATENED (P)

1996 BETULA POPULIFOLIA - GRAY BIRCH
1995 CALLA PALUSTRIS - WILD CALLA
1994 CALOPOGON TUBEROSUS - GRASS-PINK
1989 CAREX ALATA - BROAD-WINGED SEDGE
1996 CAREX ATLANTICA VAR. CAPILLACEA - HOWE'S SEDGE
1995 CAREX BEBBII - BEBB'S SEDGE
1988 CAREX CRAWEI - CRAWE'S SEDGE
1994 CAREX CRYPTOLEPIS - LITTLE YELLOW SEDGE
1977 CAREX DEBILIS VAR. DEBILIS - WEAK SEDGE
1990 CAREX DIANDRA - LESSER PANICLED SEDGE
1995 CAREX FLAVA - YELLOW SEDGE
1995 CAREX LASIOCARPA - SLENDER SEDGE
1979 CAREX RADIATA - RADIATE SEDGE
1990 CAREX SARTWELLII - SARTWELL'S SEDGE
1992 CAREX STERILIS - FEN SEDGE
1994 CAREX STRAMINEA - STRAW SEDGE
1995 CAREX UTRICULATA - BEAKED SEDGE
1980 CASTANEA DENTATA - AMERICAN CHESTNUT
1996 CHAMAEDAPHNE CALYCULATA - LEATHER-LEAF
1991 CLADIUM MARISCOIDES - TWIG-RUSH
1993 CORALLORHIZA MACULATA - SPOTTED CORAL-ROOT
1986 CORYDALIS SEMPERVIRENS - ROCK-HARLEQUIN
1988 CYPERUS DIANDRUS - LOW UMBRELLA-SEDGE
1991 DANTHONIA COMPRESSA - FLATTENED WILD OAT GRASS
1995 DESCHAMPSIA FLEXUOSA - CRINKLED HAIRGRASS
1995 DROSERA ROTUNDIFOLIA - ROUND-LEAVED SUNDEW
1988 ELEOCHARIS INTERMEDIA - MATTED SPIKERUSH
1988 ELEOCHARIS OLIVACEA - OLIVACEOUS SPIKERUSH
1993 EQUISETUM VARIEGATUM - VARIEGATED SCOURING-RUSH
1991 ERIOPHORUM VIRGINICUM - TAWNY COTTONGRASS
1995 ERIOPHORUM VIRIDICARINATUM - GREEN COTTONGRASS
1993 GENTIANA CLAUSA - CLOSED GENTIAN
1973 GENTIANOPSIS PROCERA - SMALL FRINGED GENTIAN
1996 GEUM RIVALE - WATER AVENS
1965 GLYCERIA GRANDIS - TALL MANNA-GRASS
1985 HYDROCOTYLE AMERICANA - AMERICAN WATER-PENNYWORT
1996 HYPERICUM MAJUS - TALL ST. JOHN'S-WORT
1996 JUGLANS CINEREA - BUTTERNUT
1993 JUNCUS BALTICUS - BALTIC RUSH
1996 LARIX LARICINA - TAMARACK
1985 LECHEA PULCHELLA - LEGGETT'S PINWEED
1996 NEMOPANTHUS MUCRONATUS - CATBERRY
1966 PANICUM COLUMBIANUM - AMERICAN PANIC-GRASS
1979 PHEGOPTERIS CONNECTILIS - LONG BEECH-FERN

1995 PLATANTHERA CLAVELLATA - GREEN WOODLAND ORCHID
1960 PLATANTHERA FLAVA - TUBERCLED REIN-ORCHID
1985 PLATANTHERA ORBICULATA - LARGE ROUND-LEAVED ORCHID
1955 POA LANGUIDA - WEAK SPEAR-GRASS
1990 POTAMOGETON NATANS - FLOATING PONDWEED
1988 POTAMOGETON RICHARDSONII - RICHARDSON'S PONDWEED
1988 POTAMOGETON ZOSTERIFORMIS - FLAT-STEM PONDWEED
1989 POTENTILLA PALUSTRIS - MARSH FIVEFINGER
1983 PRENANTHES RACEMOSA - PRAIRIE RATTLESNAKE-ROOT
1993 PYCNANTHEMUM MUTICUM - BLUNT MOUNTAIN-MINT
1985 RHEXIA VIRGINICA - VIRGINIA MEADOW-BEAUTY
1995 RHODODENDRON NUDIFLORUM VAR. ROSEUM - NORTHERN ROSE AZALEA
1996 RHYNCHOSPORA ALBA - WHITE BEAK-RUSH
1994 SALIX CANDIDA - HOARY WILLOW
1994 SALIX MYRICOIDES - BLUE-LEAVED WILLOW
1996 SALIX SERISSIMA - AUTUMN WILLOW
1995 SARRACENIA PURPUREA - PITCHER-PLANT
1969 SCLERIA VERTICILLATA - LOW NUT-RUSH
1980 SOLIDAGO OHIOENSIS - OHIO GOLDENROD
1995 SPARGANIUM ANDROCLADUM - KEELED BUR-REED
1993 SPHENOPHOLIS PENSYLVANICA - SWAMP-OATS
1996 TRIGLOCHIN PALUSTRE - MARSH ARROW-GRASS
1995 VACCINIUM MACROCARPON - LARGE CRANBERRY
1978 VIBURNUM ALNIFOLIUM - HOBBLEBUSH
1993 VITIS LABRUSCA - NORTHERN FOX GRAPE
1996 WOODWARDIA VIRGINICA - VIRGINIA CHAIN-FERN
1996 ZIGADENUS ELEGANS VAR. GLAUCUS - WAND-LILY

STATUS: PRESUMED EXTIRPATED (X)

1996 SPARGANIUM CHLOROCARPUM - SMALL BUR-REED

STATUS: NOT ASSIGNED (A)

1978 LYCOPODIELLA MARGUERITAE - NORTHERN PROSTRATE CLUBMOSS
1995 TOMENTYPNUM NITENS - FUZZY HYPNUM MOSS

Natural Areas Home Page
Heritage Map

OHIO NATURAL HERITAGE DATA BASE
TRUMBULL COUNTY
RARE PLANT SPECIES (1996-97 STATUS LIST)
(YEAR=MOST RECENT RECORD)

STATUS: ENDANGERED (E)
1960 CAREX CEPHALOIDEA - THIN-LEAF SEDGE
1987 ISOETES ENGELMANNII - APPALACHIAN QUILLWORT
1971 POTAMOGETON SPIRILLUS - SPIRAL PONDWEED
STATUS: THREATENED (T)
1971 CALLITRICHE VERNA - WATER-STARWORT
1990 CAREX ALBOLUTESCENS - PALE STRAW SEDGE
1989 CAREX LUPULIFORMIS - FALSE HOP SEDGE
1987 CAREX PALLESCENS - PALE SEDGE
1987 CLINTONIA UMBELLULATA - SPECKLED WOOD-LILY
1987 DRYOPTERIS CLINTONIANA - CLINTON'S WOOD FERN
1987 EPILOBIUM STRICTUM - SIMPLE WILLOW-HERB
1975 EQUISETUM SYLVATICUM - WOODLAND HORSETAIL
1984 LATHYRUS OCHROLEUCUS - YELLOW VETCHLING
1995 VACCINIUM MYRTILLOIDES - VELVET-LEAF BLUEBERRY
1995 VIBURNUM OPULUS VAR. AMERICANUM - HIGHBUSH-CRANBERRY
STATUS: POTENTIALLY THREATENED (P)
1996 BETULA POPULIFOLIA - GRAY BIRCH
1995 CAREX DEBILIS VAR. DEBILIS - WEAK SEDGE
1990 CAREX RADIATA - RADIATE SEDGE
1995 CAREX STRAMINEA - STRAW SEDGE
1996 DANTHONIA COMPRESSA - FLATTENED WILD OAT GRASS
1995 FRAXINUS TOMENTOSA - PUMPKIN ASH
1986 GENTIANA CLAUSA - CLOSED GENTIAN
1987 HYPERICUM MAJUS - TALL ST. JOHN'S-WORT
1994 JUGLANS CINEREA - BUTTERNUT
1955 LARIX LARICINA - TAMARACK
1987 LILIUM SUPERBUM - TURK'S-CAP LILY
1957 NEMOPANTHUS MUCRONATUS - CATBERRY
1960 PHEGOPTERIS CONNECTILIS - LONG BEECH-FERN
1995 POPULUS HETEROPHYLLA - SWAMP COTTONWOOD
1996 PYCNANTHEMUM MUTICUM - BLUNT MOUNTAIN-MINT
1995 RHODODENDRON NUDIFLORUM VAR. ROSEUM - NORTHERN ROSE AZALEA
1995 UTRICULARIA MINOR - LESSER BLADDERWORT
1989 VIBURNUM ALNIFOLIUM - HOBBLEBUSH
1995 WOODWARDIA VIRGINICA - VIRGINIA CHAIN-FERN

Natural Areas Home Page
Heritage Map

TABLE K-3

APPENDIX TABLE K-3. VASCULAR PLANT FLORA

VASCULAR PLANT FLORA

METHODS

Botanical surveys were conducted at the Ravenna Arsenal from April 22 to October 21, 1993. The site was visited 1-2 times per week during this period. Most of the ground within the Arsenal was surveyed at some time during the year. Representatives of each plant community type were revisited on a regular basis throughout the field season. In addition, all significant wetlands, such as ponds, meadows, and marshes, were surveyed in late summer for aquatic and wetland species. The following sites were each surveyed several times throughout the growing season:

1. The boggy depression along the North Patrol Road between Wadsworth and Paris-Windham Roads.

2. The Wadsworth Glen.

3. The scalped, wet field on the southwest side of B&O Wye Road, south of the South Service Road.

4. The wet meadows and ponds along the North Patrol Road across the entire northern perimeter of the Arsenal.

5. Eagle Creek and adjacent forests.

6. The swamp forest with buttonbush swamps south of the North Service Road.

7. Stream bottom behind ponded area associated with the impoundment on Eagle Creek just west of Wadsworth Glen.

8. The old hatchery ponds adjacent to Route 80 north of Newton Falls Road.

9. Criggy's Pond.

The results of the botanical survey are included in the annotated species list which follows this section. The species nomenclature is based on Gleason and Cronquist (1991). The relative abundance for each species is estimated as: Abundant for species which occurred in large numbers at many locations; common for species which were regularly encountered, but not in large numbers; occasional for species which were seen in several places but never occurred in large quantities; rare for species which were only seen in a few places and in small numbers. The habitat where the species usually occurs in the Arsenal is also provided. In addition, the locations where the more rare or unusual species grow are given in detail. In the case of species which are not native to the region, reference is made to the plant being an alien, or an introduced species.

RESULTS

RARE AND ENDANGERED SPECIES

Twelve species from the Arsenal are listed as rare by the Division of Natural Areas and Preserves (1992).

Betula populifolia (Grey birch)	P
Carex annectens var. *xanthocarpa* (Yellow-fruited sedge)	P
Drosera rotundifolia (Round-leaved sundew)	P
Equisetum sylvaticum (Woodland horsetail)	T
Gentiana clausa (Closed gentian)	P
Juglans cinerea (Butternut)	P
Pycnanthemum muticum (Blunt mountain-mint)	P
Rhododendron prinophyllum (Northern rose azalea)	P
Vaccinium macrocarpon (Large cranberry)	P
Viburnum alnifolium (Hobblebush)	P
Vitis labrusca (Fox grape)	P
Wolffia papulifera (Pointed water-meal)	P

One of these species is considered threatened (T) in Ohio, whereas eleven are potentially threatened (P). None of these species is common in the Arsenal and most are confined to one or at most two sites (see figure 1). The locations and habitats for these species within the Arsenal are provided in the annotated species list at the end of this section. No plant community in the Arsenal contains a large number of the rare species, rather the rare plants are scattered around the Arsenal, though mostly in the eastern half.

The largest number of rare species occurs in an unnatural, disturbed area in the southeastern corner of the Arsenal along the south side of B&O Wye Road. This area consists of a scalped field, some of which is permanently saturated. The sterile soil conditions create an acidic substrate in which *Sphagnum* moss is prolific. The round-leaved sundew is abundant on these *Sphagnum* hummocks. The large cranberry and the blunt mountain-mint also occur in this field. The cranberry is confined to one dense colony of about 3 X 30 feet. The mountain-mint is abundant in this field and also occurs along the edge of Criggy's Pond. The northern rose azalea occurs in small numbers on the south side of a bog-like depression adjacent to the North Patrol Road between Wadsworth and Paris-Windham Roads. Hobblebush occurs on hemlock slopes in Wadsworth Glen. The other state listed species occur in rather ordinary plant communities. Pointed water-meal grows in Criggy's Pond. Woodland horsetail grows in the Beech-Maple forest northwest of the intersection of Blackberry Road and the North Patrol Road. The grey birch is located on the south facing ridge overlooking the quarry lake on the north side of the Arsenal opposite Wadsworth Glen. Yellow-fruited sedge occurred in a dry roadside meadow along Greenleaf Road about one mile north of Newton Falls Road. Closed gentian was found near the small roadside dam and impoundment adjacent to the North Service Road to the west of Wadsworth Glen. Butternut occurs on the edge of Eagle Creek about 100 meters east of its intersection with Paris-Windham Road. Two populations of fox grape occur in the Arsenal. One in the beaver flooded area on Sand Creek just south of Smalley Road about 1500 feet east of Paris-

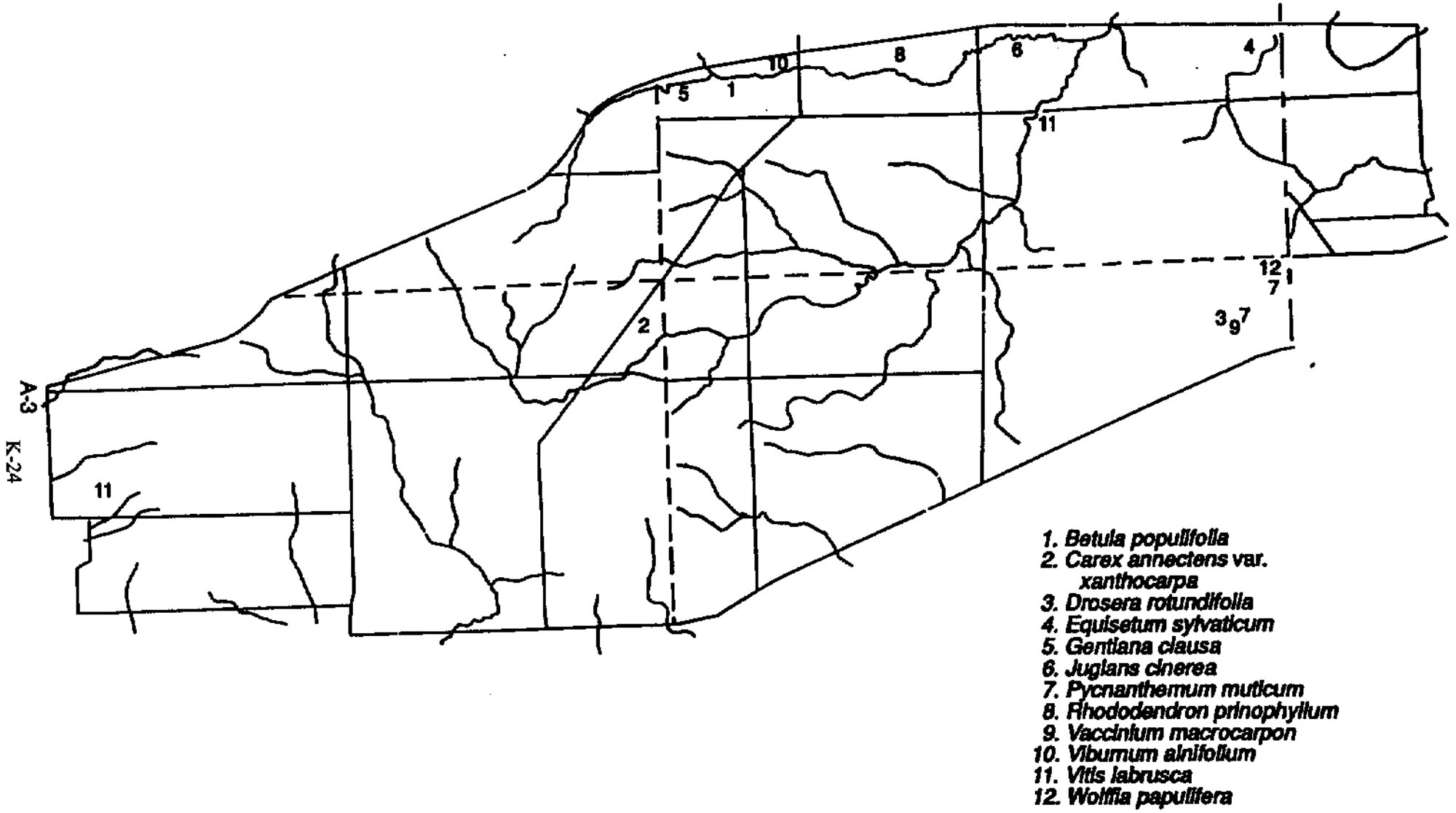

Figure 1. Locations of state listed vascular plant species, Ravenna Arsenal.

Windham Road. The second population occurs in dry soil along the abandoned YardRoad 300 feet north of its junction with McCormick Road.

NATIVE PLANT DIVERSITY

521 species of plants were recorded within the Ravenna Arsenal. This represents 39.6 % of the 1315 species of vascular known from Portage County (Andreas 1980). 410 of these species are native to northeastern Ohio. Much of the native plant diversity of the Arsenal occurs in wetlands. Many of the better wetlands occur in the northeastern part of the Arsenal along the North Service Road. The forested areas also contain significant numbers of native plants. However, when compared with similar habitats throughout northeastern Ohio, the forested areas in the Arsenal have small populations and relatively low species diversity of Spring ephemeral plants. The number of deer seen throughout the area was extremely high. In many case, the only representatives of a plant species found in the Arsenal were in small, steep ravines which deer could not penetrate. Based on the known pattern of deer overgrazing at other enclosed sites where deer take refuge, it is safe to conclude that the deer are responsible for decimating much of the Spring wildflower population. This overgrazing may represent a serious long-term problem for the forests in the Arsenal. After many consecutive seasons of near complete grazing of all seedlings, the seed bank of native wildflowers may become depleted. Only plants which are unpalatable to deer, such as sedges (*Carex spp.*), Jack-in-the-pulpit (*Arisaema triphyllum*), New York fern (*Dryopteris noveboracensis*) and a few others will persist. It may take decades for a seedbank to regenerate once it has been severely depleted.

NON-NATIVE SPECIES

Many species are not native to Ohio. These species often occur on disturbed ground along roads, railways, in open fields and around buildings. Some non-native species are extremely abundant in the Ravenna Arsenal: chicory (*Cichorium intybus*), wild carrot (*Daucus carota*), common St.John's-wort (*Hypericum perforatum*), white sweet-clover (*Melilotus alba*), English plantain (*Plantago lanceolata*), and ox-eye daisy (*Chrysanthemum leucanthemum*). These species do not usually pose a threat to native plant communities because they occur primarily on open disturbed ground. However, some weedy species do invade intact plant communities and may replace native plants. Several weedy species are considered to be a major threat to natural plant communities in Ohio. Fortunately, some of these species, such as garlic mustard (*Alliaria petiolata*), purple loosestrife, (*Lythrum salicaria*) and amur honeysuckle (*Lonicera maackii*) were not located in the Arsenal. Other serious pest species such as European buckthorn (*Rhamnus frangula*), Hungarian brome grass (*Bromus inermis*), Japanese barberry (*Berberis thunbergii*), Russian olive (*Elaeagnus angustifolia*), Japanese honeysuckle (*Lonicera japonica*), Eurasian water-milfoil (*Myriophyllum spicatum*), Morrow's honeysuckle (*Lonicera morrowii*), and multiflora rose (*Rosa multiflora*) do occur in the Arsenal but are not yet common. A few non-native species are well-established in otherwise intact communities, but do not usually pose a serious threat. These species include ground-ivy (*Glechoma hederacea*), moneywort (*Lysimachia numularia*), eutrophic water-nymph (*Najas minor*), long-bristled smartweed (*Polygonum cespitosum*), lady's-thumb (*Polygonum persicaria*), self-heal (*Prunella vulgaris*) and narrow-leaved cattail (*Typha angustifolia*).

Some non-native species were intentionally planted in the arsenal. These introduced species include trees, shrubs and some herbaceous plants which are still persisting at some of the old homestead sites, along roadsides, in old orchards, or timber plantations. These species are not likely to spread from their current sites. Some of these species include: northern catalpa (*Catalpa speciosa*), lily of the valley (*Convallaria majalis*), forsythia (*Forsythia sp.*), osage-orange (*Maclura pomifera*), Norway spruce (*Picea abies*), Scots pine (*Pinus sylvestris*), apple (*Pyrus malus*), spirea (*Spirea prunifolia*), lilac (*Syringa vulgaris*) and bald cypress (*Taxodium distichum*).

The flora of the Ravenna Arsenal is characterized by a relatively low number of non-native species. A total of 521 plant species was recorded at the Arsenal, of which 410 are native species and 111 are non-native (11 of these were intentionally planted). The 19.6% of the flora in the Arsenal which is comprised of self-perpetuating non-natives species is somewhat lower than the 23.8% which has been calculated for Ohio as a whole (Stuckey and Barkley 1993). The more natural communities in the Arsenal such as forests and wetlands have very few of the serious weedy pests that occur commonly in similar habitats elsewhere in Ohio. The fact that the Arsenal has fewer weedy species, despite the abundance of open disturbed habitats, may be explained by the minimal amount of human traffic in and out of as well as within the site during the past 50 years.

RECOMMENDATIONS

1. It is crucial that the deer population in the Arsenal be maintained at a substantially lower level. The deer are decimating the woodland herbaceous flora.

2. The areas with rare plants species and mature plant communities should be preserved. The entire area between the northern perimeter of the Arsenal and Smalley Road from Wadsworth Glen to the Portage-Trumbull County line has a significant diversity of plant species and mature plant communities. This area represents one of the largest contiguous tracts of mature forest in northeastern Ohio. It should be left undisturbed.

3. The wet meadows along the North Patrol Road east of Paris-Windham Road contain a high diversity of wetland plants. These meadows appear to be mowed regularly. They should be mowed less frequently, perhaps just once a year in the Fall. It is, however, important to mow them at least once a year to prevent them from converting to woodlands.

4. The scalped fields in the southeastern corner of the Arsenal along the south side of B&O Wye Road also contains a diverse array of plants uncommon elsewhere in the Arsenal, as well as three state listed species. This area should be left undisturbed.

5. Alien species often pose a threat to natural communities. While the communities in the Arsenal are currently free of most of the more aggressive weeds, periodic surveys should be made to monitor any influx of new weeds or increase in those already present.

6. No alien species should be planted in the Arsenal, whether for wildlife, ground cover, or any other reason.

LITERATURE CITED

Andreas, B.K. 1980. The flora of Portage, Stark, Summit and Wayne Counties, Ohio. Ph.D. Dissertation, Kent State University, Kent, OH. 680 pp.

Gleason, H.A. and A. Cronquist. 1991. Manual of Vascular Plants of Northeastern United States and Canada. The New York Botanical Garden, Bronx, New York. 910 pp.

Ohio Division of Natural Areas and Preserves. 1992. Rare native Ohio plants: 1991-92 status list. Ohio Department of Natural Resources, Columbus, Ohio. 19 pp.

Stuckey, R.L. and T.M. Barkley. 1993. Weeds. In Flora of North America, Vol. 1. Oxford, Oxford University Press.

ANNOTATED VASCULAR PLANT SPECIES LIST FOR THE RAVENNA ARSENAL, PORTAGE AND TRUMBULL COUNTIES, OHIO.

Abutilon theophrastii (Velvet-leaf) Alien species occasional in old agricultural fields on north side of Newton Falls Road, west of Slagle Road.

Acalypha rhomboidea (Three-seeded mercury) Weedy species occasional on railroad grades.

Acer negundo (Boxelder) Occasional along streams.

Acer nigrum (Black maple) Occasional throughout the arsenal. A row of large, trees, almost certainly an old fencerow planting, is evident along Newton Falls Road on the far western side of the arsenal.

Acer rubrum (Red maple) A co-dominant species in the Oak-Maple swamp forests that occur throughout much of the arsenal.

Acer saccharinum (Silver maple) Occasional in wet to mesic woods.

Acer saccharum (Sugar maple) A co-dominant species in the Beech-Maple forests throughout the arsenal.

Acer spicatum (Mountain maple) Occasional in the Wadsworth Glen.

Achillea millefolium (Yarrow) Weedy species abundant along roadsides and in fields.

Acorus calamus (Sweet flag) Occasionally found in open, wet ditches along the north and west perimeter.

Actaea alba (White baneberry) Occasional along stream terraces.

Agalinis tenuifolia (Common agalinis) Occasional in wet, open fields.

Agrimonia gryposepala (Common agrimonia) Common in moist woods.

Agrimonia parviflora (Southern agrimonia) Very abundant in open, wet fields, ditches and marshes.

Agrimonia pubescens (Downy agrimonia) Common in moist woods.

Agrostis gigantea (Red-top) Alien grass common in dry, open fields.

Ailanthus altissima (Tree of heaven) Weedy, introduced tree growing on forest edge along the south patrol road on the western side of the arsenal.

Alisma subcordatum (Southern water-plantain) Common on mudflats and in emergent marshes.

Allium canadense (Wild onion) Common in mesic woods.

Allium tricoccum (Wild leek) Occasional in mesic woods.

Alnus incana (Speckled alder) Occasional in wet thickets.

Ambrosia artemisiifolia (Common ragweed) Abundant in open fields, along roadsides and along the sides of buildings.

Amelanchier arborea (Downy serviceberry) Commonly scattered in Beech-maple woods. Flowers evident in early May before trees leaf out.

Anagallis arvensis (Pimpernel) Alien species occasional on disturbed ground.

Andropogon virginicus (Broom-sedge) Abundant in open fields and roadsides.

Anenome quinquefolia (Wood anenome) Rare in mesic woods. This is one of several normally common spring wildflowers which are apparently rare in the arsenal.

Antennaria neglecta (Field pussytoes) Common in dry open fields.

Antennaria plantaginifolia (Plantain pussytoes) Common in dry, open field west of B&O Wye Road, south of junction of this road and South Service Road.

Anthoxanthum odoratum (Sweet vernal grass) Alien species common in dry open fields.

Apocynum androsaemifolium (Spreading dogbane) Occasional in mesic forest.

Apocynum cannabinum (Hemp-dogbane) Common in open, wet areas such as fields and marshes.

Aquilegia vulgaris (European columbine) Alien species found near old homestead on Newton Falls Road at west end of arsenal.

Arisaema dracontium (Green dragon) Occasional in floodplain of Eagle Creek and lower reaches of Sand Creek.

Arisaema triphyllum (Jack-in-the-pulpit) Very abundant in mesic woods throughout.

Aristida oligantha (Prairie three-awn grass) Occasional in dry, open field west of B&O Wye Road, south of junction of this road and South Service Road.

Aronia melanocarpa (Chokeberry) This species of wet shrub thickets was found in the bog adjacent to the North Patrol Road between Wadsworth and Paris-Windham Roads and in a Button-bush swamp east of Paris-Windham Road.

Artemesia ludoviciana (Western mugwort) One small clump of this alien species was located along the North Patrol Road east of Paris-Windham Road.

Asarum canadense (Wild ginger) This common spring wildflower was present in the arsenal in mesic woods. However, it was considerably more scarce than one would expect in this habitat.

Asclepias incarnata (Swamp milkweed) Common in open wetlands and ditches throughout.

Asclepias syriaca (Common milkweed) Occasional in dry open fields.

Asclepias tuberosa (Butterfly-weed) Occasional in dry, open ground.

Asimina triloba (Pawpaw) Occasional in mesic woods.

Asparagus officinalis (Asparagus) This escaped vegetable occurs sporadically in open fields.

Aster cordifolius (Common blue heart-leaved aster) Occasional in mesic woods.

Aster lateriflorus (Goblet aster) Abundant in dry, open fields and roadsides.

Aster novae-angliae (New England aster) This common late-flowering species is abundant in fields and forest edges throughout.

Aster pilosus (Awl-aster) Abundant in old fields and on roadsides.

Aster prenanthoides (Zig-zag aster) Occasional in woods and woodland edges.

Aster puniceus (Purple-stemmed aster) Occasional in wetlands and wet ditches.

Aster racemosus (Small-headed aster) Abundant in open fields and in mesic woods.

Aster umbellatus (Tall flat-topped white aster) Extremely abundant along forest edges.

Athyrium filix-femina (Lady fern) Occasional in wet to mesic woods.

Athyrium thelypteroides (Silvery glade fern) Occasional in wet to mesic woods.

Barbarea vulgaris (Yellow rocket) Alien species abundant in open fields in early spring.

Berberis thunbergii (Japanese barberry) Alien shrub persisting at old homesteads.

Betula pendula (European white birch) Introduced tree occurring along the north service road.

Betula populifolia (Grey birch) **Ohio Potentially Threatened Species.** One population of about six small trees occurs on south facing ridge overlooking the quarry lake on the north side of the Arsenal opposite Wadsworth Glen.

Bidens cernua (Nodding beggar-ticks) Occurs on exposed mudflats in September-October.

Bidens connata (Purple-stemmed beggar-ticks) Occasional in open, wet areas and

streambanks.

Bidens coronata (Ozark tickseed-sunflower) Very common in open wet fields and roadsides.

Bidens frondosa (Devil's beggar-ticks) Common in wetlands and streambanks.

Blephilia ciliata (Wood mint) Occasional in woods and forest edges.

Blephilia hirsuta (Downy wood-mint) Occasional in woods and forest edges.

Boehmeria cylindrica (False nettle) Common in wet shaded situation such as floodplain forests.

Brassica nigra (Black mustard) Alien species occasional in fields and roadsides.

Bromus inermis (Hungarian brome grass) Alien grass often planted for grazing. Occasional in fields and roadsides in the arsenal.

Callitriche heterophylla (Water starwort) Occasional in ponds.

Caltha palustris (Marsh marigold) Abundant in swamp forests.

Calystegia sepium (Bindweed) Occasional in fields.

Campanula americana (American bellflower) Occasional along forest edges.

Cardamine concatenata (Cut-leaved toothwort) This common spring wildflower was present in the arsenal in mesic woods. However, it was considerably more scarce than one would expect in this habitat.

Cardamine diphyllum (Broad-leaved toothwort) Rare. This species was collected in two places in the vicinity of Wadkins Glen.

Cardamine douglassii (Purple spring-cress) Common growing with *Caltha palustris* and *Symplocarpus foetidus* in swamp forests.

Cardamine pennsylvanica (Pennsylvania bitter-cress) Occasional in the floodplain of Eagle Creek.

Cardamine rhomboidea (Bulbous bitter-cress) Common in swamp forests.

Carex albicans Abundant in dry to mesic woods.

Carex amphibola Common in wet woods.

Carex annectens var. *annectens* Common in fields and roadsides.

Carex annectens var. *xanthocarpa* **Ohio Potentially Threatened Species.** Rare in dry roadside meadow along Greenleaf Road about one mile north of Newton Falls Road.

Carex atlantica ssp. *atlantica* Common in bog adjacent to the North Patrol Road between Wadsworth and Paris-Windham Roads.

Carex blanda Common in dry to mesic woods.

Carex bromoides Very abundant in large tussocks in swamp forests with *Caltha palustris* and *Symplocarpus foetidus*

Carex canescens Common in bog adjacent to the North Patrol Road between Wadsworth and Paris-Windham Roads.

Carex communis Common in dry to mesic woods.

Carex comosa Common in marshes and roadside depressions.

Carex complanata Abundant in dry, disturbed areas.

Carex crinita Abundant in swamp forests.

Carex cristatella Common in marshes and roadside wetlands.

Carex emoryi This species occurs in dense stands in wet swales along the North Patrol Road east of Paris-Windham Road.

Carex festucacea Common in dry, open fields.

Carex frankii (Frank's sedge) Rare. This species was seen in a wet, disturbed area adjacent to Sand Creek.

Carex gracilescens Common in mesic woods.

Carex gracillima Abundant in wooded wetlands, often associated with streams.

Carex granulares Occasional in open wet ditches.

Carex grayii (Gray's sedge) Common in swamp forests.

Carex hyalinolepis Dominant species in sedge meadow along the North Patrol Road east of Gordon's pond.

Carex hystericina (Porcupine sedge) Common in wet roadside swales along the North Patrol Road for about 200 meters east of Paris-Windham Road.

Carex interior (Inland sedge) Rare. A small population was discovered in a wetland at the base of a hillside adjacent to the North Patrol Road about 3/4 of a mile east of Smalley

Road.

Carex intumescens Occasional in swamp forests.

Carex lacustris Dominant sedge in small sedge meadow surrounded by woods near the west entrance to Blackberry Lane.

Carex laevivaginata Occasional in open sedge meadows.

Carex laxiculmis Occasional in mesic woods

Carex lupulina Common in forested wetlands.

Carex lurida Common in wet roadside ditches, and along the edges of marshes and ponds.

Carex normalis Common in sedge meadows, marshes and roadside ditches.

Carex pedunculata Rare. Several plants were observed growing on dry hummocks in the mesic woods south of the North Patrol Road about halfway between Wadsworth and Paris-Windham Roads.

Carex pennsylvanica Common on drier hummocks in mesic woods.

Carex plantaginea One population of 15-20 plants was observed growing in mud on the southwest side of the impoundment at the Wadsworth Glen.

Carex prasina Occasional in wooded wetlands, often associated with streams.

Carex rosea Abundant in forested wetlands.

Carex scoparia Abundant in sedge meadows and wet, roadside ditches.

Carex seorsa Abundant in forested wetlands.

Carex sparganioides Scattered populations occur in wet to mesic woods.

Carex stipata Common in spring-fed sedge meadows and roadside ditches.

Carex stricta Rare. One small clump was observed adjacent to the large beaver flooding in the northeast corner of the arsenal.

Carex swanii Occasional in wet to mesic woods.

Carex tenera Occasional in sedge meadows and wet ditches.

Carex torta Abundant, growing in large swales in and on the edges of streams. This species is especially abundant in Eagle Creek.

Carex tribuloides Common species in sedge meadows and roadside ditches.

Carex vulpinoidea Very common species is wet ditches and roadsides.

Carpinus caroliniana (Musclewood) Occasional along streams.

Carya cordiformis (Bitternut hickory) Rare in wet to mesic woods.

Carya glabra (Pignut hickory) Occasional in mesic forests.

Carya ovata (Shag-bark hickory) Occasional in mesic woods.

Castanea dentata (Chestnut) Root sprouts from dead trees are seen on rare occasions.

Catalpa speciosa (Northern catalpa) Catalpa is not native to Ohio. Several trees occur in the Arsenal on old homesteads.

Caulophyllum thalictroides (Blue cohosh) Rare. Small populations were seen in protected areas along Eagle Creek.

Centarium pulchellum (Branching centarium) Alien species occasional on disturbed ground.

Cephalanthus occidentalis (Buttonbush) Dominant species in buttonbush swamps, which mostly occur in small pockets within forested wetlands.

Cerastium vulgatum (Mouse-ear chickweed) Alien species occasional on open, disturbed ground.

Ceratophyllum demersum (Coontail) Dominant species in several ponds. When this species fills entire ponds, as is the case in Snow Road and Criggs ponds, it is usually a sign of eutrophication.

Chaenorrhinum minus (Lesser toadflax) Alien species occasional on disturbed ground.

Chelone glabra (Turtle-head) Occasional along the margins of streams and ponds.

Chimaphila maculata (Spotted wintergreen) Occasional in wet to mesic woods.

Chrysanthemum leucanthemum (Ox-eye daisy) Alien species abundant along roadsides and in fields where the topsoil has been removed. This alien species is favored by mowing.

Chrysoplenium americanum (Golden saxifrage) This species was observed growing in dense mats in the shallow water of a small tributary stream on the west side of Greenleaf Road about 1 mile north of Newton Fall Road.

Cichorium intybus (Chicory) Extremely abundant species of roadsides and disturbed ground. This alien species is favored by mowing.

Cicuta maculata (Water-hemlock) Occasional in marshes and roadside ditches.

Cimicifuga racemosa (Black snakeroot) Occasional on stream terraces.

Cinna arundinacea (Common wood-reed) This grass is abundant in forested swamps.

Circaea lutetiana (Common enchanter's nightshade) Rare in wet to mesic woods

Cirsium arvense (Canada thistle) Alien species common along roadsides and on disturbed ground.

Cirsium muticum (Swamp-thistle) This species occurs on wet open ground along the North Patrol Road east of Wadsworth Road.

Cirsium vulgare (Bull thistle) Alien species occasional along roadsides.

Claytonia virginica (Spring-beauties) This usually ubiquitous spring wildflower is surprisingly rare throughout the Arsenal. This species may be heavily impacted by deer grazing.

Clematis virginiana (Virgin's bower) This vining species was observed along the North Patrol Road at the east end of the Arsenal.

Conopholis americana (Squaw-root) Occasional as a parasite on Oak.

Convallaria majalis (Lily of the valley) This species occurs as a garden escapee along roadsides. It is especially abundant along Greenleaf Road north of Newton Falls Road.

Convolvulus arvensis (Field-bindweed) Alien species occasional in open fields.

Conyza canadensis (Horseweed) Occasional on disturbed ground.

Cornus amomum (Silky dogwood) Abundant shrub in wet thickets.

Cornus florida (Flowering dogwood) Occasional as an understory tree in Beech-Maple forests.

Cornus racemosa (Northern swamp-dogwood) This species commonly forms large clumps in wet, open fields and in thickets.

Cornus stolonifera (Red-osier dogwood) Rare in open, wet situations.

Coronilla varia (Crown-vetch) Alien species abundant in large mats along roadsides. Often planted as ground cover.

Crataegus sp. (Hawthorn) Numerous species of Hawthorns, which are barely distinguishable, occur in the Arsenal. They typically occur in dry, open fields.

Cuscuta glomerata (Rope-dodder) This species commonly grows in dense, twinning masses

in wet areas while parasitizing other plants.

Cyperus bipartitus (Umbrella-sedge) This species was observed growing in a gravelly, dried up creek bed near the North Patrol Road.

Cyperus erythrorhizos (Red-rooted spike-rush) One large population of this species was discovered in a muddy opening in the swamp forest south of the North Patrol Road between Paris-Windham and Snow Roads.

Cyperus esculentes (Yellow nut-grass) Common on disturbed ground.

Cyperus strigosus (False nutsedge) Abundant in wet fields and ditches.

Dactylis glomerata (Orchard grass) Alien species occasional along roadsides and woodland edges.

Daucus carota (Wild carrot) This alien species is extremely abundant along roadsides an on disturbed ground. It is favored by mowing.

Desmodium paniculatum (Panicled tick-trefoil) Abundant in disturbed fields and roadsides.

Dianthus armeria (Deptford-pink) Alien species occasional in disturbed fields and roadsides.

Dicentra canadensis (Squirrel-corn) Rare. This species was seen in the sheltered ravine of a small tributary of Eagle Creek in the Wadsworth Glen area. This species has probably been decimated by deer grazing.

Dipsacus sylvestris (Teasel) Alien species common in old fields and roadsides.

✓ *Drosera rotundifolia* (Round-leaved sundew) **Ohio Potentially Threatened Species.** Large population of several hundred plants found growing on sphagnum hummocks in wet field with topsoil removed on west side of B&O Wye Road, south of junction of this road and South Service Road.

Dryopteris carthusiana (Toothed wood-fern) Occasional in mesic woods.

Dryopteris cristata (Crested wood-fern) Occasional in mesic woods.

Dryopteris intermedia (Fancy wood-fern) Occasional in mesic woods.

Dryopteris marginalis (Marginal wood-fern) Occasional in mesic woods.

Dryopteris noveboracensis (New York fern) Extremely abundant in mesic woods.

Echinochloa muricata (Barn-yard grass) Abundant in wet fields and ditches.

Echium vulgare (Blue-weed) Alien species occasional in disturbed ground.

Elaeagnus sp. (Russian olive) Alien species common in early successional fields.

Eleocharis ovata (Blunt spike-rush) Common on exposed mudflats.

Eleocharis palustris (Red-footed spike-rush) Common in marshes and wet roadsides.

Elodea canadensis (Waterweed) Submersed species occasional in ponds and slow-moving streams.

Elymus canadensis (Canada wild-rye) Occasional in wet fields and meadows.

Elymus hystrix (Bottle-brush grass) Common in mesic woods.

Elymus virginicus (Virginia wild-rye) Occasional along stream banks and in ditches.

Elytrigia repens (Quack-grass) Alien species in dry fields.

Epifagus virginiana (Beech-drops) Occasional as a parasite on the roots of beech trees.

Epilobium ciliatum (American willow-herb) Occasional on the edge of ponds and in marshes.

Epilobium coloratum (Eastern willow-herb) Occasional on the edge of ponds and in marshes.

Equisetum arvense (Field horsetail) Growing in large colonies along railroad beds.

Equisetum hyamale (Scouring-rush) Occasional in marshes and in wet ditches.

Equisetum sylvaticum (Woodland horsetail) **Ohio Threatened Species.** Rare in mesic woods northwest of the intersection of Blackberry Road and the North Patrol Road.

Eragrostis frankii (Frank's love-grass) Occasional in dry to mesic woods.

Erechtites hieracifolia (Fireweed) Occasional in marshes and wet roadsides.

Erigeron annuus (Annual fleabane) Common on open, dry disturbed ground.

Erigeron philidelphicus (Philadelphia fleabane) Common on open, dry disturbed ground.

Erigeron strigosus (Daisy fleabane) Common on open, dry disturbed ground.

Erythronium americanum (Yellow trout-lily) Common on stream terraces.

Euonymus obovatus (Running strawberry bush) Occasional in moist woods.

Eupatorium altissimum (Tall boneset) Occasional in open fields and roadsides.

Eupatorium fistulosum (Purple joe-pie-weed) Occasional along forest edges.

Eupatorium maculatum (Spotted joe-pie-weed) Rare. One population was observed in a wet swale along Greenleaf Road north of Newton Falls Road.

Eupatorium perfoliatum (Boneset) Abundant in wet sedge meadows, marshes and ditches.

Eupatorium rugosum (White snakeroot) Occasional in wet woods and along streambanks.

Euphorbia maculata (Milk-purslane) Alien species common on gravel roadsides and highly disturbed ground.

Euphorbia nutans (Eyebane) Alien species occasional on disturbed ground.4

Euthamia graminifolia (Grass-leaved goldenrod) Common in moist to wet fields.

Fagus grandifolia (Beech) Abundant. This tree is a major co-dominant species in the Beech-maple forest.

Floerkea proserpinacoides (False mermaid-weed) Occasional on stream terraces.

Forsythia sp. (Forsythia) This ornamental shrub persists at some old homestead sites.

Fragaria virginiana (Strawberry) Abundant along roadsides. This species is favored by mowing.

Fraxinus americana (White ash) Occasional tree in mesic to dry woods.

Fraxinus pennsylvanica (Red ash) Occasional tree in wet to mesic woods.

Galium aparine (Cleavers) Abundant in somewhat shaded wet meadows and roadside wetlands.

Galium asprellum (Rough bedstraw) Occasional in wet woods and in the bog adjacent to the North Service Road between Wadsworth and Paris-Windham Roads.

Galium tinctorium (Southern three-lobed bedstraw) Occasional in wet to mesic woods.

Galium triflorum (Sweet-scented bedstraw) Occasional in wet to mesic woods.

Gaultheria procumbens (Wintergreen) Occasional in wet to mesic woods.

✓ *Gentiana clausa* (Closed gentian) **Ohio Potentially Threatened Species.** One small population of about eight plants was seen in August near the small roadside dam and impoundment adjacent to the North Service Road to the west of Wadsworth Glen. However, two weeks later all by one plant had been grazed, presumably by deer.

Geranium maculatum (Large-flowered geranium) Rare. This species which is often common in similar habitats in the region was very scarce in the Arsenal. This is another of the Spring ephemeral species which have apparently been reduced by deer grazing.

Geum canadense (White avens) Occasional in mesic woods.

Geum laciniatum (Rough avens) Occasional in marshes and wet ditches.

Glechoma hederacea (Gill-over-the-ground) Alien species common in many habitats.

Gleditsia tricanthos (Honey-locust) Occasional along roadsides and stream bottoms.

Glyceria septentrionalis (Eastern mannagrass) Occasional in wet woods and in partially shaded wet ditches.

Glyceria striata (Fowl manna-grass) Common in marshes and wet ditches.

Gnaphalium obtusifolium (Fragrant cudweed) Occasional in dry, open fields.

Hamamelis virginiana (Witch-hazel) This species was somewhat rare in the Arsenal. One large population was noted growing on a dry ridge over-looking the large quarry lake south of the North Patrol Road.

Hedeoma pulegioides (American pennyroyal) Occasional along stream bottoms.

Hedyotis caerulea (Bluets) Common in open disturbed ground.

Helenium autumnale (Common sneezeweed) Occasional in wet ditches and thickets.

Helenium flexulosum (Southern sneezeweed) Common along roadsides.

Helianthus decapetalus (Forest sunflower) One population of about 20 plants in a gravelly, dried up creek bed behind the impoundment south of the North Patrol Road and west of Wadkins Glen.

Helianthus tuberosus (Jerusalem artichoke) Occasional along streams.

Heliopsis helianthoides (Ox-eye sunflower) Occasional along streambanks and roadsides.

Hemerocallis fulva (Day-lily) This species occurs as a garden escapee along roadsides.

Hesperis matronalis (Dame's rocket) This alien species occurs as a garden escapee along roadsides.

Hieracium auranticum (Orange Hawkweed) Alien species abundant in dry, open fields and roadsides.

Hieracium floribundum (Glaucus hawkweed) Alien species abundant in dry, open fields and roadsides.

Holcus lanatus (Velvet grass) Alien species abundant in dry, open fields and roadsides.

Hordeum jubatum (Squirrel-tail barley) Occasional along roadsides and in open fields. This species was introduced into Ohio from the west.

Hypericum mutilum (Dwarf St.John's-wort) Common in wet ditches.

Hypericum perforatum (Common St.John's-wort) Alien species extremely abundant along roadsides and on disturbed ground.

Hypericum prolificum (Shrubby St.John's-wort) Occasional in open, moist fields.

Hypericum punctatum (Spotted St.John's-wort) Occasional in marshes and ditches.

Ilex verticillata (Winterberry) This species was observed growing in a small buttonbush swamp amidst a swamp forest south of the North Patrol Road between Paris-Windham and Snow Roads and in the bog adjacent to the North Patrol Road between Wadsworth and Paris-Windham Roads.

Impatiens capensis (Jewelweed) This species, which is usually abundant in moist woods, is relatively rare in the Arsenal. It is apparently favored by deer.

Inula helenium (Elecampane) A small population (about 20 plants) of this alien species, which is often used in gardens, occurs on the south-west side of the intersection of Greenleaf and Fuze Booster Roads.

Iris pseudacorus (Yellow flag) Alien species occasional in wet ditches.

Iris versicolor (Northern blue flag) Occasional in marshes and pond edges.

✓*Juglans cinerea* (Butternut) **Ohio Potentially Threatened Species.** Four trees occur on the edge of Eagle Creek about 100 meters east of its intersection with Paris-Windham Road.

Juglans nigra (Black walnut) Occasional in mesic woods.

Juncus acuminatus (Acuminate rush) Occasional on wet, open ground.

Juncus articulatus (Jointed rush) Occasional on wet, open ground.

Juncus canadensis (Canada rush) Rare on wet, open ground.

Juncus dudleyi (Dudley's rush) Common in wet, open fields and roadside ditches.

Juncus effusus (Soft rush) Abundant on the edges of ponds and marshes and in wet ditches.

Juncus marginatus (Grassleaf rush) Occasional on wet, open ground.

Juncus tenuis (Path rush) Common on dry, disturbed ground.

Juncus torreyi (Torrey's rush) Abundant on the edges of ponds and marshes and in wet ditches.

Laportea canadensis (Wood nettle) Abundant in wet to mesic woods.

Lathyrus latifolius (Everlasting pea) This ornamental species has persisted from cultivation at several locations along roadsides.

Leersia oryzoides (Rice cut-grass) Abundant in dense colonies in marshes.

Leersia virginica (White grass) Common in swales in wet woods.

Lemna minor (Lesser duckweed) Extremely abundant floating plant, often covering the entire surface of ponds.

Lepidium campestre (Field-cress) Alien species occasional along roadsides.

Lepidium densiflorum (Pepper-grass) Abundant in disturbed gant, especially along gravelly roadsides.

Linaria vulgaris (Butter and eggs) Alien species occasional along roadsides.

Lindera benzoin (Spice-bush) Common understory shrub in mesic woods.

Linum virginianum (Virginia yellow flax) Occasional in dry, open fields.

Liriodendron tulipifera (Tulip tree) Common in mesic woods.

Lobelia cardinalis (Cardinal flower) Occasional in wet woods and roadside ditches.

Lobelia inflata (Indian tobacco) Common in stream bottoms and other moist habitats.

Lobelia siphilitica (Blue lobelia) Occasional in open, wet habitats.

Lolium perenne (Perennial rye-grass) Alien grass occasional in dry, open fields and roadsides.

Lonicera dioica (Wild honeysuckle) Occasional in wet woods.

Lonicera japonica (Japanese honeysuckle) Alien species which is often a very abundant pest. This species is rare in the Arsenal.

Lonicera morrowii (Morrow's honeysuckle) Alien species rare along roadsides.

Lotus corniculatus (Bird's-foot trefoil) Alien species, occasional in old fields and roadsides. One very large, dense population occurs in the hay field along Paris-Windham Road.

Ludwigia alternifolia (Square-pod water-purslane) Occasional in marshes and sedge

meadows.

Ludwigia palustris (Common water-purslane) Abundant on mudflats.

Luzula multiflora (Wood-rush) Common in dry to mesic woods.

Lycopodium complanatum (Ground-pine) Occasional in dry soil in Wadsworth Glen.

Lycopodium dendrooideum (Ground-pine) Occasional in well drained woods.

Lycopodium digitatum (Ground pine) Occasional in well drained woods.

Lycopodium inundatum (Bog clubmoss) Rare. This species was found growing in wet, sterile soil in open field on west side of Blowie Road, south of junction of this road and South Service Road.

Lycopodium lucidulum (Shining clubmoss) Occasional on rocks in the Wadsworth Glen.

Lycopus americanus (American water-horehound) Occasional in marshes and wet ditches.

Lycopus virginicus (Bugleweed) Occasional along streams.

Lysimachia ciliata (Fringed loosestrife) Occasional in wet ditches and roadsides.

Lysimachia numularia (Moneywort) Alien species abundant on mudflats and in shallow pools.

Lysimachia quadrifolia (Whorled loosestrife) Rare along forest edges.

Lysimachia terrestris (Swamp candles) Rare in wet meadow along the North Patrol Road.

Maclura pomifera (Osage-orange) Introduced tree occasional along roadsides.

Magnolia acuminata (Cucumber-tree) Rare in mesic woods.

Maianthemum canadense (Canada mayflower) Abundant under hemlocks in Wadsworth Glen. Also scattered in other wooded habitats.

Medicago lupulina (Black medic) Alien species occasional as roadside weed.

Melilotus alba (White sweet-clover) Alien species common in dry, open fields and roadsides.

Melilotus officinalis (Yellow sweet-clover) Alien species occasional along roadsides.

Mentha arvensis (Field mint) Common in open, wet habitats.

Mentha piperita (Peppermint) Alien species occasional as roadside weed.

Mentha spicata (Spearmint) Alien species occasional as roadside weed.

Milium effusum (Wood-millet) Occasional in wet woods.

Mimulus alatus (Sharp-winged monkey-flower) Occasional on wet, shaded ground adjacent to streams.

Mimulus ringens (Monkey flower) Common in open, wet fields, marshes and pond edges.

Mitchella repens (Partridge-berry) Abundant under hemlocks in Wadsworth Glen. Occasional in woods elsewhere.

Mitella diphylla (Miterwort) Rare on sandstone ledges along Eagle Creek.

Morus alba (White mulberry) Alien species occasional throughout the arsenal.

Myosotis scorploides (Water scorpion-grass) Alien species common on wet, open ground.

Myriophyllum spicatum (Eurasian water-milfoil) Alien, submersed species occurs in one of the settling ponds northeast of the junction of Greenleaf and Fuze Booster Roads.

Najas minor (Eutrophic water-nymph) Alien, submersed species common in ponds.

Nuphar advena (Spatterdock) Floating-leaved to emergent species abundant in ponds and marshes.

Nymphaea odorata (White water-lily) Floating-leaved species rare in ponds.

Nyssa sylvatica (Black gum) Occasional tree in mesic to wet woods.

Oenothera biennis (Evening primrose) Common along roadsides.

Oenothera fruticosa (Southern sundrops) Common along roadsides and forest edges.

Onoclea sensibilis (Sensitive fern) Abundant in swamp forests.

Osmunda cinnamomea (Cinnamon fern) Occasional in wet woods.

Osmunda claytoniana (Interrupted fern) Rare in wet woods.

Osmunda regalis (Royal fern) Occasional in wet woods and common in the bog adjacent to the North Patrol Road between Wadsworth and Paris-Windham Roads.

Ostrya virginiana (Hop-hornbeam) Occasional tree in mesic woods.

Oxalis stricta (Common yellow wood-sorrel) Alien species occasional in open, disturbed ground and roadsides.

Panax trifolium (Dwarf ginseng) Rare in moist to wet woods.

Panicum capillare (Witch-grass) Occasional in wet ditches and around the edges of abandoned buildings.

Panicum clandestinum Abundant in large colonies in partial shaded wet swales.

Panicum lanuginosum (Panic grass) Abundant along dry roadsides and in open fields.

Parthenocissus quinquefolia (Virginia creeper) Abundant vine in mesic woods.

Pastinaca sativa (Wild parsnip) Alien species occasional as roadside weed.

Penstemon digitalis (Foxglove beardstongue) Common in open fields.

Penthorum sedoides (Ditch-stonecrop) Common in wet swales and marshes.

Phalaris arundinacea (Reed-canary grass) Common, often in very large stands in wet meadows.

Phleum pratense (Timothy) Alien species often planted for hay common along roadsides and dry fields.

Phlox divaricata (Wild blue phlox) Rare. This species which is often common in similar habitats in the region was very scarce in the Arsenal. This is another of the Spring ephemeral species which have apparently been reduced by deer grazing.

Phlox paniculata (Summer phlox) One plant was seen near an old homestead where it has probably persisted from cultivation.

Phragmites australis (Giant reed grass) This species occurs in 2-3 large swales.

Picea abies (Norway spruce) This commonly planted European tree occurs throughout the Arsenal.

Pilea pumila (Clearweed) Occasional in shaded, wet areas.

Pinus nigra (Austrian pine) European tree occasionally planted throughout the Arsenal.

Pinus strobus (White pine) Occasional as planted tree throughout the Arsenal. Also occurs in a large plantation on the southeastern side of the Arsenal along the small road which straddles the Portage-Trumbull County line.

Pinus sylvestris (Scots pine) Several very large trees of this popular ornamental species occur in rows near old homesteads.

Plantago lanceolata (English plantain) Alien species abundant on disturbed ground and mowed areas.

Plantago rugelii (Broad-leaved plantain) Alien species abundant on disturbed ground and

mowed areas.

Platanthera lacera (Ragged fringed orchid) One plant seen in open field on National Guard Training Grounds.

Platanus occidentalis (Sycamore) Occasional along streams.

Poa cuspidata (Woodland bluegrass) Abundant in mesic woods.

Podophyllum peltatum (May-apple) Occasional in mesic woods; this is another species which appears to be more rare in the Arsenal than in similar habitats elsewhere in the region.

Polygala sanguinea (Field milkwort) Common in open fields.

Polygala verticillata (Whorled milkwort) Rare. This species occurs in disturbed ground in the field on the west side of B&O Wye Road, south of junction of this road and South service Road.

Polygonum amphibium (Water smartweed) Common in shallow water and on mudflats.

Polygonum arifolium (Halberd-leaved tearthumb) Rare in shaded, wet thickets.

Polygonum aviculare (Dooryard weed) Alien species occasional on disturbed ground.

Polygonum cespitosum (Long-bristled smartweed) Alien species occasional on mudflat along streams.

Polygonum hydropiper (Water-pepper) Alien species rare on mudflats.

Polygonum hydropiperoides (False water-pepper) Common in very shallow water and on mudflats.

Polygonum lapathifolium (Nodding smartweed) Occasional on the margins of ponds and marshes.

Polygonum pensylvanicum (Pennsylvania smartweed) Occasional on the margins of ponds and marshes.

Polygonum persicaria (Lady's-thumb) Alien species common on moist, disturbed ground.

Polygonum punctatum (Dotted smartweed) Common in wet meadows and along stream margins.

Polygonum sagittatum (Arrow-leaved tearthumb) Common in partially shaded wet thickets and swales.

Polygonum scandens (False buckwheat) One population seen in a gravelly, dried up creek

bed behind an impoundment south of the North Patrol Road and west of Wadkins Glen.

Polygonum virginianum (Jumpseed) Occasional in wet to mesic woods.

Polystichum acrostichoides (Christmas fern) Abundant in mesic woods.

Pontederia cordata (Pickerel-weed) One population seen in one of the Hatchery ponds near the northwest corner of Newton Falls Road and Route 80.

Populus deltoides (Cottonwood) Abundant throughout in a variety of habitats.

Populus grandidentata (Big-toothed aspen) Occasional in early successional habitats.

Populus tremuloides (Quaking aspen) Abundant throughout in a variety of habitats, often as an early successional tree of old fields and roadsides.

Potamogeton diversifolius (Diverse-leaved Pondweed) Rooted, floating-leaved species occurs in several ponds.

Potamogeton epihydrus (Ribbon-leaved pondweed) Rooted, floating leaved-species occurs in several ponds.

Potamogeton foliosus (Leafy pondweed) Submersed species occurs in several ponds.

Potamogeton nodosus (Longleaf pondweed) Rooted, floating-leaved species occurs in several ponds.

Potamogeton pectinatus (Sago pondweed) Submersed species occurs in several ponds.

Potentilla norvegica (Strawberry-weed) Common in open fields.

Potentilla recta (Sulfur five-fingers) Alien species abundant along roadsides.

Potentilla simplex (Old-field five-fingers) Common in open fields.

Prunella vulgaris (Self-heal) Alien species occasional in open fields.

Prunus serotina (Wild blackcherry) Common tree in the Beech-Maple forest.

Prunus virginiana (Chokecherry) Occasional small, shrubby tree in mesic woods and along roadsides.

Pteridium aquilinum (Bracken fern) Occasional in dry to mesic woods.

✓ *Pycnanthemum muticum* (Blunt mountain-mint) **Ohio Potentially Threatened Species.** Grows in several open fields in the southeastern corner of the Arsenal.

Pycnanthemum tenuifolium (Narrow-leaved mountain-mint) Abundant in open fields throughout.

Pycnanthemum virginianum (Virginia mountain-mint) Abundant in open fields throughout.

Pyrus coronaria (Sweet crab) Occasional in fields and along roadsides

Pyrus malus (Apple) A large grove indicating the probable location of a past orchard occurs along the North Service Road west of Slagle Road.

Quercus alba (White oak) Occasional in dry to mesic forests.

Quercus bicolor (Swamp white oak) Abundant in swamp forests.

Quercus macrocarpa (Bur oak) Occasional along roadsides and in mesic forests.

Quercus palustris (Pin oak) Dominant species in most of the swamp forests in the Arsenal.

Quercus rubra (Red oak) Abundant in wet to mesic woods.

Ranunculus abortivis (Kidney-leaved crowfoot) Common in wet woods and stream terraces.

Ranunculus acris (Meadow buttercup) Alien species abundant in open fields and roadsides.

Ranunculus hispidus (Hispid buttercup) Occasional in mesic woods.

Ranunculus recurvatus (Hooked crowfoot) Common in wet woods and stream terraces.

Ranunculus repens (Creeping buttercup) Alien species occasional along roadsides.

Ranunculus septentrionalis (Swamp buttercup) Occasional along stream terraces.

Rhamnus frangula (European buckthorn) Alien species occasional in the bog adjacent to the North Patrol Road between Wadsworth and Paris-Windham Roads.

Rhododendron prinophyllum (Northern rose azalea) **Ohio Potentially Threatened Species.** Rare on the south side of the bog adjacent to the North Patrol Road between Wadsworth and Paris-Windham Roads.

Rhus typhina (Staghorn sumac) Occasional along roadsides.

Ribes cynobati (Gooseberry) Occasional in mesic woods.

Robinia pseudoacacia (Black locust) Abundant tree along roadsides and forest edges.

Rorippa palustris (Common yellow-cress) Occasional on mudflats.

Rosa canina (Dog rose) Alien species occasional in dry fields.

Rosa multiflora (Multiflora rose) Alien species occasional in dry fields.

Rosa palustris (Swamp rose) Common in wet thickets.

Rosa setigera (Prairie climbing-rose) Common in dry fields.

Rubus alleghenlensis (Blackberry) Abundant in woods and along woodland edges.

Rubus flagellaris (Northern dewberry) Abundant in woods and along woodland edges.

Rubus hispidus (Swamp dewberry) Abundant in woods and along woodland edges.

Rubus idaeus (Red raspberry) Abundant in woods and along woodland edges.

Rubus occidentalis (Black raspberry) Abundant in woods and along woodland edges.

Rudbeckia fulgida (Eastern coneflower) Occasional in roadside swales.

Rudbeckia hirta (Black-eyed susan) Common in open fields and roadsides.

Rudbeckia laciniata (Green-headed coneflower) Occasional along streams and in ditches.

Rumex acetosella (Sheep-sorrel) Alien species occasional in open fields.

Rumex crispus (Curly dock) Alien species abundant in disturbed ground

Sagittaria latifolia (Broad-leaved arrowhead) Common in marshes and along pond edges.

Salix alba (White willow) This non-native tree grows occasionally in the Arsenal.

Salix amygdaloides (Peach-leaf willow) Occasional in wet thickets.

Salix discolor (Pussy willow) Occasional in wet thickets.

Salix eriocephala (Diamond willow) Abundant in marshes and roadside ditches.

Salix exigua (Sandbar willow) Occasional in wet thickets.

Salix lucida (Shining willow) Occasional in wet thickets.

Salix nigra (Black willow) Occasional in floodplain forests.

Salix sericea (Silky willow) Occasional in wet thickets.

Sambucus canadensis (Common elderberry) Occasional in thickets along the edge of wet areas.

Sambucus racemosa (Red-berried elder) Occasional in thickets along the edge of wet areas.

Sanguinaria canadensis (Bloodroot) Occasional in mesic woods. This species, which is usually abundant in mesic woods, is relatively rare in the Arsenal.

Saponaria officinalis (Soapwort) Alien species occasional along roadsides where it often persists as a cultivar.

Sassafras albidum (Sassafras) Small tree common in Beech-maple forests.

Scirpus atrovirens (Dark-green bulrush) Common in marshes and roadside ditches.

Scirpus cyperinus (Wool-grass) Abundant in wet swales and roadside ditches.

Scirpus hattorlensis (Bulrush) Common in roadside ditches.

Scirpus pendulus (Nodding bulrush) Abundant in wet, open fields and ditches.

Scirpus polyphyllus (Woodland bulrush) Common in moist woods, especially along streams.

Scirpus validus (Soft-stemmed bulrush) Common in marshes and pond edges.

Scutellaria galericulata (Marsh skullcap) Common along the edges of marshes and ponds.

Scutellaria lateriflora (Mad-dog skullcap) Common in wet meadows and along streams.

Sedum ternatum (Stonecrop) Occasional on exposed rock, especially common in Wadsworth Glen.

Senecio aureus (Heart-leaved ragwort) Occasional in shaded, moist situations, especially along stream terraces.

Senecio vulgaris (Common groundsel) Alien species occasional on disturbed ground.

Setaria faberi (Nodding foxtail grass) Alien species common in dry, open fields, especially abundant in old agricultural fields.

Setaria glauca (Yellow foxtail grass) Alien species common on disturbed ground.

Setaria viridis (Green foxtail grass) Alien species common on disturbed ground.

Sisyrinchium angustifolium (Blue-eyed grass) Common in open fields.

Sium suave (Water-parsnip) Occasional in marshes and roadside ditches.

Smilacina racemosa (False Solomon's-seal) This species which is often common in similar habitats in the region was very scarce in the Arsenal. This is another of the Spring ephemeral species which have apparently been reduced by deer grazing.

Smilax hispida (Bristly greenbriar) Occasional in wet to mesic woods.

Solanum carolinense (Horse-nettle) Alien species occasional on disturbed ground.

Solanum dulcamara (Bittersweet nightshade) Alien species occasional in wet thickets and ditches.

Solanum nigrum (Black nightshade) Alien species occasional on disturbed ground.

Solidago caesia (Blue-stemmed goldenrod) Occasional in mesic woods.

Solidago canadensis (Canada goldenrod) Abundant in dry, open fields.

Solidago flexicaulis (Zigzag goldenrod) Occasional in mesic woods.

Solidago gigantea (Tall goldenrod) Common in moist fields.

Solidago juncea (Early goldenrod) Abundant in dry, open fields.

Solidago nemoralis (Gray goldenrod) Abundant in dry, open fields, especially common on disturbed ground.

Solidago patula (Rough-leaved goldenrod) Occasional in wet meadows.

Solidago rugosa (Wrinkle-leaved goldenrod) Common in moist, partially shaded habitats.

Sonchus oleraceus (Common sow-thistle) Alien species occasional as roadside weed.

Sparganium americanum (American bur-reed) Abundant along the margins of marshes and ponds.

Sparganium eurycarpum (Giant bur-reed) Abundant along the margins of marshes and ponds.

Spiranthes cernua (Nodding ladies' tresses) Occasional in open, moist ground, especially abundant in the wet meadow with topsoil removed on west side of B&O Wye Road, south of junction of this road and South Service Road.

Spiranthes tuberosa (Little ladies' tresses) Rare in sterile soil in the wet meadow with topsoil removed on west side of B&O Wye Road, south of junction of this road and South Service Road.

Spirea alba (Meadowsweet) Abundant along roadsides and in open fields.

Spirea prunifolia (Spirea) Ornamental shrub occasionally persisting at old homestead sites.

Spirea tomentosa (Steeplebush) Abundant along roadsides and in open fields.

Spirodela polyrhiza (Greater duckweed) Floating plant, often mixed with *Lemna minor* on the surface of ponds.

Stellaria graminea (Common stichwort) Alien species occasional on disturbed ground.

Symplocarpus foetidus (Skunk-cabbage) Abundant, often forming dense colonies in swamp forests.

Syringa vulgaris (Lilac) Ornamental shrub occasionally persisting at old homestead sites.

Taraxacum officinale (Dandelion) Alien species occasional along roadsides and on disturbed ground.

Taxodium distichum (Bald cypress) Species of swamps in the southeastern U.S. planted along the edge of Snow Pond and in the bog adjacent to the North Patrol Road between Wadsworth and Paris-Windham Roads.

Teucrium canadense (American germander) Occasional in wet, open habitats.

Thelypteris palustris (Marsh fern) Occasional in wet, open meadows.

Tiarella cordifolia (Foam-flower) Infrequent along Eagle Creek in the vicinity of Wadsworth Glen.

Tilia americana (Basswood) Occasional tree in Beech-Maple woods.

Toxicodendron radicans (Poison ivy) Abundant in wet to mesic woods.

Toxicodendron vernix (Poison sumac) Common in the bog adjacent to the North Patrol Road between Wadsworth and Paris-Windham Roads.

Triadenum virginianum (Marsh St.John's-wort) Common in the bog adjacent to the North Patrol Road between Wadsworth and Paris-Windham Roads.

Tridens flavus (Grease grass) Abundant along roadsides.

Trientalis borealis (Starflower) Occasional in wet meadow near Sand Creek and west of Paris-Windham Road.

Trifolium aureum (Palmate hop-clover) Alien species abundant along roadsides and on disturbed ground.

Trifolium hybridum (Alsike clover) Alien species abundant along roadsides and on disturbed ground.

Trifolium pratense (Red clover) Alien species abundant along roadsides and on disturbed ground.

Trifolium repens (White clover) Alien species abundant along roadsides and on disturbed ground.

Trillium erectum (Purple trillium) This species was discovered growing in a small ravine in the Wadsworth Glen. This was the only population of any species of *Trillium* found in the Arsenal. *Trillium* is known to be highly susceptible to deer grazing.

Tsuga canadensis (Eastern hemlock) Dominant species in much of Wadsworth Glen.

Tussilago farfara (Coltsfoot) Alien species common along roadsides.

Typha angustifolia (Narrow-leaved cattail) Alien species abundant along the edges of ponds and marshes, also common in wet meadows. This species of cattail often forms dense stands on wet, disturbed ground.

Typha latifolia (Broad-leaved cattail) Abundant along the edges of ponds and marshes, also common in wet meadows and ditches.

Ulmus americanus (American elm) Occasional along streams.

Ulmus rubra (Slippery elm) Occasional along streams.

Urtica dioica (Common nettle) Occasional on disturbed, open ground.

Utricularia gibba (Humped bladderwort) Abundant on floating mats in spring-fed pond southeast of the intersection of George and Newton Falls Roads.

Utricularia vulgaris (Common bladderwort) Common in several shallow ponds and ditches.

Uvularia sessilifolia (Bellwort) Rare. One population was found along a stream terrace in the National Guard training grounds east of the arsenal.

Vaccinium corymbosum (Highbush blueberry) Common in open fields and in the bog adjacent to the North Patrol Road between Wadsworth and Paris-Windham Roads.

√*Vaccinium macrocarpon* (Large cranberry) **Ohio Potentially Threatened Species.** This species occurs in an open field with topsoil removed on west side of B&O Wye Road, south of junction of this road and South Service Road.

Vaccinium pallidum (Hillside blueberry) Occasion in the northeast corner of the Arsenal

Vaccinium stamineum (Deerberry) Occasional in the Pin Oak swamp forests.

Verbascum blatteria (Moth-mullein) Alien species abundant along roadsides.

Verbascum thapsus (Common mullein) Alien species occasional along roadsides and on disturbed ground.

Verbena hastata (Blue vervain) Common in wet, open meadows and ditches.

Verbena urticifolia (White vervain) Occasional in moist, open fields.

Verbesina alternifolia (Wingstem) Abundant in moist woods, especially along streams.

Vernonia gigantea (Tall ironweed) Common in dry, open fields and roadsides.

Veronica officinalis (Common speedwell) Alien species occasional on disturbed ground.

Veronica perigrina (Purslane speedwell) Alien species occasional on disturbed ground.

Viburnum acerifolium (Maple-leaved viburnum) Common in mesic woods.

Viburnum alnifolium (Hobblebush) Occasional in the Wadsworth Glen.

Viburnum dentatum (Arrow-wood) Abundant in wet fields and thickets.

Viburnum opulus var. *opulus* (Guelder-rose) Allen shrub, often used as ornamental. Occasional along roadsides.

Vinca minor (Periwinkle) Allen species abundant along Eagle Creek.

Viola blanda (Sweet white violet) Occasional on stream terraces.

Viola cucullata (Blue marsh-violet) Abundant in wet woods.

Viola hastata (Spear-leaved violet) Abundant in dry to mesic woods.

Viola rotundifolia (Round-leaved yellow violet) Occasional in mesic woods.

Viola sororia (Common blue violet) Abundant in mesic woods and on disturbed open ground.

Viola striata (Creamy violet) Abundant in mesic woods.

Vitis aestivalis (Summer grape) Abundant along roadsides and woodland edges.

Vitis labrusca (Fox grape) **Ohio Potentially Threatened Species.** Two populations occur in the Arsenal. One in the beaver flooded area along Sand Creek just south of Smalley Road and about 1500 feet east of Paris-Windham Road. The second population occurs in dry soil along the abandoned Yard Road 300 feet north of its junction with McCormick Road.

Wisteria sp. (Wisteria) This ornamental shrub persists at some old homestead sites.

Wolffia columbiana (Water-meal) Common floating on the surface of ponds.

Wolffia papulifera (Pointed water-meal) **Ohio Potentially Threatened Species.** Occasional floating on the surface Criggy's pond.

TABLE K-4

APPENDIX TABLE K-4. MAMMALS

Ravenna Army Ammunition Plant

Additions to Mammals Inventory

30 April 1996

In addition to the species identified in this inventory the following species are also known to exist at the RVAAP.

1. Gray Squirrel, Sciurus carolinensis
2. Red Squirrel, Tamiasciurus hudsonicus
3. Southern Flying Squirrel, Glaucomys volans
4. House Mouse, Mus musculus
5. Gray Fox, Urocyon cinereoargenteus

MAMMALS

INTRODUCTION

Mammal surveys at the Ravenna Arsenal were conducted with the primary goal of identifying the terrestrial species inhabiting the area and assessing the status of those species determined to be present. While the inventory of small mammals in Ohio has lagged behind other plant and animal inventories in the state in more recent years, sufficient work has been done by past investigators so that the general distributions of the smaller mammals are known.

Important early studies in northeast Ohio by B. P. Bole of the Cleveland Museum of Natural History in the 1930's provide the data for much of our knowledge of the mammals in this area of the state (Bole 1932, Bole and Moulthrop 1942). A series of inventories in southwestern Ohio by Goodpaster (1941) and Gottschang (1965) coupled with surveys in southeastern Ohio by Reynolds (1939) provide the basis for our knowledge of southern Ohio mammals. A variety of other local studies can be added to these broader based studies. Much of the data from these and other studies of Ohio mammals has been synthesized by Gottschang (1981) in "A guide to the mammals of Ohio".

Of the 54 species of mammals currently residing in Ohio (Gottschang 1981), 46 have state ranges encompassing northeastern Ohio where this study is located. Flenniken (1961) listed a total of 27 species of mammals known for Portage County based on museum records and the literature available to him at the time of his report. Gottschang (1981) had museum and literature records for 30 species for Portage County, but this total didn't include some of the larger species such as fox, mink, or deer which don't often end up as study skins in a museum collection.

METHODS AND MATERIALS

Mammal inventories were conducted from late winter through early autumn of 1993. Early winter studies involved tracking surveys the few times enough snow was present. Pine plantations around the Arsenal were also searched for owl pellets though in the end the pine plantings were mostly too small to provide roosting habitat for owls and their pellets were few and far between. From late spring on, mammals were identified and recorded using the following methods:

1. Visual sightings.

   This was the primary method employed to census the larger mammals found on the property. The date and location of individual sightings were recorded on USGS topographic maps. Sightings were usually made while driving through the area or while walking through trapping stations. On 4 occasions during the summer, night observations were possible during car drives around the Arsenal. The populations of 4 species (white-tailed deer, raccoons, woodchuck, and fox squirrel) were so high on the Arsenal grounds and individuals were encountered so frequently that individual sightings were not recorded during the study and no attempt was made to quantify their populations.

2. Indirect evidence.

Whenever possible indirect evidence was used to identify the presence of mammals. This included the use of animal tracks, scat, burrows, and lodges. This information was usually obtained while walking through trapping stations or exploring areas as possible trapping locations.

3. Trapping.

Populations of small mammals were censused directly by trapping. A variety of small mammal traps and trapping methods were employed during the course of this study. Unless otherwise indicated, the ratio of traps used at each trapping station was as follows:

Victor mouse traps	50%
Museum specials	15%
Sherman live traps	15%
Victor rat traps	18%
Trueman live traps	2%

Sherman live traps measured 3 x 3 x 10 inches in size, while the Trueman live traps were a rigid double door trap measuring 6 x 6 3/8 x 24 inches. All traps were baited with a mixture of peanut butter, bacon grease, and sunflower seeds. Syrup of ipecac (an emetic) and tabasco sauce were tried in several of the bait mixtures as a potential deterrent to the raccoons which continually set off and otherwise destroyed many of the small mammal traps. These mixtures were only partially effective.

The extensive acreage on the Arsenal made it impossible to trap every area so representative habitats were chosen as trapping stations. Rare or unique habitat types on the Arsenal such as some of the wetland communities were also sampled in an effort to catch more habitat specific species potentially present. The locations and descriptions of these trapping stations are presented in Figure 1 and Appendix A.

In the early part of the study, traps were set in transects with set distances between traps in the lines. This procedure was changed once it became obvious that raccoons were running the trap lines and tripping the majority of the traps in the process. Instead of transect lines, small clusters of many traps set close together were used. This method of numerous small clusters coupled with the bait deterrents minimized the raccoon problem but never eliminated it.

Data recorded for each individual captured included date and station number. Voucher specimens of the small mammals collected at each trapping station were preserved and donated to the Cleveland Museum of Natural History.

It was not possible to census the bat population present on the Arsenal due to time constraints and the lack of necessary equipment. Because of these limitations and the difficulty in identifying bats in flight no species could be identified. It should be noted, however, that bats could be seen flying above most open fields at dusk. The extensive woodlands, riparian corridors, and numerous buildings on the site provide abundant potential roosting sites for bats.

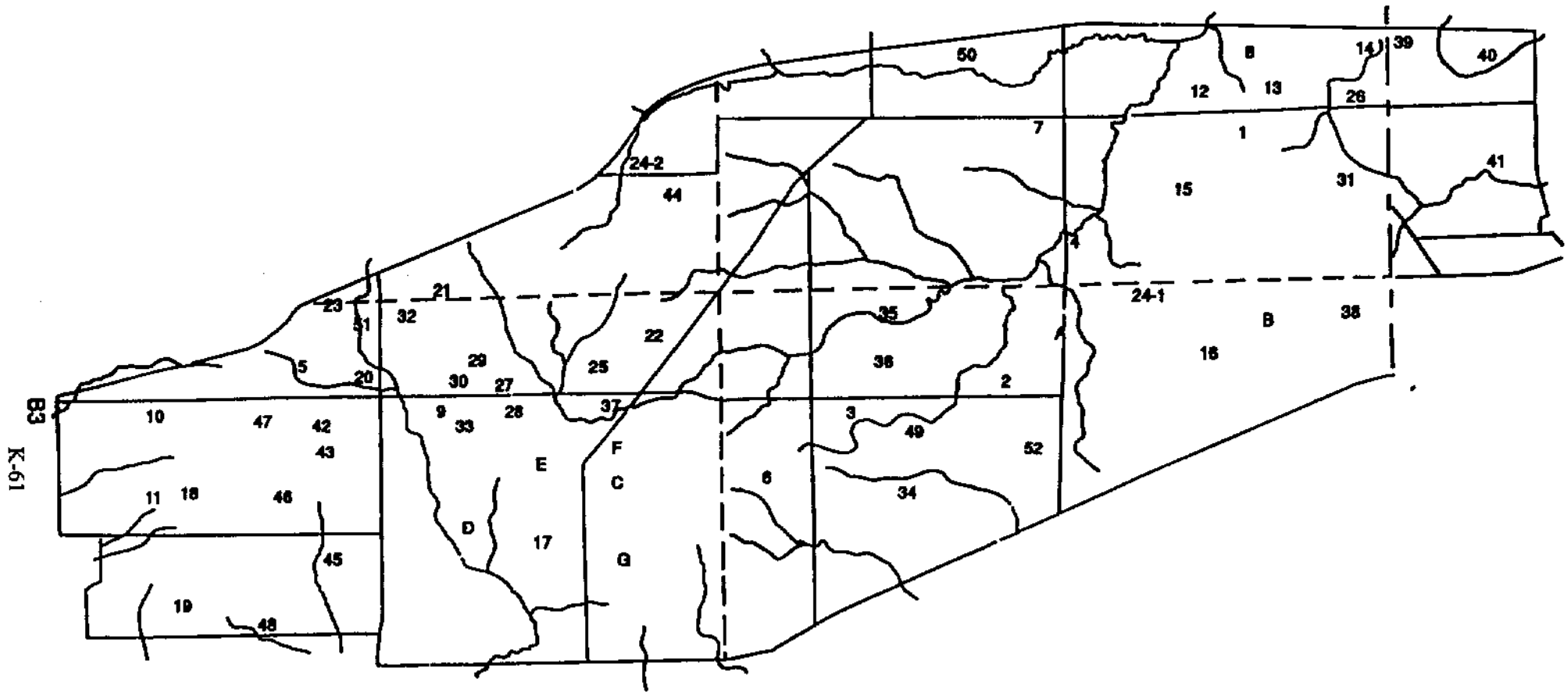

Figure 1. Locations of mammal trapping stations at the Ravenna Arsenal.

RARE AND ENDANGERED SPECIES

No federally or state listed species were recorded at the Ravenna Arsenal during these surveys. One species, the woodland jumping mouse (*Napaeozapus insignus*), which is listed as special concern for Ohio and may warrant a higher status was captured at several sites on the Arsenal. This species was first collected in Ohio in Lake County in northeastern Ohio in 1925 and was subsequently reported from several other adjacent counties in northeastern Ohio. It was also reported from 4 additional counties in eastern Ohio on the Pennsylvania and West Virginia borders prior to 1960. There have been very few reports of this species for Ohio during the last 30 years and its status in Ohio is unknown. It is primarily an inhabitant of the cool ravines and wooded gorges in eastern Ohio and its capture at the Arsenal was an unexpected but pleasant surprise. A total of 7 individuals were captured at 6 different trapping stations in the Arsenal (Figure 2) indicating the presence of a fairly widespread and healthy population.

RESULTS

The results of this survey are presented primarily in the form of an annotated list found in this section. For the surveys as a whole 21 species of mammals were documented on the Arsenal (Table 1). Of these 21 species, only 8 were captured by trapping with the other 13 species being documented either through direct observation or through indirect evidence. A total of 12,734 trap nights were expended trapping for the smaller mammals resulting in the capture of 376 individuals (see Appendix B). While these 376 individuals represented 8 different species, 3 species (short-tailed shrew, meadow vole, and white-footed mouse) accounted for 359 (95%) of the total (Table 2). Based on the results of similar types of surveys elsewhere, the length of this particular survey, and the total trapping effort expended, these results with respect to species and numbers of individuals seem far lower than might have been expected. The problems encountered with foraging raccoons setting off the traps may explain some of the observed results. It could also have been a down year for small mammal populations in general, or it may be that the small mammal populations on the Arsenal are low for other unexplained reasons.

SPECIES ACCOUNTS

Virginia Opossum, *Didelphis virginiana*

This animal represents Ohio's only marsupial. Although primarily a species of the southern states and not well equipped to handle harsh Ohio winters (as evidenced by stubby tails and missing ear tips) the opossum has done surprisingly well and is rather common statewide. The species is omnivorous feeding on a variety plant and animal matter. This species is most frequently observed at night when crossing roadways or, as frequently happens, as road kills themselves. As this species is nocturnal in its habits and of little value as a furbearer or game animal, data on population densities are usually lacking. Roadkill surveys conducted by the Ohio Division of Wildlife provide the only indices of population levels available. At Ravenna, this species was occasionally sighted though the few numbers observed offer no insight to current population levels on the property. Individuals were sighted at the intersection of Paris-Windham Road and the North Perimeter Road on 6-28-93, on Wilcox-Wayland Road 1000 feet south of Newton Falls Road on 3-29-93, on Fuze and Booster Road 1000 feet west of Newton Falls Road on 7-28-93, and on Load Line 3 Road near the South Service Road on 7-28-93. A skull and

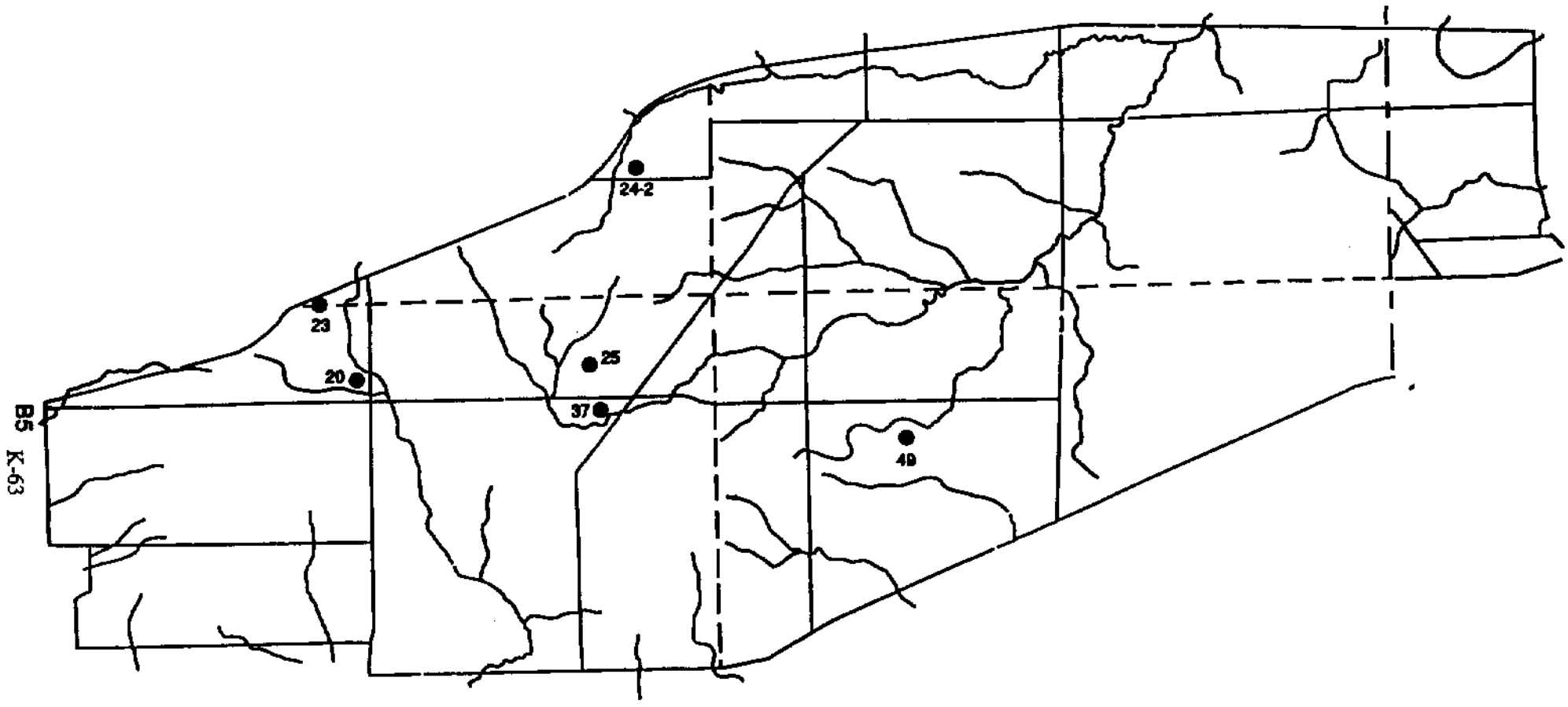

Figure 2. Distribution of Woodland Jumping Mouse at Ravenna Arsenal.

TABLE 1. A CHECKLIST OF THE MAMMALS FOUND ON THE RAVENNA ARSENAL, PORTAGE AND TRUMBULL COUNTIES, OHIO.

Virginia Opossum, *Didelphis virginiana*
Masked Shrew, *Sorex cinereus*
Short-tailed Shrew, *Blarina brevicauda*
Least Shrew, *Cryptotis parva*
Star-nosed Mole, *Condylura cristata*
Eastern Cottontail, *Sylvilagus floridanus*
Eastern Chipmunk, *Tamias striatus*
Woodchuck, *Marmota monax*
Fox Squirrel, *Sciurus niger*
Beaver, *Castor canadensis*
White-footed Mouse, *Peromyscus leucopus*
Meadow Vole, *Microtus pennsylvanicus*
MUskrat, *Ondatra zibethicus*
Southern Bog Lemming, *Synaptomys cooperi*
Woodland Jumping Mouse, *Napaeozapus insignis*
Coyote, *Canis latrans*
Red Fox, *Vulpes vulpes*
Raccoon, *Procyon lotor*
Mink, *Mustela vison*
Striped Skunk, *Mephitis mephitis*
White-tailed Deer, *Odocoileus virginianus*

TABLE 2. SUMMARY OF SMALL MAMMAL TRAPPING AT THE RAVENNA ARSENAL.

Species	No. Captured	Individ./Trap Night
Masked Shrew	7	0.0005
Short-tailed Shrew	117	0.009
Star-nosed Mole	1	0.00008
Eastern Chipmunk	1	0.00008
White-footed Mouse	137	0.011
Meadow Vole	105	0.008
Southern Bog Lemming	1	0.00008
Woodland Jumping Mouse	7	0.0005

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partial skeleton were found in the early spring in the pine woods at the intersection of Burns-Kisler Road and the perimeter road on the Portage County line.

Masked Shrew, *Sorex cinereus*

This small shrew is found primarily in the northern half and south-central portions of Ohio. This species can be difficult to trap due to its small size and secretive nature making assessments of their population densities difficult. They can occur in a variety of habitats, but show a preference for mesic woodlands with uncompacted layers of organic leaf mulch. At Ravenna, 7 individuals were captured at 3 different trapping stations. With the exception of one individual captured at the ammunition dump on Pais-Windham Road (Station #52), this species was captured in extremely wet areas. Four individuals were captured at Station #23 around the old beaver pond on the North Perimeter Road west of Route 80 and 2 other individuals were captured at Station #34 around the beaver pond on the east side of Wilcox-Wayland Road.

Short-tailed Shrew, *Blarina brevicauda*

This short tailed shrew is the largest and most common of the 5 species of shrews found in Ohio. These animals are a component of almost every habitat type found in the state. They can be found in habitats ranging from old fields to wetlands to mature forests. Their diet consists primarily of insects and plant matter, but they will also feed on dead rodents. This species, like other members of the family, tend to be most active at night. Their larger size makes them more susceptible to the various traps used in these surveys making population indices more reliable. At Ravenna, this was the 2nd most abundant animal recorded in the trapping surveys with a capture rate of 0.009 animals per trap night. It was captured at 38 of the 52 stations sampled and included every habitat type found on the Arsenal. The largest number at any one site (16 individ.) were taken at Station #4, a mosaic of old fields and young woodlands punctuated by wet sedge habitats. This area was located on the east side of Paris-Windham Road halfway between Remalia Road and the bridge on Sand Creek.

Least Shrew, *Cryptotis parva*

This is one of Ohio's smallest mammals with a mean length of 78 mm. As with the other species of shrews in Ohio, their diet consists primarily insects and small dead rodents. Although once thought to be rare in the state, more recent trapping studies by Gottschang (1981) reveal it is more common than previously believed. While this species occurs statewide there are few records for the unglaciated sections of eastern Ohio. The least shrew is primarily a resident of old fields, but has also been found in forested habitats. At Ravenna, this species presence was determined solely on the basis of two skulls recovered from owl pellets collected in one of the pine woods in late winter. The succession of the old field habitats preferred by this species at the Arsenal into woody habitats will tend to limit the population of the species here.

Star-nosed Mole, *Condylura cristata*

Of the 3 species of moles found in Ohio, the star-nosed mole is probably the most unusual and has the most restricted distribution. It is found primarily only in the northeastern quarter of the state. While there is a record for Defiance County in northwestern Ohio, this species is absent from the remainder of the state. Moles are not generally captured in small mammal studies such as this and the capture of a single individual at Station #14 cannot be used as a measure of this species abundance (or lack of) at the Ravenna Arsenal. The star-nosed mole is more aquatic than other members of the genus in Ohio, and it usually lives around swamps, ponds, and other

wet areas. Ravenna offers an abundance of suitable habitat for this species and probably hosts a larger population than indicated by this study.

Eastern Cottontail, *Sylvilagus floridana*

This familiar mammal occurs in every county in Ohio inhabiting a fairly wide variety of habitats. It shows a preference for brushy fields and edge habitats while tending to avoid heavily forested habitats. At Ravenna, this species was sighted over the entire area of the Arsenal. Sightings were more frequent at dusk as might be expected. Overall this species was not encountered as frequently as one might have expected. Visual sightings were made in the spruce-pine woods across the road from the South Service Road pond (4-12-93), on Newton Falls Road 500 feet west of Greenleaf Road (7-22-93), on George Road halfway between Newton Falls Road and the South Service Road (7-8-93), on Newton Falls Road 3000 feet east of George Road (6-13-93), and on Newton Falls Road 500 feet west of Paris-Windham Road (6-13-93). The current succession of many of the old fields into young woods will probably have a depressing action on the population of this species at the Arsenal.

Eastern Chipmunk, *Tamias striatus*

This familiar member of the rodent family is found throughout most of the eastern United States and is a common resident in most Ohio counties. While normally thought of as a denizen of woods and forest they are equally at home in a variety of urban habitats where their propensity to eat fruits and bulbs in home gardens often makes them less than welcome guests. Although this species is active year round they tend to be less active in the winter months and may even go into hibernation during prolonged periods of extreme cold. This small ground squirrel was found in several areas throughout the Arsenal. Although no quantitative measure of the chipmunk populations was made during this study it did seem from observations that the populations were lower than expected. One possible explanation might be that in many areas there seemed to be insufficient ground cover. This may be partially a result of timber removal but is more likely a result of overgrazing by the large deer herd on the Arsenal. In addition to the two captures at stations #6 and #8, chipmunks were sighted at trapping stations #1 (6-17-93), #4 (6-22-93), #8 (6-29-93), #12 (7-9-93), #13 (7-9-93), #25 (7-14-93), #34 (8-31-93), #37 (9-1-93), #44 (9-16-93), and #47 (9-16-93). additional sightings were made in the woods just east of Snow Road (7-20-93), in the woods surrounding Big Paul's Pond (6-16-93), and in the gorge area east of Wadsworth Road (8-3-93).

Woodchuck, *Marmota monax*

This is one of Ohio's common animals and is the one voted most likely to be found DOR (dead on road). Groundhogs are a common sight on warm spring days throughout Ohio feeding on new spring growth along roadsides, fences, and in farm fields. Once scarce in Ohio, groundhog populations have increased as forests were converted to farm fields. Their preferred habitat is woodland edges bordering on meadows and croplands. This species and their characteristic burrows were so common and widespread throughout the Ravenna Arsenal that specific locality data was not recorded. They were most frequently observed along the roadsides, fencelines, and other mowed areas around the property. During a drive around the Arsenal one day in April, Dan Rice, an ODNR biologist, counted 13 individuals along the roads driven.

Fox Squirrel, *Sciurus niger*

This another of the common Ohio mammals occurring in every county in the state in varying numbers. Fox squirrels prefer the more open deciduous woodlands and frequent the small

woodlots of western Ohio. They are also found in urban settings in parks, cemeteries, lawns, and similar habitats when suitable denning and nest trees are available to them. This species is less common in the more heavily forested regions in southern and eastern Ohio. At Ravenna this species was so numerous that individual sightings were not recorded. It was abundant throughout all areas of the Arsenal. This species was particularly noticeable along roadsides in the spring of the year becoming less noticeable as the summer progressed. On several occasions for reasons unknown fox squirrels were observed apparently chewing the tar off the roads. This was the only species of squirrel found at the Arsenal.

Beaver, *Castor canadensis*

This is Ohio's largest and most well known rodent. Extirpated from Ohio around 1830, the species was able to slowly re-establish itself in the state in the 1930's and 40's starting in the northeast corner of the state. At the present time, beaver can be found in a majority of Ohio counties although it is still most numerous in northeastern Ohio and in strip-mined areas of eastern and southeastern Ohio. The numerous small streams, ponds, and natural wetlands found on the Arsenal provide an abundance of suitable habitats for this species and beaver were consequently found throughout the Arsenal. The wetlands and impoundments built by these animals are a characteristic and important component of the habitats found on the Arsenal. Beaver ponds not only serve as a home to the beaver but also provide critical habitat to many other species of mammals, fish, birds, plants, and invertebrates found at the Arsenal. Because these habitats are vital to so many other plants and animals, beaver impoundments should be allowed wherever they are not a threat to the buildings or other facilities on the property. At the present time a small number of beaver are trapped annually. Trapping should not hurt this population as long as the numbers taken are regulated in some manner. Trapping records for the Arsenal in 1993 indicated a take of approximately 8 individuals which is certainly not a large number for the size of the area.

White-footed Mouse, *Peromyscus leucopus*

This attractive nocturnal mouse is common throughout the entire state. It is usually the most common species recorded in trapping studies such as this. It is primarily a woodland species but will encroach into open fields and meadows where it directly competes with the meadow vole (*Microtus pennsylvanicus*). They are also frequently found in urban areas and are often found in houses and other buildings. This species feeds primarily on woodland seeds and grasses and a variety of insects and are themselves in turn the primary prey item for a number of woodland predators. This was the most common species of small mammal recorded in the trapping surveys at the Arsenal. A total of 137 individuals were captured at 31 of the 52 stations sampled yielding a capture rate of 0.011 individuals per trap night. This species was found in virtually every habitat sampled on the Arsenal. The largest number at any one site was taken at Station #4, a mosaic of old fields and young woodlands punctuated by small, sedge dominated wetlands.

Meadow Vole, *Microtus pennsylvanicus*

This small hamster-like animal is the dominant mammal of open grassy fields throughout Ohio. They will also inhabit a variety of other habitats including brushy fields, open woods, and grassy edge habitats. Numbers in prime habitats can run as high as 50 individuals per acre. Their presence in grassy fields are usually indicated by the system of runways these animals create. They are primarily vegetarians feeding on seeds and grasses. Meadow voles have a relatively short lifespan (6-16 months) which they compensate for with their high reproductive potential. At

Ravenna, this was the 3rd most abundant mammal (105 individ.) taken in the traps with a capture rate of 0.008 individuals per trap night. It was taken at 32 of the 52 trapping stations plus 2 out of the 6 late winter stations. Some of the old beaver ponds (Station #17 & 23) and the hatchery ponds (Station #20) provided some of the better habitats for this species on the Arsenal, but on the whole they seemed to be generally distributed around the Arsenal in a variety of open habitats.

Muskrat, *Ondatra zibethicus*

This large aquatic mammal is found in lakes, ponds, streams, and wetlands throughout Ohio. It is found in streams as large as the Ohio River and in streams so small that they are little more than drainage ditches. As with the beaver, the many streams, ponds, lakes, and wetlands present on the Arsenal provide abundant habitats for this species. This species has certainly benefitted from the presence of the beaver at the Arsenal and muskrat houses were a common sight in most of the older beaver impoundments. Sightings of this animal were rare as it is primarily nocturnal in its habits and the few sightings made do not permit an accurate assessment of the population currently found on the Arsenal. This species is trapped in small numbers on the Arsenal which provides the most effective method for monitoring the population levels here. This species is probably found in about equal numbers between the pond environments and the stream habitats where entrances to bank dens were observed in the lower sections of the major tributaries.

Southern Bog Lemming, *Synaptomys cooperi*

This small mammal closely resembles a meadow vole in general appearance and frequents many of the same habitats as the latter. It occurs statewide but is nowhere common and populations are largely disjunct from each other. This species is frequently found in bogs, marshes, and other wet areas. In southwestern Ohio where wetlands are scarce it is most often found in grassy fields. In these habitats they make and utilize a system of runways similar to the meadow vole. Where the species co-exist, runway systems are probably shared. Bog lemmings feed on a variety of grasses, sedges, and other plant material along with small insects and other invertebrates. Only one specimen of this interesting mammal was captured at the Ravenna Arsenal. It was collected at Station #23, an old beaver pond on the North Perimeter Road west of Route 80. The site is characterized by fallen trees, large expanses of sphagnum mosses, and thick growths of sedges in the old impoundment areas. Other suitable habitats are found around the Arsenal and continued sampling would likely turn up other individuals of this elusive species.

Woodland Jumping Mouse, *Napaeozapus insignis*

The capture of this rare Ohio mammal at the Arsenal was unexpected. The species is primarily associated with cool ravines and wooded gorges in northeastern and eastern Ohio. Specimens have been reported from a total of 8 counties in these areas of the state. Recent records are largely lacking, particularly after 1960. As discussed earlier in this report, 7 individuals were captured at 6 different trapping stations indicating a fairly widespread population on the Arsenal. This species was captured in a variety of habitats including areas around old beaver ponds and the hatchery ponds, brushy fields, and an old apple orchard bordering a wetland.

Coyote, *Canis latrans*

Although there is still some debate concerning the original status of the coyote in Ohio, this species has moved westward into the state during the last 40-50 years. It is now considered to be a resident in every county in the state. Accurate assessments of the statewide population

is difficult as the species closely resembles a small german shepherd and many reported sightings of this species may be based on misidentifications. Few of the reported specimens taken by trappers, farmers, or hunters end up as vouchers where their identities can be verified. This species is more prone to raid livestock than their smaller cousins, the red and gray foxes. Coyotes will also prey on fox and their own dead. At the Arsenal, this species was sighted on 2 different occasions. Two individuals were spotted at the intersection of George and Newton Falls Road on 7-15-93 and another individual with a freshly captured woodchuck was observed by Kelly's Pond on the South Service Road on 6-28-93. A larger population of this species at the Arsenal might help to control the deer population as deer will make up 13% of a coyotes diet under normal circumstances. With the large populations of deer, raccoon, woodchuck, and fox squirrel on the Arsenal it would seem that area farmers and pet owners have little to fear from this species.

Red Fox, *Vulpes vulpes*

This species is believed to have been absent from pre-settlement Ohio advancing into the state as the unbroken tracts of primeval forests were cleared by the early settlers. This species is found in every county of the state at the current time. It is primarily a resident of more open habitats, preferring a mix of farm fields, woodlots and associated edge habitats. The few direct sightings and indirect evidence observed for this species at the Arsenal do not allow for an overall assessment of this species' population here. This animal's secretive nature and wariness make it a difficult species to monitor. This species was observed at Station #33 on 7-10-93 which represents the only direct observation during the study. Indirect evidence consisted of a fox den found in the bunker area at the far eastern end of the Arsenal 700 feet east of Ramsdell Road on 6-5-93, and observations of fox tracts at the igloo area on Smalley Road (Spring 1993), at Newton Falls Road just east from Paris-Windham Road (Spring 1993), and along the stream floodplain under the bridge on Paris-Windham Road 6000 feet south east of Smalley Road (8-9-93).

Raccoon, *Procyon lotor*

This is probably one of Ohio's best known mammals. It is common in every county in Ohio inhabiting a variety of habitats including urban and residential areas where they quickly learn the location of the nearest trash can. Raccoons are often associated with water and just about every stream in Ohio supports a population of these animals. Raccoons will utilize a variety of den sites including storm sewers in urban areas, natural cavities in trees, hollow logs, rock crevices, and holes dug by other animals. They will eat just about any animal or vegetable matter they can find and diets change on a seasonal basis. In the past large numbers of raccoons were trapped for the fur industry which helped control their numbers as they really have no natural predators. With the fall in fur prices, populations of this species have been increasing over the last several years and are reaching nuisance levels in many areas. At Ravenna this species was common and widespread throughout the Arsenal and wrecked havoc with the small mammal traps. These animals would run the lines of small animal traps setting them off, stealing the bait and the small mammals in them, and destroying many of the traps in the process. Deterrent measures were only partially successful with tabasco sauce yielding the best results of the methods tried. The tracks of this animal could be observed around every body of water on the Arsenal.

Mink, *Mustela vison*

This is the largest and one of the best known of the mustelids inhabiting Ohio although few Ohio residents have ever actually seen one. It occurs in varying numbers throughout Ohio,

usually in the vicinity of a lake or stream. They are semi-aquatic in their habits feeding on a variety of aquatic animals including muskrats, frogs, fish, crayfish, mollusc, and small mammals. Deb sites include old logs, tree stumps, or old muskrat lodges. Their nocturnal habits and wariness around traps make them a difficult animal to census. At Ravine this species' presence was ascertained on the basis of indirect evidence only. The tracks and scat of this animal were observed along the flood plain of South Fork Eagle Creek in the Wadsworth Glen after a late winter snow in March 1993 by Mary Gustafson and Dan Rice.

Striped Skunk, *Mephitis mephitis*

This is the best known of the mustelids in Ohio, if not by sight then by scent. More people have probably smelled the results of this animal's displeasure than have actually seen one in the wild. Skunks are found statewide in Ohio and while relatively common, their numbers do not approach those of the raccoon, woodchuck, and other mammals of similar size. This species is primarily nocturnal in its habits and is often found as roadkills. While they inhabit a variety of habits, they are most common in brushy, semi-open habitats with some rock exposures. This species is generally not trapped in Ohio and population indices are based primarily on roadkill censuses conducted by the state. This species was documented for the Arsenal on the basis of visual sightings made on the North Perimeter Road halfway between Snow and Paris-Windham roads on 7-28-93 and at the intersection of Newton Falls and George roads on 7-28-93. These few sightings do not allow for an evaluation of this species' population status on the Arsenal.

White-tailed Deer, *Odocoileus virginianus*

Originally common statewide, this species was extirpated from Ohio around the turn of the century. Populations have rebuilt over the last 50 or so years so that it is once again a common resident in most Ohio counties and in many cases is found in greater numbers than existed in pre-settlement conditions. Overpopulation by this species in many urban parks is becoming more of a problem as statewide numbers continue to grow. This species was present in unusually high numbers throughout the Arsenal and the effects of overbrowsing were in evidence in many places particularly on the herbaceous flora of the area. The natural conversion of most of the open field habitats into brushy successional stages produce ideal habitats for this species. While this species is subjected to a controlled hunt every year the numbers present are still to high and a greater reduction in the herd is needed. Gottschang (1981) lists the optimum density as 1 per 35 acres which is certainly exceeded by the Arsenal population.

As discussed earlier, no attempts were made to inventory the bat populations on the Arsenal. Such an inventory would likely add several more species to the list presented here. In addition to some of the more common species of bats that one might expect to find there are several other mammalian species likely to be present which were not found in this survey. Following is a listing of those species which might be found on the Arsenal with additional studies:

Smokey Shrew, *Sorex fumeus*
Hairy-tailed Mole, *Parascalops breweri*
Eastern Mole, *Scalops aquaticus*
Gray Squirrel, *Sciurus carolinensis*
Red Squirrel, *Tamiasciurus hudsonicus*
Southern Flying Squirrel, *Glaucomys volans*
Deer Mouse, *Peromyscus maniculatus*
Pine Vole, *Microtus pinetorum*

Norway rat, *Rattus norvegicus*
House Mouse, *Mus musculus*
Meadow Jumping Mouse, *Zapus hudsonius*
Gray Fox, *Urocyon cinereoargenteus*
Ermine, *Mustela erminea*
Least Weasel, *Mustela nivalis*
Long-tailed Weasel, *Mustela frenata*

RECOMMENDATIONS

The following recommendations are presented not only with the goal of protecting or enhancing the mammal populations present on the Arsenal but also consider the effects some of these populations have on other species and communities found at the Arsenal.

A bat survey should be undertaken on the Arsenal. Appropriate habitat exists for the Indiana Bat (Myotis sodalis), a federally listed species, along some of the riparian corridors, particularly on South Fork Eagle Creek. The summer distribution of this species in Ohio is poorly understood at this time and Ravenna could prove to be east of its primary range in the state.

The deer population should be further reduced on the Arsenal. The herbaceous flora, particularly the spring wild flowers have been severely impacted by this species.

An effort needs to be made to find some way to reduce the raccoon population on the Arsenal. Ground nesting birds and their young are preyed upon by raccoons and one can only guess how many birds are being taken by the large raccoon population present on the Arsenal.

Beaver should be allowed to create new wetlands as long as they don't pose a threat to the facilities present on the Arsenal. Many of the mammals, birds, fish, macroinvertebrates, and plants found on the Arsenal are dependent on the wetland habitats created by this species. Limited trapping as employed in the past should not hurt this population and may be needed to help control it.

Additional studies should be done on the populations of woodland jumping mice and southern bog lemmings to further assess their populations and habitat requirements on the Arsenal.

The few coyotes present on the property should be protected for the time being as they may help to control the deer population in some small way as well as providing a control measure for the woodchuck population.

LITERATURE CITED

Bole, B. P.,Jr. 1932. An addition to the known list of Ohio mammals. Ohio J. Sci. 32:402.

Bole, B. P.,Jr. and P. N. Moulthrop. 1942. The Ohio recent mammal collection in the Cleveland Museum of Natural History. Sci. Publ. Cleveland Mus. Nat. Hist. 5:83-181.

Flenniken, J. F. 1961. Mammals of Ohio throughout historic time. Senior Paper. Muskingum College, New Concord, Ohio. 215 pp.

Goodpaster, W. W. 1941. Mammals of southwestern Ohio. J. Cincinnati Soc. Nat. Hist. 22:41-47.

Gottschang, J. L. 1981. A guide to the mammals of Ohio. Ohio State University Press, Columbus, Ohio. 176 pp.

Gottschang, J. L. 1965. Winter populations of small mammals in old-fields in southwestern Ohio. J. Mammology 46:44-52.

Reynolds, L. P. 1939. Ecological distribution of certain small mammals in southeastern Ohio. M. S. thesis, Ohio Univ., Athens, Ohio. 63 pp.

TABLE K-5

APPENDIX TABLE K-5. ANNOTATED LIST OF THE BIRDS OF THE RVAAP

ANNOTATED LIST OF THE BIRDS OF THE RAVENNA ARSENAL - 1993

American Bittern (*Botaurus lentiginosis*) - One sighting, of this "Ohio Endangered Species", was made on 13 April 1993 by Dan Rice and Mary Gustafson in Logging tract 10.

Great Blue Heron (*Ardea herodias*) - This species was seen on every trip in every logging tract, a small rookery contained 7 active nest sites in Logging Tract 1. An inactive site was found in Logging Tract 3. The highest breeding code number attained was 39.

Green-backed Heron (*Buterides striatus*) - This summer resident species was seen in expected small numbers, a young bird was observed in a beaver pond area of Logging Tract 6. A total of 7 birds were seen in Logging Tract 10. The highest breeding code number was 34.

Canada Goose (*Branta canadensis*) - Resident species. Confirmed nesting in Logging Tracts 1, 3, 4, 5, and 10. The highest breeding code number was 34.

Wood Duck (*Aix sponsa*) - This species occurred as migrant and summer resident. Confirmed nesting was noted in Logging Tracts 2, 4, 7, and 10. The highest breeding code number was 34.

Mallard (*Anas platyrhncos*) - This is a resident species (provided open water is available in the winter). Confirmed nesting was noted in Logging Tract 10 and 3w. The highest breeding code number was 34.

Blue-winged Teal (*Anas discors*) - This species occurred as migrant and probable nester. In recent years this species has declined greatly as a nesting bird throughout North America. It was seen through spring and summer, but no young observed. The possibility of nesting on the arsenal gives hope for the establishment of small population in Portage County. The highest breeding code number attained was 22.

Ring-necked Duck (*Aythya collaris*) - This species was seen in migration in Logging Tracts 5 & 10.

Bufflehead (*Bucephala albeola*) - A flock of 12 was reported by arsenal personnel in Logging Tract 5.

Hooded Merganser (*Lophodytes cucullatus*) - A family with 4 young was seen along the Eagle Creek by Dan Rice and Tim Morgan in Logging Tract 9. This constituted the first known Portage County nesting record for this species. Two females were seen in Logging tract 10 in early June. The highest breeding code number was 34.

Turkey Vulture (*Cathartes aura*) - This species was a migrant and abundant summer resident, it was seen in all logging tracts. Young birds noted Logging Tracts 4e and 7. A total of 107 was conservatively estimated. The highest breeding code number was 34.

Osprey (*Pandion haliaetus*) - NM. This is a migrant species, which no longer nesting in Ohio. Single birds seen on two June visits and one in September. Of the June birds, one was fishing a beaver pond along Wilcox Wayland Road in Logging Tract 5 and the other was

migrating over the headquarter buildings in Logging Tract 3.

Northern Harrier (*Circus cyaneus*) - This Ohio endangered species nested on the ground in Logging Tract 3. Two young were fledged on the west side of Greenleaf Road south of Fuze and Booster Road and just north of Detonator Road. The fields and shrubby wetlands of the western logging tracts offer an ideal habitat for this species to expand in the near future. Two immature birds (perhaps last year nestlings) were seen in Logging Tract 4w on 2 occasions. The highest breeding code number attained was 39.

Sharp-shinned Hawk (*Accipiter striatus*) - Adults of this species were in Logging Tract 3e seen of several dates. The most noteworthy sighting was of 2 immatures in Logging Tract 4e on the Smalley - North Line Breeding Bird Survey Route. The small pockets of coniferous areas provide ideal nesting habitats for this locally beleagured species. The highest breeding code number was 34.

Cooper's Hawk (*Accipiter cooperii*) - This resident and migrant species was widespread in lower than expected numbers. The total of 6 probably reflects the species ability to escape detection by an observer on foot . The highest breeding code number was 31 in Logging Tract 4.

Red-shouldered Hawk (*Buteo lineatus*) - A nest was discovered in a mixed woodland behind a the bunkers in Logging Tract 2. Success of this nest was unknown. This species was also seen in Logging Tract 10. The highest breeding code number was 37.

Broad-winged Hawk (*Buteo platypterus*) - NM. This species was seen once in June in Logging Tract 4w. The highest breeding code number attained was 10.

Red-tailed Hawk (*Buteo jamaicensis*) - Resident and abundant nester throughout the arsenal, species was seen in all logging tracts. The highest breeding code number was 39.

American Kestrel (*Falco sparverius*) - This species was in expected totals (16) and successfully nested in Logging Tracts 3e and 9. Although a nest was not found it was fairly obvious that this species nested in one of the large magazine type buildings in Logging Tract 9. The highest breeding code number attained was 34.

Ring-necked Pheasant (*Phasianus colchicus*) - This is an introduced species by local hunting club. Several were seen, heard, and photographed in good plumage in Logging Tracts 3w, 4w, and 7. These areas have large fields and provide the necessary habitat for this ground nesting species. The highest breeding code number was 10.

Ruffed Grouse (*Bonasa umbellus*) - This ground nesting resident species was reported to be fairly common by arsenal personnel. With the many acres of woodland edges and clearings, this species should flourish at the arsenal. The effects of hunting on the population are unknown but, this observer encountered it only in Logging Tract 8. The highest breeding code number was 10.

Wild Turkey (*Meleagris gallopavo*) - A resident species, a total of 3 was found in Logging Tracts 2 and 3w. Highest breeding code number attained was 10.

Northern Bobwhite (*Colinus virginianus*) - This resident species is thriving in Logging Tract 3e, 3w, 4e, 4w, 5, and 10 where a total of 22 were seen and heard. This location and the surrounding areas of Portage and Trumbull Counties represent the only stable population of this once common species throughout northern Ohio. The highest breeding code number was 30.

Virginia Rail (*Rallus limicola*) - This species is a migrant and summer resident in the larger cattails marshes on the property. It probably nested in the wetland at the northeast corner of study site. The highest breeding code number attained was 22 in Logging Tract 10.

Sora (*Porzana carolina*) - This species is a migrant and summer resident in the large cattail marsh in Logging Tract 10. This species was also seen in Logging Tract 6. The highest breeding code number was 22.

Killdeer (*Charadrius vociferus*) - A common summer resident, it was seen in all logging tracts except 2, 6, and 8. This species is a prolific ground nester and should have been seen in higher numbers. The presence of feral cats may have been a factor in their less than expected numbers. The highest breeding code number attained was 34 in Logging Tracts 4e, 7, and 10.

Solitary Sandpiper (*Tringa solitaria*) - This migrant species, which winters almost exclusively in the tropics, was noted in Logging Tract 4w during the last week of May.

Spotted Sandpiper (*Actitus macularia*) - This migrant and summer resident species was surprising scarce and noted only in Logging Tract 9. The highest breeding code number attained was 10. The presence of fox and mink may be a factor in the poor breeding numbers.

American Woodcock (*Scolopax minor*) - This migrant and summer resident species was an abundant nester throughout the open areas of arsenal. The spectacular evening courtship displays were evident throughout the field and shrubby woods on each evening visit in May and June. Since the arsenal contains 10,000+ acres of woodcock habitat, it provides the lion's share of available nesting area in Portage and Trumbull counties. The preservation of this habitat is imperative in order to maintain a stable population in Northeastern Ohio. The highest breeding code number was 30.

Ring-billed Gull (*Larus delawarensis*) - Visitors from nearby West Branch Reservoir were seen on many occasions.

Herring Gull (*Larus argentatus*) - Visiting immatures from nearby West Branch Reservoir were seen flying over the arsenal on several occasions.

Rock Dove (*Columbia livia*) - This resident species nested in areas where buildings were prevalent. The highest breeding code number attained was 37 in Logging Tract 3e.

Mourning Dove (*Zenaida macroura*) - This resident species was present in below expected numbers in all but Logging Tracts 2 and 8. The total of only 77 was difficult to understand. The highest breeding code number was 34.

Black-billed Cuckoo (*Coccyzus erythropthalmus*) - NM . This species was present in expected low numbers. This species normally nests near streams and nests are placed at 3-5' in well-concealed vegetation. The highest breeding code number attained in any logging tract was 22. If the entire property is considered, the code number was 30.

Yellow-billed Cuckoo (*Coccyzus americanus*) - NM. This species was present in slightly higher numbers than the previous species. It normally nests in saplings, shrubs, and vines. The property contains 1000s of acres of this type and the species should thrive here. The highest breeding code number attained in any logging tract was 22. If the entire property is considered, the code number was 30.

Barn Owl (*Tyto alba*) - Possible nester, a bird was sighted on 18 June 1993 by ODNR biologist Ralph Pfingsten. The large number of buildings having little disturbance by man provide excellent nest sites for this species. A concentrated effort to inspect all structures may produce favorable results. The highest breeding code number attained was 10.

Eastern Screech-owl (*Otus asio*) - This species proved to be a scarce resident. Much effort in censusing yielded only 3 birds in the entire study area. The highest breeding code number attained was 10.

Great Horned Owl (*Bubo virginianus*) - This resident species was a widespread with young birds observed in Logging Tracts 4e and 5. The highest breeding code number was 34.

Barred Owl (*Strix varia*) - Resident species. The night would filled with the call of this owl along the mature woodlands near Eagle Creek. Territorial birds were found in Logging Tract 4e, 5, 6, 7, 9, and 10. Highest breeding code number attained was 34.

Common Nighthawk (*Chordeiles minor*) - NM. This species was not detected until late summer. While many available nesting sites are present no nesting indication was found. A total of 110 were seen on 30 August 1993 hawking insects over study area.

Chimney Swift (*Chaetura pelagica*) - NM. This species was a common late summer migrant and an uncommon nester. This species should have been more prevalent due to availability to nesting structures throughout the arsenal. The highest breeding code number was 37.

Ruby-throated Hummingbird (*Archilochus colubris*) - NM. This species was common in all logging tracts. This species nests in coniferous as well as deciduous habitats and the property provides many acres of this habitat. The highest breeding code number attained was 30.

Belted Kingfisher (*Ceryle alcyon*) - This bank nesting species was seen in expected numbers do to the many wetland areas and small streams available for foraging. Young birds were noted at beaver pond areas in in Logging Tracts 1, and 10. This species also probably nested along the Eagle Creek in Logging Tracts 9, and 7 and along Hinckley Creek in Logging tract 2. Highest breeding code number was 34.

Red-bellied Woodpecker (*Melanerpes carolinus*) - This resident species was common in the mature and second growth wooded areas of all Logging Tracts except 3w. A total of 42 was low, but when compared to other county summer breeding bird censuses, is about the norm.

The highest breeding code number attained was 34.

Yellow-bellied Sapsucker (*Sphyrapicus varius*) - A pair lingered on a very tall tulip tree until late May in Logging Tract 6. This species is a very rare nester in Ohio and the possibility of a pair breeding in the arsenal represent a locally significant ornithological event. The highest breeding code number was 22.

Downy Woodpecker (*Piciodes pubescens*) - This resident species was common throughout arsenal except Logging Tract 9. Confirmed nesting was established in 7 logging tracts. The highest breeding code number attained was 34.

Hairy Woodpecker (*Piciodes villosus*) - This resident species was seen in all Logging Tracts in normal numbers. Comparative numbers to Red-bellied Woodpecker were what has become expected over the past 2 decades. The highest breeding code number attained was 34.

Northern Flicker (*Colaptes auratus*) - This species was the most common summering woodpecker species at the Ravenna Arsenal. The highest breeding code number was 34.

Pileated Woodpecker (*Dryocopus pileatus*) - This resident species was present in higher than expected numbers. This was thought to be due to the lack of incessant human pressure in the few mature woodlands available. The highest breeding code number was 34 in Logging Tracts 3e and 4e.

Eastern Wood-Pewee (*Contopus virens*) - NM. This species was the most common flycatcher at the arsenal. The total of 179 reflects the ability of this species to take advantage of available habitat without the presence of human disturbances. Confirmed nesting was made in in all logging tracts except 9. The highest breeding code number attained was 36 in Logging Tract 4e.

Yellow-bellied Flycatcher (*Empidonax flaviventris*) - NM. One was seen in September in Logging Tract 5.

Acadian Flycatcher (*Empidonax virescens*) - NM. This species was a common summer resident throughout all logging tracts. The highest breeding code number attained was 39.

Alder Flycatcher (*Empidonax alnorem*) - NM. Due to the amount of available habitat, this species was in good numbers in all logging tracts except 9. The total of 62 was nearly as high as the much more expected Willow Flycatcher. Again, the shrubby wetlands are favored by E. alnorem. Nesting by this uncommon Neotropical migrant was confirmed in 4 logging tracts. The highest breeding code number was 36.

Willow Flycatcher (*Empidonax traillii*) - NM. This species was common in expected numbers in all logging tracts except Logging Tract 9. The highest breeding code number was 36.

Least Flycatcher (*Empidonax minimus*) - NM. This species was uncommon but in expected numbers. This species was found in 6 logging tracts and nesting was confirmed in Logging Tract 5. The highest breeding code number attained was 36.

Eastern Phoebe (*Sayornis phoebe*) - This species was in exceptional numbers due to all of the nesting sites provided by the loading docks on the bunkers and magazines. The total of 125 for a study area was simply outstanding. Nesting was confirmed in all logging tracts. The highest breeding code number was 37.

Great Crested Flycatcher (*Myiarchus crinitus*) - NM. This species was encountered in good numbers in all areas except Logging Tract 6. The highest breeding code number was 36.

Eastern Kingbird (*Tyrannus tyrannus*) - NM. This species was conspicuous in all logging tracts in good numbers. Young birds lingered into mid-September. The highest breeding code number attained was 36.

Horned Lark (*Eremophila alpestris*) - This species was found only on the UTES property in Logging Tract 10. The highest breeding code number was 10.

Tree Swallow (*Tachycineta bicolor*) - The most common swallow in study area. This species took advantage of the many bluebird boxes on the property. A gathering along Route 80 numbered 56 in late July. The highest breeding code number attained was 39.

Northern Rough-winged Swallow (*Stelgidopteryx serripennis*) - NM. This species was found in small numbers in half of the logging tracts. The highest breeding code number was 34.

Bank Swallow (*Riparia riparia*) - NM. Visitors from nearby gravel pit operation along the south side of property encountered daily. The highest breeding code number attained was 10.

Barn Swallow (*Hirundo rustica*) - NM. This species was widespread but not numerous except in Logging Tracts 6, 7, and 10. The magazine areas in Logging Tract 6 provided the lion's share of nesting sites. The highest breeding code number attained was 34.

Blue Jay (*Cyanocitta cristata*) - This resident species was common in all logging tracts. Nesting was confirmed in all logging tracts. The highest breeding code number attained was 34.

American Crow (*Corvus brachyrhnchos*) - This resident species was common in all logging tracts. The highest breeding code number attained was 34.

Black-capped Chickadee (*Parus atricapillus*) - This resident species was common in all logging tracts. Nesting was confirmed in all logging tracts. The highest breeding code number attained was 34.

Tufted Titmouse (*Parus bicolor*) - This resident species was common in all logging tracts. Nesting was confirmed in all logging tracts. The highest breeding code number attained was 34.

Red-breasted Nuthatch (*Sitta canadensis*) - Numerous fall migrants were found in September 1993.

White-breasted Nuthatch (*Sitta carolinensis*) - This resident species was common in all logging tracts. The highest breeding code number attained was 34.

Brown Creeper (*Certhia americana*) - Encountered only Logging Tract 2. The highest breeding code number attained was 10.

Carolina Wren (*Thryothorus ludovicianus*) - Encountered widely throughout most logging tracts. The highest breeding code number attained was 22.

House Wren (*Troglodytes aedon*) - NM. Common in all logging tracts. Nesting was confirmed in all logging tracts. Highest breeding code number attained was 36.

Marsh Wren (*Cistothorus palustris*) - Encountered on 2 days and in only 2 logging tracts. The highest breeding code number attained was 10.

Golden-crowned Kinglet (*Regulus satrapa*) - Early spring migrant.

Ruby-crowned Kinglet (*Regulus calendula*) - resident Spring migrant

Blue-gray Gnatcatcher (*Polioptila caerulea*) - NM. Encountered in 7 logging tracts. The highest breeding code number attained was 36.

Eastern Bluebird (*Sialia sialis*) - The most numerous thrush in the study area. Nesting was confirmed in all logging tracts. The highest breeding code number attained was 39.

Veery (*Catharus fuscescens*) - NM. This species was particularly conspicuous and numerous. Nesting was confirmed in all logging tracts. The highest breeding code number attained was 36.

Wood Thrush (*Hylocichla mustelina*) - NM. Commonly encountered in all logging tracts. Nesting was confirmed in all logging tracts. The highest breeding code number attained was 36.

American Robin (*Turdus migratorius*) - This species winters at study site in large numbers. Breeding bird census does not reflect the number totals for this species accurately. Nesting was confirmed in all logging tracts. The highest breeding code number attained was 39.

Gray Catbird (*Dumetella carolinensis*) - NM. Commonly encountered in all logging tracts. Nesting was confirmed in all logging tracts. The highest breeding code number attained was 36.

Northern Mockingbird (*Mimus polyglottos*) - A migrant was noted in late May in Logging Tract 3e.

Brown Thrasher (*Toxostoma rufum*) - This species was located in above expected numbers in all logging tracts except 5 and 8. In recent years this species has become beleaguered in Northeastern Ohio, the arsenal provides a last stronghold for it. The highest breeding code number attained was 34.

Cedar Waxwing (*Bombycilla garrulus*) - This resident species was in expected totals. The highest breeding code number attained was 34.

Northern Shrike (*Lanius excubitor*) - This species is a winter visitor and was seen by Mary

Gustafson in late winter 1993. Historically, this species has been seen on the property at this time.

European Starling (*Sturnus vulgaris*) - Nesting birds were encountered in all logging tracts except Logging Tract 9. Breeding bird numbers were lower than expected although, large flocks were encountered in late summer. The highest breeding code number attained was 34.

White-eyed Vireo (*Vireo griseus*) - This species was encountered in all logging tracts. This area is probably Ohio's northern most breeding site where the species is common. The total of 86 was truly impressive, especially when one looks at the historical occurrence of the species. The highest breeding code number attained was 34.

Solitary Vireo (*Vireo solitarius*) - NM. This species was found in Logging Tracts 4e and 6. A pair was regularly seen into June in Logging Tract 6. The highest breeding code number attained was 25.

Yellow-throated Vireo (*Vireo flavifrons*) - NM. This species was commonly encountered in all logging tracts. Nesting of this vireo was confirmed in all but 2 of the logging tracts. The highest breeding code number attained was 36.

Warbling Vireo (*Vireo gilvus*) - NM. For unknown reasons this species was encountered in below average numbers. The many trees near the many ponds provided many nesting areas but few birds were seen or heard. The highest breeding code number attained was 36.

Red-eyed Vireo (*Vireo olivaceus*) - NM. This species was commonly encountered in all logging tracts. The total of 367 was a conservative estimate. Of this number, 90% were singing males. This indicates that the population is considerably higher than indicated on the census tallies. Nesting was confirmed in all logging tracts. The highest breeding code number attained was 36.

Blue-winged Warbler (*Vermivora pinus*) - NM. This species was abundantly encountered in all logging tracts except 3w. The many acres of suitable habitat provide the base for a strong and successful population. The surrounding areas of the arsenal have become so urbanized that the species has all but disappeared from the area as a nester. The highest breeding code number attained was 36.

Tennessee Warbler (*Vermivora peregrina*) - NM. Encountered in spring only.

Nashville Warbler (*Vermivora ruficapilla*) - NM. This species was encountered only in spring.

Yellow Warbler (*Dendroica petechia*) - NM. This species was abundant in all logging tracts. This species is thought to be in great decline nationally. The total of 478 reflects a stronghold area for the species. Nesting was confirmed in all logging tracts. The highest breeding code number attained was 36.

Chestnut-sided Warbler (*Dendroica pensylvanica*) - NM. The total number of this species was impressive (65). Due to the disturbed nature of much of the habitat at the arsenal, this species is thriving in numbers of previously unheard of proportions. The brambles, grapes,

and slash areas from logging offer ideal nesting locations for this species. This species was encountered in all logging tracts except 10. The highest breeding code number attained was 36.

Magnolia Warbler (*Dendroica magnolia*) - NM. This species was encountered in both periods of migration.

Cape May Warbler (*Dendroica tigrina*) - NM. This species was seen in September in Logging Tract 2.

Yellow-rumped Warbler (*Dendroica coronata*) - This migrant and winter resident species was encountered in expected numbers at expected times.

Black-throated Green Warbler (*Dendroica virens*) - NM. This species was encountered in both spring and fall migration in expected numbers.

Blackburnian Warbler (*Dendroica fusca*) - NM. This migrant species was seen in September in Logging Tract 2.

Palm Warbler (*Dendroica palmarum*) - NM. This species was encountered only in spring migration.

Bay-breasted Warbler (*Dendroica castanea*) - NM. This species was seen in September in Logging Tract 2.

Cerulean Warbler (*Dendroica cerulea*) - NM. This species was common in older woodlands. Due to the fragmentation of preferred habitats locally, the arsenal provides a last remnant of proper habitat to ensure the survival of this species in the Northeastern Ohio. The highest breeding code number attained was 36.

Black-and-white Warbler (*Mniotilta varia*) - NM. This species was seen on 3 occasions with singing males indicating territories. The establishment of a confirmed breeding record for the arsenal would set a precedent for Portage County and Northeastern Ohio. Future work is desired on this biological quality indicator species. The highest breeding code number attained was 22.

American Redstart (*Setaphaga ruticilla*) - NM. This species was commonly encountered in all logging tracts except 1, 3w, and 9. The highest breeding code number attained was 36.

Ovenbird (*Seiurls aurocapillus*) - NM. This species was present in higher than expected numbers and in wider than expected distribution. This was due to the dry woodland areas associated with Eagle Creek. The highest breeding code number attained was 34.

Louisiana Waterthrush (*Seiuris motacilla*) - NM. This species nested in Logging Tract 4e along Eagle Creek. The highest breeding code number attained was 36.

Kentucky Warbler (*Oporonis formosus*) - NM. This species was encountered in only 3 logging tracts. The highest breeding code number attained was 10.

Mourning Warbler (*Oporonis philadelphia*) - NM. This species was found in only 2 logging tracts. The highest breeding code number attained was 10.

Common Yellowthroat (*Geothlypis trichas*) - NM. The was most abundant warbler species in study area. Nesting was confirmed in all logging tracts. The highest breeding code number attained was 36.

Hooded Warbler (*Wilsonia pusilla*) - NM. This species was common in all logging tracts except 10. The count 118 individuals reflects a healthy woodland environment for many Neotropical migrants. The highest breeding code number attained was 36.

Wilson's Warbler (*Wilsonia pusilla*) - NM. This species was seen in September in Logging Tract 2.

Canada Warbler - (*Wilsonia canadensis*) - NM. This species was encountered during both migration.

Yellow-breasted Chat (*Icteria virens*) - NM. This species was found in all logging tracts except 10. The many acres of suitable habitat provided ample areas to support a solid population of chats. The highest breeding code number attained was 36.

Scarlet Tanager (*Piranga olivacea*) - NM. This species was seen commonly in most logging tracts. The total of 136 individuals represented a stable and healthy population at the arsenal. The highest breeding code number attained was 36.

Northern Cardinal (*Cardinalis cardinalis*) - This species was encountered commonly in all logging tracts. The highest breeding code number attained was 34.

Rose-breasted Grosbeak (*Phueticus ludovicianus*) - NM. This species was encountered commonly in all logging tracts. Nesting was confirmed in all logging tracts. The highest breeding code number attained was 36.

Indigo Bunting (*Passerina cyanea*) - NM. This species was found in all logging tracts. The total of 154 was expected for the size of the study area. The highest breeding code number attained was 36.

Rufous-sided Towhee (*Pipilo erythrophthalmus*) - This migrant and summer resident species was encountered abundantly in all logging tracts. The arsenal provides the single most dense population of this species in Northeastern Ohio, if not the state. Nesting was confirmed in all logging tracts. The highest breeding code number attained was 36.

American Tree Sparrow (*Spizella arborea*) - Widespread and common winter resident.

Chipping Sparrow (*Spizella passerina*) - This summer resident species was encountered only in areas where Norway Spruce prevailed. The highest breeding code number attained was 34.

Field Sparrow (*Spizella pusilla*) - This species was encountered abundantly in all logging tracts.

The number of these birds defies calculation. The 688 reported represent only a fraction of the total. The arsenal has 20,000 acres of Field Sparrow habitat. Nesting was confirmed in all logging tracts. The highest breeding code number attained was 39.

Savannah Sparrow (*Passerculus sandwichensis*) - This species was seen only in Logging Tracts 4w, 6, 9, and 10. The highest breeding code number attained was 34 in logging Tracts 4w and 10.

Grasshopper Sparrow (*Ammodramus savannarum*) - NM. This species was found only in the "Drop Zone" area of Logging Tract 4w. This area provided one of the few Portage County nesting records in the past 2 decades. The highest breeding code number attained was 34.

Henslow's Sparrow (*Ammodramus henslowii*) - This species nested in the UTES property on east side of Logging Tract 10. This provided one of the few confirmed nesting records from Northeast Ohio. As many as 9 males were seen and heard in July by many observers. The highest breeding code number attained was 30.

Song Sparrow (*Melospiza melodia*) - This species was encountered abundantly in all logging tracts. A total of 653 was tallied. This number reflected mostly males and the arsenal most likely supports 1000s of this species. The highest breeding code number attained was 36.

White-throated Sparrow (*Zonotrichia albicollis*) - This species was a common winter resident and migrant.

White-crowned Sparrow (*Zonotrichia leucophrys*) - This species was seen once during normal migration period in May.

Dark-eyed Junco (*Junco hyemalis*) - This species was a common winter resident and migrant.

Swamp Sparrow (*Melospiza geogiana*) - This species was widespread in small numbers in all logging tracts except 4e. The highest breeding code number attained was 31.

Bobolink (*Dolichonyx oryzivorus*) - NM. This species was commonly heard overhead in several logging tracts. Nesting confirmed in UTESarea of Logging Tract 10. The highest breeding code number attained was 34.

Red-winged Blackbird (*Agelaius phoeniceus*) - This species was encountered abundantly in all logging tracts. Nesting was confirmed in all logging tracts. The highest breeding code number attained was 36.

Eastern Meadowlark (*Sturnella magna*) - This species was seen in most logging tracts. It was particularly common around buildings on South Patrol Road. The highest breeding code number was 34.

Rusty Blackbird (*Euphagus carolinus*) - Migrant. A single sighting in Logging Tract 4w in April.

Common Grackle (*Quiscalus quiscula*) - This species was encountered abundantly in all logging tracts, after the breeding season. The highest breeding code number was 34.

Brown-headed Cowbird (*Molothrus ater*) - This species was abundant and widespread throughout the arsenal. The number of these parasitic birds is high enough in all tracts to warrant some sort of control program. The highest breeding code number attained was 36.

Orchard Oriole (*Icterus spurius*) - NM. This species was seen on 3 occasions. The highest breeding code number attained was 10.

Northern Oriole (*Icterus galbula*) - NM. This species was encountered commonly in all logging tracts. The highest breeding code number attained was 36.

Purple Finch (*Carpodacus purpureous*) - This migrant and resident species was uncommon but widespread throughout most of the property. It was found in most tracts with small coniferous regions. The highest breeding code number attained was 34.

House Finch (*Carpodacus mexicanus*) - This resident species was a locally common resident. Logging Tract 3e harbored nesting individuals and the lion's share of the arsenal population. The highest breeding code number attained was 34.

American Goldfinch (*Carduelis tristis*) - This resident and migrant species was encountered abundantly in all logging tracts. The availability of many thistle plants provides an ample food source for the continuing presence of this attractive species. The highest breeding code number attained was 30.

House Sparrow (*Passer domesticus*) - This introduced and resident species was locally abundant in Logging Tracts 3e and 3w. Competition with Eastern Bluebirds for nest sites is not an apparent problem (for the bluebird) at this time. The highest breeding code number attained was 37.

Notes
NM - means Neotropical migrant

TABLE K-6

APPENDIX TABLE K-6. AMPHIBIANS AND REPTILES FOUND AT THE RVAAP

TABLE 1: AMPHIBIANS AND REPTILES FOUND AT THE RAVENNA ARSENAL IN 1993.

Salamanders

1. mudpuppy (*Necturus maculosus*)
2. eastern newt (*Notophthalmus viridescens*)
3. Jefferson salamander (*Ambystoma jeffersonianum*)
4. dusky salamander (*Desmognathus fuscus*)
5. mountain dusky salamander (*Desmognathus ochrophaeus*)
6. two-lined salamander (*Eurycea bislineata*)
7. four-toed salamander (*Hemidactylium scutatum*)
8. redback salamander (*Plethodon cinereus*)
9. slimy salamander (*Plethodon glutinosus*)
10. red salamander (*Pseudotriton ruber*)

Frogs and Toads

1. American toad (*Bufo americanus*)
2. western chorus frog (*Pseudacris triseriata*)
3. spring peeper (*Pseudacris crucifer*)
4. gray treefrog (*Hyla versicolor*)
5. bullfrog (*Rana catesbeiana*)
6. green frog (*Rana clamitans melanota*)
7. pickerel frog (*Rana palustris*)
8. northern leopard frog (*Rana pipiens*)
9. wood frog (*Rana sylvatica*)

Snakes

1. northern ringneck snake (*Diadophis punctatus edwardsi*)
2. smooth green snake (*Opheodrys vernalis*)
3. black racer (*Coluber constrictor*)
4. milk snake (*Lampropeltis doliata*)
5. northern water snake (*Nerodia sipedon*)
6. brown snake (*Storeria dekayi*)
7. red-bellied snake (*Storeria occipitomaculata*)
8. eastern ribbon snake (*Thamnophis sauritus*)
9. common garter snake (*Thamnophis sirtalis*)

Lizards

1. five-lined skink (*Eumeces fasciatus*)

Turtles

1. snapping turtle (*Chelydra serpentina*)
2. painted turtle (*Chrysemys picta*)

DISCUSSION

Unless otherwise noted, salamander, frog, and toad localities are represented by several specimens while snake, skink and turtles localities are represented by a single specimen.

Mudpuppy (*Necturus maculosus*)

Uncommon. (Figure 1). New records: Portage Co., Windham Twp. Several individuals were found while shocking for fish in the main stem of Sand Creek and Eagle Creek. Based on the number of individuals and age classes represented,it appears that both populations are well established.

Red-spotted newt (*Notophthalmus viridescens*)

Common. (Figure 2). New records: Braceville, Charlestown, Freedom, Paris Twps. The eastern newt was found at 17 localities. Almost all of the specimens were obtained from funnel traps placed in vernal ponds in early spring. Only two juvenile efts were seen during the year despite reports from security guards that "those little red things are all over the tracks during the summer." However, the extremely dry conditions of the summer most likely prevented the normal diurnal wanderings of these creatures. With the ever increasing population of beavers and the ponds they create, the number of newt populations should continue to increase throughout the arsenal.

Jefferson salamander (*Ambystoma jeffersonianum*)

Uncommon. (Figure 3). New records: Windham Twp. Despite the abundance of seemingly ideal vernal ponds, Jefferson's salamander was found at only 3 localities. More surprising was the fact that the even more common spotted salamander was not found anywhere in the arsenal. However, there were some areas discovered late in the year which might harbour these pond breeding species in the spring. The most notable is the Charlestown Twp., locality (#194) where four-toed salamanders were found.

Dusky salamander (*Desmognathus fuscus*)

Abundant. (Figure 4). New records: Freedom, Paris, Windham Twps. The dusky salamander was found in all four Portage County Townships. This is a common salamander found in almost any rocky stream bed at the arsenal. It was not found east of the Eagle Creek drainage.

Mountain dusky salamander (*Desmognathus ochrophaeus*)

Abundant. (Figure 5). New records: Freedom, Paris, Windham Twps. This species is on the western edge of its range in northeastern Ohio but in the rocky seeps of Eagle Creek Gorge, it is the most abundant species. Elsewhere in the arsenal it is uncommon and usually confined to headwater springs and seeps. It was not found east of the Eagle Creek drainage.

Two-lined salamander (*Eurycea bislineata*)

Abundant. (Figure 6). New records: Freedom, Paris, Windham Twps. This is one of the most common streamside salamanders in Ohio and also in the arsenal. It was found in nearly every rocky stream bed. It is apparently absent east of the Eagle Creek Drainage.

Four-toed salamander (*Hemidactylium scutatum*)

Uncommon. (Figure 7). New records: Windham Twp. This species was found at

only two localities within the arsenal. This was perhaps the best amphibian find during the study. This species was listed as "threatened" on the first state list in 1976 (ODNR, 1976). It has since been removed from the list but is still a very difficult acquisition. Mossy (generally sphagnum) bogs with mature forest are the habitat requirements which make this species difficult to find.

Redback salamander (*Plethodon cinereus*)

Abundant. (Figure 8). New records: Freedom, Paris, Windham Twps. This indicator organism of the Beech-Maple forest is the most common species of salamander in Ohio. It was found in or near just about every woodlot on the property. In some cases it was found in highly unlikely places such as under a board in the middle of the ore pile area where the nearest tree was several hundred meters away. One individual was seen crossing a road during a rain storm.

Redback salamander (*erythristic phase*)

Common. (Figure 9). This unusual color morph was found at 10 localities in the arsenal. It occurs in only a few areas of North America. In three of these areas, northeastern Ohio, southern New England and the Bay of Funday region, a few populations contain 15% or more of the all red phase. Because this phase was found so frequently at the arsenal, a study was undertaken late in the year to see if one or more of the arsenal localities was of the high percentage red phase type. At only one locality (#48) were enough individuals found to draw any conclusions. Of 129 individuals found, 103 were of the normal striped variety, 18 were all red, and 8 were all black. The red phase made up 14% of this population. (See Pfingsten and Downs, 1989, for discussion of this phenomenon).

Slimy salamander (*Plethodon glutinosus*)

Uncommon. (Figure 10). New records: Paris, Windham Twps. The common woodland salamander was surprisingly difficult to find in the arsenal. There are many suitable talus slopes which apparently remain unoccupied by this species.

Red salamander (*Pseudotriton ruber*)

Uncommon. (Figure 11). New records: Charlestown, Windham Twps. One of the most colorful species in Ohio, it is found in areas of large permanent springs. All specimens were found at the head of springs in the upper reaches of Hinckley and Eagle Creeks.

American toad (*Bufo americanus*)

Abundant. (Figure 12). New records: Braceville, Charlestown, Freedom, Paris, Windham Twps. The American toad is found throughout the arsenal. Among the hundreds of specimens examined, no Fowler's toads or hybrids between the two species were found.

Chorus frog (*Pseudacris triseriata*)

Common. (Figure 13). New records: Braceville, Charlestown, Freedom, Paris, Windham Twps. This elusive frog was heard calling at nine widely scattered ponds. No adults were captured but the species appears to be well established in open grassy/marshy areas.

Spring peeper (*Pseudacris crucifer*)

Abundant. (Figure 14). New records: Trumbull Co.; Braceville, Charlestown, Freedom, Paris, Windham Twps. The peeper was found at 43 localities throughout the

arsenal. On warm spring evenings, one is never out of reach of the call of peepers. Several individuals were obtained in funnel traps but most records are based on the calls of males in the spring and fall.

Gray tree frog (*Hyla versicolor*)

Common. (Figure 15). New records: Braceville, Charlestown, Paris, Windham Twps. The tree frog is extremely difficult to capture even though it is one of the more common amphibians at the arsenal. Favorite perches include hawthorne, blackberry and multiflora rose thickets, and they can almost never be found until after dark. It was recorded from 43 localities but only seven individuals were captured. They are most often heard on warm humid evenings in June and July.

Bullfrog (*Rana catesbeiana*)

Common. (Figure 16). New records: Charlestown, Freedom, Paris, Windham Twps. Bullfrogs were found in just about every large permanent stream or pond on the property, exceptions being the newer beaver impoundments. If the newer ponds remain in place for three or four years, bullfrogs will undoubtedly become established.

Green frog (*Rana clamitans melanota*)

Abundant. (Figure 17). New records: Braceville, Charlestown, Freedom, Paris Twps. The green frog is without doubt the most common herptile in the arsenal. It was found in virtually every body of water from the size of a puddle to the largest pond. Furthermore, it was almost always found in great numbers.

Pickerel frog (*Rana palustirs*)

Common. (Figure 18). New records: Charlestown, Paris, Windham Twps. The pickerel frog was found at 10 localities. In all cases it was found in a ravine or small stream valley. In late July when tadpoles had transformed, the young frogs were often very numerous.

Leopard frog (*Rana pipiens*)

Uncommon. (Figure 19). New record: Braceville Twp. One of the great amphibian mysteries of recent years is "what has happened to the leopard frogs?" Only one confirmed siting was made in the arsenal. On two occasions, I thought I heard a male call. However it was late in the breeding season and I could not be certain of the very brief call. It would appear that the green frog has replaced or at least moved into the habitat vacated by leopard frogs.

Wood frog (*Rana sylvatica*)

Common. (Figure 20). New records: Freedom, Charlestown, Paris Twps. This explosive breeder is easy to find during the early spring breeding season and difficult to find thereafter. As many as seven individuals were found in a single funnel trap. They were found throughout the arsenal with the exception of the extreme eastern and western ends of the property. Almost all records were obtained during the breeding season.

Ring neck snake (*Diadophis punctatus edwardsi*)

Uncommon. (Figure 21). New records: Portage Co.; Windham Twp. Only one ring

neck snake was found (site #22) during the study. It was found in early spring under a rock where a small milk snake and a small water snake were also found. More species of herps (10) were found at this locale than at any other site in the arsenal.

Smooth green snake (*Opheodrys vernalis*)

Uncommon. (Figure 22). New records: Paris, Windham Twps. One of the most beautiful snakes in Ohio and certainly the most colorful at the arsenal. The yellow green color provides a striking contrast when uncovered from beneath a dark rock. Only two specimens were seen at the arsenal-ironically both were found on the same day (Sept. 10) at widely separated localities.

Black racer (*Coluber constrictor*)

Uncommon. (Figure 23). New record: Windham Twp. Despite reports that six foot black snakes could be seen sunning themselves on railroad sidings (Gorisek, 1986), the reality of 1993 was quite different. Only two black snakes, both racers, were seen during the course of this study and one of those had been killed by a mower. A third report of a black snake by several different security guards seemed valid but it could not be determined if it was a racer or pilot black snake.

Milk snake (*Lampropeltis doliata*)

Uncommon. (Figure 24). New records: Braceville, Paris, Windham Twps. This beautifully patterned king snake was found at four localities. It is often mistaken by the "locals" for a copperhead. One security guard insisted that copperheads were at the arsenal because he could smell them-I never asked him what they smelled like!

Water snake (*Nerodia sipedon*)

Common. (Figure 25). New records: Braceville, Charlestown, Paris, Windham Twps. The water snake was found at 12 localities. However, the state's most common snake was found far less frequently than one would expect.

Brown snake (*Storeria dekayi*)

Uncommon. (Figure 26). New records: Freedom, Paris, Windham Twps. Seven widely scattered localities representing four townships were found for the brown snake. These inoffensive little snakes are probably far more common than are represented in this study.

Red-bellied snake (*Storeria occipitomaculata*)

Uncommon. (Figure 27). New records, Freedom, Windham Twps. Only three localities were found for this little snake. This is another secretive species that is probably far more common than is represented in this study. Late in the year (10/14) five animals were found under one rock including a juvenile which lacked red pigment and had a slate grey belly.

Eastern ribbon snake (*Thamnophis sauritus*)

Common. (Figure 28). New records: Braceville, Charlestown, Paris Windham Twps. This handsome wetland species was found nine times in all townships except Freedom.

Common garter snake (*Thamnophis sirtalis*)

Common. (Figure 29). New records: Braceville, Freedom, Paris, Windham Twps.

The snake was found at 15 localities evenly distributed throughout the entire arsenal. It was found in all five townships.

Blue-tailed skink (*Eumeces fasciatus*)

Uncommon. (Figure 30). New records: Braceville, Paris, Windham Twps. The eleven locality records for the blue-tailed skink are all concentrated in the eastern half of the arsenal. This is a species which has undergone a considerable reduction in numbers in the state in the last 50 years and it was encouraging to find so many individuals in the arsenal.

Snapping turtle (*Chelydra serpentina*)

Common. (Figure 31). New records: Freedom, Paris, Windham Twps. The common snapping turtle was trapped at eight localities including the larger streams and the older ponds.

Eastern painted turtle (*Chrysems picta*)

Common. (Figure 32). New records: Charlestown, Freedom, Paris, Windham Twps. The common painted turtle was found in just about every pond except for those which are the most recently created. Both snapping and painted turtles will populate newer beaver impoundments within a few years.

RECOMMENDATIONS

One of the amazing things about the arsenal is the diversity of habitat. Just about every type of habitat found in Ohio is found within the arsenal. One of the most obvious that is missing is that of a mature forest. It is therefore recommended that at least some of the older woodlots be set aside so that they may continue to mature.

1. It is suggested that an area of 2-10 acres centered around sites #45 and #194 be set aside and that no logging or other disturbance occur. These are the two sites where four-toed salamanders were found and already contain some of the older trees as well as boggy vernal ponds.

2. It is also suggested that the deer population continue to be reduced so that the browse line so evident throughout the arsenal be eliminated.

3.It Is further suggested that the beaver population be controlled to prevent every stream on the property from being turned into a pond.

4.Finally, it is suggested that the raccoon population be managed for a reduction in their numbers.

TABLE K-7

APPENDIX TABLE K-7. SPECIES AND NUMBERS OF FISH COLLECTED ON THE RVAAP

TABLE 2. TOTAL SPECIES AND NUMBERS OF FISH COLLECTED ON THE RAVENNA ARSENAL.

	SPECIES	NO.
1	Mountain Brook Lamprey (*Ichthyomyzon greeleyi*)	22
2	Bowfin (*Amia calva*)	2
3	Gizzard Shad (*Dorosoma cepedianum*)	2
4	Rainbow Trout (*Oncorhynchus mykiss*)	11
5	Central Mudminnow (*Umbra limi*)	259
6	Grass Pickerel (*Esox americanus vermiculs*)	298
7	Golden Redhorse (*Moxostoma erythrurum*)	8
8	Northern Hog Sucker (*Hypentelium nigricans*)	151
9	White Sucker (*Catostomus commersoni*)	702
10	Spotted Sucker (*Minytrema melanops*)	26
11	Common Carp (*Cyprinus carpio*)	19
12	Golden Shiner (*Notemigonus crysoleucas*)	313
13	Blacknose Dace (*Rhinichthys atratulus*)	1036
14	Creek Chub (*Semotilus atromaculatus*)	2362
15	South. Redbelly Dace (*Phoxinus erythrogaster*)	742
16	Redside Dace (*Clinostomus elongatus*)	20
17	Striped Shiner (*Luxilus chrysocephalus*)	190
18	Sand Shinier (*Notropis stramineus*)	1
19	Silverjaw Minnow (*Notropis buccatus*)	896
20	Fathead Minnow (*Pimephales promelas*)	381
21	Bluntnose Minnow (*Pimephales notatus*)	1010
22	Central Stoneroller (*Compostoma anomalum*)	729
23	Hybrid X Minnow (HYBRID)	3
24	Channel Catfish (*Ictalurus punctatus*)	7
25	Yellow Bullhead (*Ameiurus natalis*)	62
26	Brown Bullhead (*Ameiurus nebulosus*)	15
27	Black Crappie (*Poxomis nigromaculatus*)	19
28	Rock Bass (*Ambloplites rupestris*)	38
29	Largemouth Bass (*Micropterus salmoides*)	309
30	Warmouth SF (*Lepomis gulosus*)	91
31	Green Sunfish (*Lepomis cyanellus*)	1333
32	Bluegill Sunfish (*Lepomis macrochirus*)	1807
33	Pumpkinseed Sunfish (*Lepomis gibbosus*)	498
34	Bluegill X Pumpkinseed (HYBRID)	2
35	Green SF X Bluegill (HYBRID)	18
36	Green Sunfish X Pumpkinseed (HYBRID)	43
37	Green Sunfish X Hybrid (HYBRID)	27
38	Hybrid X Sunfish (HYBRID)	14
39	Yellow Perch (*Perca flavescens*)	1
40	Blackside Darter (*Percina maculata*)	36
41	Logperch (*Percina caprodes*)	1
42	Johnny Darter (*Etheostoma nigrum*)	590
43	Greenside Darter (*Etheostoma blennioides*)	58
44	Rainbow Darter (*Etheostoma caeruleum*)	2
45	Fantail Darter (*Etheostoma flabellare*)	194
46	Mottled Sculpin (*Cottus bairdi*)	62
47	Brook Stickleback (*Culaea inconstans*)	22
	Total Individuals:	14,432

RARE SPECIES LIST

RAVENNA ARMY AMMUNITION PLANT (RVAAP)
RARE SPECIES LIST
3 May 1999

I. Species confirmed to be on the RVAAP property during the 1993 or subsequent Species Inventories.

A. State Endangered

1. Northern Harrier, Circus cyaneus
2. Common Barn-Owl, Tyto alba
3. Yellow-bellied Sapsucker, Sphyrapicus varius
4. Mountain Brook Lamprey, Ichthyomyzon greeleyi
5. Graceful Underwing, Catocala gracilis
6. Ovate Spikerush, Eleocharis ovata (Blunt spike-rush)
7. Lurking Leskea, Plagiothecium latebricola
8. Little blue heron, Egretta caerulea (suspected)
9. American bittern, Botaurus lentiginosu (migrant)
10. Canada warbler, Wilsonia canadensis (migrant)
11. Osprey, Junco hyemalis (migrant)
12. Trumpeter swan, Cygnus buccinator (migrant)
13. Little blue heron, Egretta caerulea (migrant)

B. State Threatened

1. Simple willow-herb, Epilobium strictum

C. State Potentially Threatened

1. Gray Birch, Betula populifolia
2. Round-leaved sundew, Drosera rotundifolia
3. Closed gentian, Gentiana clausa
4. Butternut, Juglans cinerea
5. Blunt mountain-mint, Pycnanthemum muticum
6. Northern rose azalea, Rhododendron nudiflorum var. roseum
7. Large cranberry, Vaccinium macrocarpon
8. Hobblebush, Viburnum alnifolium
9. Long Beech Fern, Phegopteris connectilis
10. Woodland Horsetail, Equisetum sylvaticum
11. Weak sedge, Carex debilis var. debilis
12. Straw sedge, Carex straminea
13. Water avens, Geum rivale
14. Tall St. John's wort, Hypercium majus
15. Swamp oats, Sphenopholis pensylvanica
16. Shinning ladies'-tresses, Spiranthes lucida

D. State Special Interest

1. Sora, Porzana carolina
2. Virginia Rail, Rallus limicola
3. Four-toed Salamander, Hemidactylium scutatum
4. Smooth green snake, Opheodrys vernalis
5. Woodland Jumping Mouse, Napaeozapus insignis
6. Sharp-Shinned Hawk, Accipiter striatus
7. Solitary Vireo, Vireo solitarius
8. Pygmy shrew, Sorex hoyi
9. Star-nosed mole, Condylura cristata
10. Red-shouldered hawk, Buteo lineatus
11. Henslow's sparrow, Ammodramus henslowii
12. Cerulean warbler, Dendroica cerulea
13. Common moorhen, Gallinula chloropus
14. Eastern box turtle, Carolina carolina

E. Rare Plant Communities/Significant Natural Areas

1. The area known as the northern woods contains Beech-sugar maple forest, oak-maple swamp forest, mixed swamp forest, oak-maple-tulip forest, oak-hickory forest, mixed floodplain forest, and successional woods, floating-leaved marsh, submergent marsh, emergent marsh, cat-tail marsh, sedge-grass meadow, mixed shrub swamp, buttonbush swamp, shrub bog, wet fields, ponds, and disturbed wetlands. This area is approximately 1.500 acres and includes a Pin Oak-Swamp White Oak-Red Maple-(Northern Pin Oak) Flatwoods Forest. This community is ranked as a G2 community. This means that it is " imperiled globally because rarity (6 to 20 occurrences or few remaining individuals) or because of some factor(s) making it very vulnerable to extinction throughout its range." According to Dr. Barbara Andreas, who did my plant communities inventory, the best examples of this community in NE Ohio are at Ravenna AAP. This area also contains good examples of Beech-Maple Forests (G4?).

2. The Wadsworth Glenn contains the following communities Hemlock-White Pine-Northern Hardwood Forest (G3/G4), oak-hickory forest, mixed floodplain forest, floating-leaved marsh, submergent marsh, emergent marsh, cat-tail marsh, and ponds. This area is approximately 90 acres.

3. The Group 3 woods is approximately 700 acres and contains mixed swamp forest, beech-sugar maple forest, oak-maple-tuliptree forest, red maple woods, successional woods, cat-tail marsh, and disturbed habitats.

4. The B&O Wye Road area contains Sphagnum thicket, oak-maple swamp forest, mixed swamp forest, dry fields, buttonbush swamp, wet meadows, cat-tail marsh, a pond, and seeps. This area consists of approximately 145 acres and is on the southeastern perimeter in Portage County on the Portage and Trumbull County line.

5. The South Patrol Road swamp forest is about 120 acres and contains mixed swamp forest, oak-maple swamp forest, beech-maple forest, buttonbush swamp, and open swamps.

F. Other Biological Items of Interest

1. Turkey Vulture Roosts - Turkey Vultures roost and breed throughout the RVAAP, primarily on and around earth covered magazine headwalls and abandoned buildings.

2. Great Blue Heron - Up to three heron rookeries have been identified at the RVAAP in a given year. The rookeries are normally small and are abandoned for better areas from time to time.

3. Wild Turkey - Wild turkey is making a come back at the RVAAP with sightings of 10 to 20 birds at a time common. Sightings are scattered throughout the plant, but most large group sightings occur within a few specific areas.

II. Species documented by the US F&WS or the ODNAP within the vicinity of the RVAAP, but not known to be on the RVAAP property.

A. Federal Endangered

1. Indiana Bat, Myotis sodalis (RVAAP is within historic range)

B. Federal Threatened

1. Northern Monkshood, Aconitum noveboracense (Nearby)
2. Bald Eagle, Haliaetus leucocephalus (Potage County)

C. State Endangered

1. White-stem Pondweed, Potamogeton praelongus (Nearby)
2. Bald Eagle, Haliaetus leucocephalus (Portage County)
3. Northern Monkshood, Aconitum noveboracense (Nearby)
4. Indiana Bat, Myotis sodalis (RVAAP is within historic range)
5. Mountain Brook Lamprey, Ichthyomyzon greeleyi (within 1 mile)

D. State Threatened

1. Spiral Pondweed, Potamogeton spirillus (Nearby)
2. Pale Sedge, Carex pallescens (Nearby)
3. Upland Sandpiper, Bartamia longicauda (Nearby/Nest)

E. State Potentially Threatened

1. Richardson's Pondweed, Potamogeton richardisonii (Nearby)
2. Flat-Stem Pondweed, Potamogeton zosteriformis (Nearby)
3. American Water-Pennywort, Hydrocotyle americana (Nearby)
4. Large Round-Leaved Orchid, Platanthera orbiculata (Nearby)
5. American Water-Pennywort, Hydrocotyle americana (w/in 1 mile)
6. Long Beech Fern, Phegopteris connectilis (within 1 mile)
7. Butternut, Juglans cinerea (Portage County)

F. State Special Interest (ODOW)

1. Iowa Darter, Etheostoma exile (1991, Nearby)
2. Cliff Swallow, Hirundo pyrrhonota (within 1 mile)

G. Rare Plant Communities

1. Floodplain Forest (within 1 mile, Windham Quad.)

Note: This listing is for consideration of off site impacts for major projects. These are also potential future species of concern on the RVAAP property.

RISK ASSESSMENT METHODOLOGY

LORING AIR FORCE BASE
RISK ASSESSMENT METHODOLOGY

FINAL

AUGUST 1994

Prepared by
HAZARDOUS WASTE REMEDIAL ACTIONS PROGRAM
Environmental Restoration and Waste Management Programs
Oak Ridge, Tennessee 37831-7606
managed by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

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ACRONYMS AND ABBREVIATIONS

ABB-ES	ABB Environmental Services, Inc.
AET	Apparent Effects Threshold
AOC	Area of Concern
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	Ambient Water Quality Criteria
B(a)P	Benzo(a)Pyrene
BAF	Bioaccumulation Factor
BKU	Biokinetic Uptake model
BTF	Biotransfer Factor
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CPC	Chemicals of Potential Concern
CSF	Cancer Slope Factor
CSF_{derm}	Cancer Slope Factor (dermal)
DCE	Dichloroethene
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DOD	Department of Defense
ECAO	Environmental Criteria and Assessment Office
ER-L	Effects Range - Low
ER-M	Effects Range - Medium
HEAST	Health Effects Assessment Summary Tables
HI	Hazard Index
HQ	Hazard Quotient
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
K_{oc}	Organic Matter-Water Partitioning Coefficient
K_{ow}	Octanol-Water Partitioning Coefficient
LAFB	Loring Air Force Base
LOAEL	Lowest Observed Adverse Effect Level
LOEL	Lowest Observed Effect Level
MAPCL	Maine Air Pollution Control Laws
MCL	Maximum Contaminant Level
MEDEP	Maine Department of Environmental Protection
MEDHS	Maine Department of Health Services
MENHP	Maine National Heritage Program
MEG	Maximum Exposure Guideline
NCP	National Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No Observed Adverse Effect Level
NOEL	No Observed Effect Level
NPL	National Priorities List
NWI	National Wetlands Inventory
OSHA	Occupational Safety and Health Administration
OU	Operable Unit

ACRONMYMS AND ABBREVIATIONS (continued)

PAHs	Polynuclear Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PCE	Tetrachloroethene
RA	Risk Assessment
RAGS	Risk Assessment Guidance for Superfund
RfC	Reference Concentration (Inhalation)
RfD	Reference Dose
RfD_{derm}	Reference Dose (dermal)
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonable Maximum Exposure
RTV	Reference Toxicity Value
SAF	Society of American Foresters
SARA	Superfund Amendments and Reauthorization Act of 1986
SCS	Soil Conservation Service
SQL	Sample Quantitation Limit
TCE	Trichloroethene
TIC	Tentatively Identified Compound
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VC	Vinyl Chloride
VOC	Volatile Organic Compound

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TABLE 4.3.
REFERENCE SOURCES FOR BIOACCUMULATION FACTORS (BAFS)[a]

Organism	Function of BAF (units)	Associated Equation[b,c]	Source
Plants	Relates concentration in plants to concentration in soil	$C_{veg} = BAF_{veg} * C_{soil}$	Organics: Travis and Arms (1988), Briggs et al. (1982, 1983), Ryan et al. 1989 Inorganics: Baes et al. (1984)
Invertebrates	Relates concentration in invertebrates to concentration in soil	$C_{invert} = BAF_{invert} * C_{soil}$	Organics: Menzie et al. (1992) Inorganics: Conduct contaminant-specific literature search
Herbivorous birds and mammals	Relates concentration in herbivore to concentration in plant feed (organics) or to daily intake of contaminant (inorganics)	Organics $C_{bird} = BAF_{bird} * C_{veg}$ $C_{mamm} = BAF_{mamm} * C_{veg}$ Inorganics $C_{bird} = BTF_{bird} * C_{veg} * IR_{bird}$ $C_{mamm} = BTF_{mamm} * C_{veg} * IR_{mamm}$	Organics: Garten and Trabalka (1983), Travis and Arms (1988) Inorganics: Baes et al. (1984)
Herpetofauna	Relates concentration in herpetofauna to concentration in invertebrates	$C_{herp} = BAF_{herp} * C_{invert}$	Organics and inorganics: Conduct contaminant-specific literature search
Fish	Relates concentration in aquatic organisms to concentration in water	$C_{fish} = BAF_{fish} * C_{water}$	Organics and inorganics: Barnthouse et al. (1988) Organics: Veith et al. 1985

[a] BAFs for a variety of organisms and chemicals are also available from Jorgensen et al. (1991) and Opresko et al. (1993).

[b] C_{veg}, C_{soil}, C_{invert}, C_{bird}, C_{mamm}, C_{herp}, and C_{fish} denote chemical concentrations in vegetation, soil, invertebrates, birds, mammals, herpetofauna and fish, respectively (mg/kg). C_{water} denotes chemical concentrations in water (mg/L).

[c] BAF_{veg}, soil to plant bioaccumulation factor (mg kg^{-1}plant/mg kg^{-1} soil).
BAF_{invert}, soil to invertebrate bioaccumulation factor (mg kg^{-1} invertebrate/mg kg^{-1} soil).
BAF_{bird}, , plant to bird bioaccumulation factor (mg kg^{-1} bird tissue/mg kg^{-1} plant feed).
BAF_{mamm}, plant to mammal bioaccumulation factor (mg kg^{-1} mammal tissue/mg kg^{-1} plant feed).
BAF_{herp}, invertebrate to herpetofauna bioaccumulation factor (mg kg^{-1} herpetofauna tissue/mg kg^{-1} invertebrate).
BAF_{fish}, water to fish bioaccumulation factor (mg kg^{-1} fish/mg L^{-1} water).
BTF_{bird}, feed to bird biotransfer factor (mg kg^{-1} bird tissue/mg day^{-1}).
BTF_{mamm}, feed to mammal biotransfer factor (mg kg^{-1} mammal tissue/mg day^{-1}).
IR_{bird}, daily ingestion rate of bird prey (kg plant/day).
IR_{mamm}, daily ingestion rate of mammal prey (kg plant/day).

TABLE 4.4
BIOACCUMULATION FACTORS FOR INVERTEBRATES, PLANTS, SMALL MAMMALS, SMALL BIRDS, REPTILES AND AMPHIBIANS, AND FISH FROM PREVIOUS LORING AIR FORCE BASE REMEDIAL INVESTIGATION REPORTS

CHEMICAL	log Kow [Source] [b]	BIOACCUMULATION FACTOR (BAF) [a]					
		Invert [c]	Plant [d]	Small Mammal [e]	Small Bird [f]	Reptiles & amphibs [f]	Fish [g]
VOLATILES							
1,1,2,2-Tetrachloroethane	2.6	5.0E-02	2.0E-02	6.0E-04	6.0E-04	6.0E-04	8.0E+00 [g1]
1,2-Dichloroethane	1.5	5.0E-02	2.0E-02	4.8E-05	4.8E-05	4.8E-05	2.0E+00 [g1]
1,2-Dichloroethene	2	5.0E-02	2.0E-02	1.5E-04	1.5E-04	1.5E-04	8.6E-01 [g1]
2-Butanone	0.29	5.0E-02	2.0E-02	2.9E-06	2.9E-06	2.9E-06	6.0E-01 [g1]
4-Methyl-2-pentanone	1.2	5.0E-02	2.0E-02	2.4E-05	2.4E-05	2.4E-05	6.0E+00 [g1]
Acetone	-0.24	5.0E-02	2.0E-02	8.7E-07	8.7E-07	8.7E-07	2.0E-01 [g1]
Benzene	2.1	5.0E-02	2.0E-02	1.9E-04	1.9E-04	1.9E-04	3.2E+01 [g1]
Chlorobenzene	2.8	5.0E-02	2.0E-02	9.5E-04	9.5E-04	9.5E-04	4.5E+02 [g1]
Chloroform	2	5.0E-02	2.0E-02	1.5E-04	1.5E-04	1.5E-04	6.0E+00 [g1]
Ethylbenzene	3.2	5.0E-02	2.0E-02	2.4E-03	2.4E-03	2.4E-03	2.9E+02 [g1]
Methylene chloride	1.3	5.0E-02	2.0E-02	3.0E-05	3.0E-05	3.0E-05	4.0E+00 [g1]
Tetrachloroethene	3.4	5.0E-02	2.0E-02	3.8E-03	3.8E-03	3.8E-03	4.4E+01 [g1]
Toluene	2.7	5.0E-02	2.0E-02	7.6E-04	7.6E-04	7.6E-04	8.3E+01 [g1]
Trichloroethene	2.4	5.0E-02	2.0E-02	3.8E-04	3.8E-04	3.8E-04	1.7E+01 [g1]
Xylenes (total)	3.2	5.0E-02	2.0E-02	2.4E-03	2.4E-03	2.4E-03	1.7E+01 [g1]
SEMIVOLATILES							
2,4,6-Trichlorophenol	3.7	5.0E-02	2.0E-02	7.6E-03	7.6E-03	7.6E-03	3.3E+02 [g2]
2,6-Dinitrotoluene	2.1	5.0E-02	2.0E-02	1.9E-04	1.9E-04	1.9E-04	2.6E+01 [g1]
2-Methylnaphthalene	-1.9	5.0E-02	2.0E-02	1.9E-08	1.9E-08	1.9E-08	4.3E+02 [ac]
2-Methyphenol	2	5.0E-02	2.0E-02	1.5E-04	1.5E-04	1.5E-04	1.5E+01 [g2]
2-Nitrophenol	1.9	5.0E-02	2.0E-02	1.2E-04	1.2E-04	1.2E-04	1.3E+01 [g2]
3-Nitroaniline	1.4	5.0E-02	2.0E-02	3.8E-05	3.8E-05	3.8E-05	5.1E+00 [g2]
4-Chloroaniline	1.8	5.0E-02	2.0E-02	9.5E-05	9.5E-05	9.5E-05	1.1E+01 [g2]
4-Chloro-3-methylphenol	3.1	5.0E-02	2.0E-02	1.9E-03	1.9E-03	1.9E-03	1.1E+02 [g2]
4-Methyphenol	1.9	5.0E-02	2.0E-02	1.2E-04	1.2E-04	1.2E-04	1.3E+01 [g2]
4-Nitroaniline	1.4	5.0E-02	2.0E-02	3.8E-05	3.8E-05	3.8E-05	5.1E+00 [g2]
4-Nitrophenol	1.9	5.0E-02	2.0E-02	1.2E-04	1.2E-04	1.2E-04	1.3E+01 [g2]
Acenaphthene	3.9	5.0E-02	2.0E-02	1.2E-02	1.2E-02	1.2E-02	3.9E+02 [g1]
Acenaphthylene	4.1	5.0E-02	2.0E-02	1.9E-02	1.9E-02	1.9E-02	6.9E+02 [g2]
Anthracene	4.5	5.0E-02	2.0E-02	4.8E-02	4.8E-02	4.8E-02	1.4E+03 [g2]
Benzo(a)anthracene	5.7	5.0E-02	3.9E-03	7.6E-01	7.6E-01	7.6E-01	1.3E+04 [g2]
Benzo(a)pyrene	6	5.0E-02	2.6E-03	1.5E+00	1.5E+00	1.5E+00	3.0E+01 [g1]
Benzo(b and k)fluoranthene	6.1	5.0E-02	2.3E-03	1.9E+00	1.9E+00	1.9E+00	2.6E+04 [g2]
Benzo(g,h,i)perylene	6.6	5.0E-02	1.2E-03	6.0E+00	6.0E+00	6.0E+00	6.5E+04 [g2]
Bis(2-ethylhexyl)phthalate	5.1	5.0E-02	8.7E-03	1.9E-01	1.9E-01	1.9E-01	3.1E+02 [g1]
Butylbenzylphthalate	4.9	5.0E-02	2.0E-02	1.2E-01	1.2E-01	1.2E-01	6.6E+02 [g1]
Carbazole	3.76 [1]	5.0E-02	2.0E-02	8.7E-03	8.7E-03	8.7E-03	3.7E+02 [g2]
Chrysene	5.7	5.0E-02	3.9E-03	7.6E-01	7.6E-01	7.6E-01	1.3E+04 [g2]
Dibenzofuran	4.1	5.0E-02	2.0E-02	1.9E-02	1.9E-02	1.9E-02	6.9E+02 [g2]
Dibenz(a,h)anthracene	6.5	5.0E-02	1.4E-03	4.8E+00	4.8E+00	4.8E+00	5.4E+04 [g2]
Diethylphthalate	3.2	5.0E-02	2.0E-02	2.4E-03	2.4E-03	2.4E-03	1.2E+02 [g1]
Di-n-butylphthalate	5.2	5.0E-02	7.6E-03	2.4E-01	2.4E-01	2.4E-01	5.1E+03 [g2]
Di-n-octylphthalate	9.2	5.0E-02	3.7E-05	2.4E+03	2.4E+03	2.4E+03	9.3E+03 [g1]
Fluoranthene	4.95 [2]	5.0E-02	2.0E-02	1.3E-01	1.3E-01	1.3E-01	3.2E+03 [g2]
Fluorene	4.2	5.0E-02	2.0E-02	2.4E-02	2.4E-02	2.4E-02	8.3E+02 [g2]
Indeno(1,2,3-c,d)pyrene	6.6	5.0E-02	1.2E-03	6.0E+00	6.0E+00	6.0E+00	6.5E+04 [g2]
Naphthalene	3.6	5.0E-02	2.0E-02	6.0E-03	6.0E-03	6.0E-03	4.3E+02 [g1]
Nitrobenzene	1.9	5.0E-02	2.0E-02	1.2E-04	1.2E-04	1.2E-04	1.3E+01 [g2]
N-Nitrosodiphenylamine	3.1	5.0E-02	2.0E-02	1.9E-03	1.9E-03	1.9E-03	8.1E+01 [g1]
Phenanthrene	4.5	5.0E-02	2.0E-02	4.8E-02	4.8E-02	4.8E-02	1.4E+03 [g2]
Phenol	1.5	5.0E-02	2.0E-02	4.8E-05	4.8E-05	4.8E-05	7.8E+02 [g1]
Pyrene	5.3	5.0E-02	6.7E-03	3.0E-01	3.0E-01	3.0E-01	6.1E+03 [g2]

TABLE 4.4
BIOACCUMULATION FACTORS FOR INVERTEBRATES, PLANTS, SMALL MAMMALS, SMALL BIRDS, REPTILES AND AMPHIBIANS, AND FISH FROM PREVIOUS LORING AIR FORCE BASE REMEDIAL INVESTIGATION REPORTS

CHEMICAL	log Kow [Source] [b]	BIOACCUMULATION FACTOR (BAF) [a]					
		Invert [c]	Plant [d]	Small Mammal [e]	Small Bird [f]	Reptiles & amphibs [f]	Fish [g]
PESTICIDES/PCBs							
4,4'-DDD	6	3.3E+00 [g]	1.3E-03 [h]	2.9E+00 [i]	2.9E+00	2.9E+00	1.7E+05 [g1]
4,4'-DDE	5.7	1.7E+00 [g]	2.0E-03 [h]	2.9E+00 [i]	2.9E+00	2.9E+00	1.8E+07 [g1]
4,4'-DDT	6.4	5.7E-01 [g]	7.7E-04 [h]	2.9E+00 [i]	2.9E+00	2.9E+00	3.4E+04 [g1]
Aldrin	3	5.6E-01 [u]	2.0E-02	2.9E+00 [i]	2.9E+00	2.9E+00	1.1E+04 [g1]
Aroclor-1254	6 [3]	5.8E+00 [j]	3.8E-01 [k]	2.9E+00 [i]	2.9E+00	2.9E+00	1.0E+07 [g1]
Aroclor-1260	7.1 [3]	5.8E+00 [j]	3.8E-01 [k]	2.9E+00 [i]	2.9E+00	2.9E+00	1.0E+07 [g1]
alpha-BHC	3.8	2.6E+00 [v]	2.0E-02	2.9E+00 [i]	2.9E+00	2.9E+00	7.1E+02 [g1]
beta-BHC	3.8	2.6E+00 [v]	2.0E-02	2.9E+00 [i]	2.9E+00	2.9E+00	7.2E+02 [g1]
delta-BHC	4.1	2.6E+00 [v]	2.0E-02	2.9E+00 [i]	2.9E+00	2.9E+00	6.9E+02 [g2]
gamma-BHC (Lindane)	4.1	2.6E+00 [u]	2.0E-02	2.9E+00 [i]	2.9E+00	2.9E+00	1.0E+03 [g1]
alpha-Chlordane	5.5	1.6E+00 [w]	5.1E-03	2.9E+00 [i]	2.9E+00	2.9E+00	1.4E+06 [g1]
gamma-Chlordane	5.5	1.6E+00 [x]	5.1E-03	2.9E+00 [i]	2.9E+00	2.9E+00	7.6E+04 [g1]
Dieldrin	4.6	5.5E+00 [u]	2.0E-02	2.9E+00 [i]	2.9E+00	2.9E+00	1.4E+04 [g1]
Endosulfan I	3.6	5.5E+00 [y]	2.0E-02	2.9E+00 [i]	2.9E+00	2.9E+00	2.8E+02 [g2]
Endosulfan II	3.6	5.5E+00 [y]	2.0E-02	2.9E+00 [i]	2.9E+00	2.9E+00	2.8E+02 [g2]
Endosulfan sulfate	3.1	5.5E+00 [y]	2.0E-02	2.9E+00 [i]	2.9E+00	2.9E+00	1.1E+02 [g2]
Endrin	5.6	1.9E+00 [x]	4.5E-03	2.9E+00 [i]	2.9E+00	2.9E+00	2.6E+03 [g1]
Endrin aldehyde	3.14 [4]	1.9E+00 [z]	2.0E-02	2.9E+00 [i]	2.9E+00	2.9E+00	1.2E+02 [g2]
Endrin ketone	3.14 [4]	1.9E+00 [z]	2.0E-02	2.9E+00 [i]	2.9E+00	2.9E+00	1.2E+02 [g2]
Heptachlor	4.3	1.0E+00 [aa]	2.0E-02	2.9E+00 [i]	2.9E+00	2.9E+00	1.4E+04 [g1]
Heptachlor epoxide	5.4	1.0E+00 [x]	5.9E-03	2.9E+00 [i]	2.9E+00	2.9E+00	1.4E+04 [g1]
Methoxychlor	4.8	5.7E-01 [ab]	2.0E-02	2.9E+00 [i]	2.9E+00	2.9E+00	8.3E+03 [g1]
INORGANICS							
Aluminum	——	7.5E-02 [l]	8.0E-04 [m]	7.5E-02 [n]	7.5E-02	7.5E-02	1.0E+01 [ad]
Antimony	——	5.0E-02 [l]	4.0E-02 [m]	5.0E-02 [n]	5.0E-02	5.0E-02	1.0E+00 [g1]
Arsenic	——	6.6E-03 [o]	8.0E-03 [m]	1.0E-01 [n]	1.0E-01	1.0E-01	2.8E+02 [g1]
Barium	——	7.5E-03 [l]	3.0E-02 [m]	7.5E-03 [n]	7.5E-03	7.5E-03	4.0E+00 [g1]
Beryllium	——	5.0E-02 [l]	2.0E-03 [m]	5.0E-02 [n]	5.0E-02	5.0E-02	2.0E+00 [g1]
Cadmium	——	1.1E+01 [j]	1.1E-01 [m]	2.8E-02 [n]	2.8E-02	2.8E-02	5.0E+01 [g1]
Chromium	——	1.6E-01 [j]	1.5E-03 [m]	2.8E-01 [n]	2.8E-01	2.8E-01	2.0E+02 [g1]
Cobalt	——	1.0E+00 [l]	4.0E-03 [m]	1.0E+00 [n]	1.0E+00	1.0E+00	3.0E+02 [g1]
Copper	——	1.6E-01 [j]	8.0E-02 [m]	5.0E-01 [n]	5.0E-01	5.0E-01	2.1E+02 [g1]
Cyanide	——	0.0E+00 [p]	1.0E+00 [q]	0.0E+00 [p]	0.0E+00	0.0E+00	0.0E+00 [g1]
Lead	——	[r]	9.0E-03 [m]	1.5E-02 [n]	1.5E-02	1.5E-02	3.0E+02 [g1]
Manganese	——	2.0E-02 [l]	5.0E-02 [m]	2.0E-02 [n]	2.0E-02	2.0E-02	4.0E+02 [g1]
Mercury	——	3.4E-01 [s]	1.8E-01 [m]	1.3E+01 [n]	1.3E+01	1.3E+01	6.3E+04 [g1]
Nickel	——	2.3E-01 [t]	1.2E-02 [m]	3.0E-01 [n]	3.0E-01	3.0E-01	1.0E+02 [g1]
Selenium	——	7.6E-01 [o]	5.0E-03 [m]	7.5E-01 [n]	7.5E-01	7.5E-01	8.0E+00 [g1]
Silver	——	1.5E-01 [l]	8.0E-02 [m]	1.5E-01 [n]	1.5E-01	1.5E-01	2.0E+00 [g1]
Vanadium	——	1.3E-01 [l]	1.1E-03 [m]	1.3E-01 [n]	1.3E-01	1.3E-01	1.0E-02 [g1]
Zinc	——	1.8E+00 [j]	3.0E-01 [m]	5.0E+00 [n]	5.0E+00	5.0E+00	1.0E+03 [g1]

[a] Units for bioaccumulation factors are (mg/kg fresh wt tissue over mg/kg dry wt soil) for invertebrates and plants, and (mg/kg fresh wt tissue over mg/kg fresh wt. food) for small mammals, small birds, reptiles and amphibians.

[b] Source of log Kow's: Superfund Chemical Data Matrix (SCDM), March 9, 1993, unless otherwise noted.
[1] Hansch and Leo (1979)
[2] USEPA (1992b), Dermal Exposure Guidance.
[3] USEPA (1990c) - Basics of Pump-and-Treat Ground-Water Remediation Technology
[4] Arthur D. Little, Inc. (1981).

[c] Average of earthworm BAFs (Beyer, 1990) converted from dry weight to wet weight assuming earthworm is 80% water, unless otherwise noted.

[d] Plant BAF calculated using the following equation presented by Travis and Arms (1988) unless otherwise noted: log (Plant Uptake Factor)=1.588-0.578 log Kow; if log Kow < 5, BAF assumed to be 0.02 assuming plants are 80% water.

[e] Calculated using the following equation by Travis and Arms (1988) unless otherwise noted: log (biotransfer factor) = log Kow-7.6.

TABLE 4.4
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CHEMICAL	log Kow [Source] [b]	BIOACCUMULATION FACTOR (BAF) [a]					
		Invert [c]	Plant [d]	Small Mammal [e]	Small Bird [f]	Reptiles & amphibs [f]	Fish [g]

BTF converted to BAF by multiplying by average food ingestion rate of 12 kg/d. BAF converted from wet/dry wt to wet/wet wt assuming food is 80% water.

[f] Small mammal BAF value used unless otherwise noted.

[g1] From Barnthouse et al. (1988) unless otherwise noted.

[g2] Fish BCFs calculated from Veith et al. (1985) using the following regression equation: log (BCF) = 0.79 log Kow - 0.40

[g] Geometric means of 4,4'-DDT [Davis (1968), Davis & Harrison (1966), Wheatley & Hardman (1968), Bailey et al. (1970), Cramp & Olney (1967), and Beyer & Gish (1980)], 4,4'-DDE [Davis (1968), Davis & Harrison (1966), Cramp & Olney (1967), Collett & Harrison (1968), Hunt & Sacho (1969), and Gish (1970)], and 4,4-DDD [Barker (1958), Davis (1968), Davis & Harrison (1966), Cramp & Olney (1967), Collett & Harrison (1968), Wheatley & Hardman (1968), Hunt & Sacho (1969), Bailey et al. (1970), Dimond et al. (1970), Gish (1970), and Beyer & Gish (1980)] reported for earthworms. Dry soil concentrations calculated assuming 10% moisture content in sandy-loam soils (Donahue et al., 1977).

[h] Geometric mean of 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE BAFs (fresh wt/dry wt) reported for roots (carrot, potato, sugar beet), grains (corn, oats), and legumes (alfalfa) derived from USEPA (1985) converted from dry weight to wet-weight per values provided by Suter (1993).

[i] Whole-body pheasant BAF for 4,4'-DDT presented in USEPA (1985c); derived from Kenaga (1973). Used as surrogate for other pesticides for both birds and mammals.

[j] BCF for earthworms from Diercxsens et al. (1985).

[k] Plant uptake value for leafy produce from MADEP (1992).

[l] Prey-specific value not available; value shown is small mammal BAF for this chemical.

[m] Value from Baes et al. (1984) multiplied by 0.2 to represent 80% water composition of plants.

[n] Value derived from biotransfer factors (BTFs), presented in Baes et al. (1984) for uptake into cattle. BTF converted to BAF by multiplying by food ingestion rate of 50 kg/day wet weight.

[o] Average of values for industrial soils (Beyer and Cromartie 1987) multiplied by 0.2 to represent 80% water composition in earthworms.

[p] Cyanide has not been shown to bioaccumulate in any organisms.

[q] Cyanide is naturally occurring in some plants; the extent to which it is taken up from soil is unknown and therefore a BAF of 1 is conservatively assumed.

[r] BAF from regression equation for worms derived from Corp and Morgan (1991):

$$\log Y = 1.16 + 0.916 \log(X) - 0.326 \log(Ca)$$

Where: Y = worm tissue concentration.
X = average or maximum site soil lead concentration (mg/kg).
Ca = average site soil calcium concentration (mg/kg).

Y is converted from dry weight to wet weight by multiplying Y by 0.2 (assuming worm is 80% water). This value is then divided by the lead concentration.

[s] USEPA, 1985f.

[t] Value from nickel sludge document (USEPA, 1985) multiplied by 0.2 to represent 80% water composition of earthworms.

[u] Geometric mean of reported BAFs for earthworms (Edwards & Thompson, 1973). Values provided by Gish (1970) were converted from dry weight to wet weight by multiplying by a conversion factor of 0.2 assuming 80% water composition of earthworms.

[v] Value for gamma-BHC used as a surrogate

[w] Value for gamma-chlordane used as a surrogate

[x] Geometric mean of reported BAFs for earthworms (Gish, 1970) converted from dry weight to wet weight assuming 80% water composition of earthworms.

[y] Value for dieldrin used as a surrogate.

[z] Value for endrin used as a surrogate.

[aa] Value for heptachlor epoxide used as a surrogate.

[ab] Value for 4,4'-DDT used as a surrogate.

[ac] Value for naphthalene used as surrogate.