

APPENDIX C

ECOLOGY

The Savannah River Plant (SRP) occupies a 780-square-kilometer site on the upper coastal plain of South Carolina (Figure C-1). At the time of government acquisition, approximately one-third of the site was forested and the rest was cropland. During the past 32 years, natural succession, forestry management practices, and the construction and operation of nuclear reactors and their support facilities have contributed to the current ecological complexity and diversity.

In 1972, the Savannah River Plant was designated a National Environmental Research Park. It contains perhaps one of the most intensively studied environments in this country. Wiener and Smith (1981) list more than 700 scientific publications resulting principally from research efforts by three institutions on the SRP site: the Savannah River Laboratory, the Savannah River Ecology Laboratory, and the U.S. Forest Service. Other research efforts include: (1) surveys of the aquatic ecology of the Savannah River since 1951 by the Academy of Natural Sciences of Philadelphia, (2) temperature and flow monitoring of the river by the United States Geological Survey (USGS) since 1959, (3) remote sensing of the plant using aerial imagery, and (4) various ecological studies by state government and by industry. In addition, research has been performed by visiting scientists from other universities and laboratories in the United States.

This appendix is based on these sources, and also on recent ecological studies conducted by the Savannah River Ecology Laboratory (SREL) and Environmental and Chemical Services, Inc. (ECS). These studies include research by Smith et al. (1981, 1982a,b, 1983), Du Pont (1982, 1983), and ECS (1982, 1983a,b,c). This appendix emphasizes Steel Creek and the Savannah River swamp (Figure C-1), and the "important" biota that reside there, as these areas will be impacted by L-Reactor for both the reference case (direct discharge) and the preferred cooling-water alternative (see Appendix L for more detail). The important biota are defined as species that are (1) commercially or recreationally valuable, (2) endangered or threatened, (3) important to the well-being of the species included in categories 1 and 2, or (4) critical to the structure and function of the ecosystem. |TC

C.1 SOILS

Soils are an important component of the environment because they influence the occurrence and distribution of the vegetation, wildlife, and potential land use by man. The distribution of soils of the Steel Creek watershed is shown in Figure C-2. The portion of the watershed depicted here covers approximately 20,000 acres, and includes 24 different soil types (Table C-1). The most widely distributed soils of the Steel Creek watershed include Blanton sand (14 percent), Wagram loamy sand (13 percent), Troup sand (12 percent), Orangeburg loamy sand (8 percent), Rembert sandy loam (8 percent), Fuquay loamy sand (7 percent), and Wehadkee loam (7 percent). Streambed soils of Steel Creek consist primarily

of Bibb sandy loam; these soils were scoured and eroded during previous reactor operations. The dominant texture of the surficial horizons is loamy sand and sandy loam. Slopes typically range less than 6 percent, and most soils are well drained.

C.2 VEGETATION

The phytogeography of Georgia and South Carolina includes two principal forest types. Associated with the Piedmont is the oak-hickory-pine forest whereas the southern mixed forest overlies the coastal plain (Kuchler, 1964). Dominant canopy species of the oak-hickory-pine forest include hickory, short-leaf and loblolly pine, white oak, and post oak. Beech, sweetgum, magnolia, slash and loblolly pine, white oak, and laurel oak characterize the canopy of the southern mixed forest. The southern floodplain forest, which adjoins major rivers such as the Savannah, typically consists of tupelo, numerous species of oak, and bald cypress.

The Savannah River Plant (SRP) is near the line that divides the oak-hickory-pine forest and the southern mixed forest. Consequently, species representative of each occur. In addition, SRP vegetation has been influenced strongly by farming, fire, edaphic features, and topography. There is no virgin forest in the region (Braun, 1950). Except for the nuclear production areas and their support facilities, many previously disturbed areas have been reclaimed by natural plant succession or have been planted with pine by the U.S. Forest Service.

The vegetation that will be most affected by the proposed action includes: (1) the plant communities of the Steel Creek corridor from the reactor outfall to the delta, and (2) the Steel Creek delta, which is contiguous with the Savannah River swamp (Figure C-3). The structure and species composition of these communities reflects not only the heterogeneity of the physical environment, but also the influence of previous reactor operations.

During earlier L-Reactor operations, the thermal effluent eliminated vegetation in the Steel Creek channel, floodplain, and swamp. A delta developed rapidly at the entrance of the creek to the swamp from the sediments transported down the creek. A tree-kill zone, covering about 300 acres, developed in the swamp.

These impacts were caused by the elevation of stream temperatures and marked increases in the stream flow. The discharge of thermal reactor effluents into Steel Creek before 1968 essentially eradicated the emergent and semiemergent flora, as well as portions of the swamp forest, leaving stumps and standing dead cypress and tupelo. Since 1968, when the reactor was shut down, the Steel Creek corridor and portions of the swamp have been overgrown by successional woody and herbaceous vegetation (Smith et al., 1981, 1982a).

C.2.1 Steel Creek corridor

The vegetation of the Steel Creek corridor, which is classified as palustrine wetland (Cowardin et al., 1979), varies markedly between P-Reactor and the delta. More than 85 species of plants representing 50 families were listed in this area in the summer of 1981 (Smith et al., 1981). Tables C-2 and C-3 list the structural attributes of the flora, including estimates of the species' basal area and biomass. Figure C-3 shows the distribution of the principal plant communities, including sampling locations. The following detailed list describes the characteristic vegetation in the various communities:

1. Aquatic bed

W - Open Water. The outfall canal of L-Reactor contained open water bordered by persistent herbaceous species and occasional shrubs.

2. Emergent wetland

P - Persistent. This community was dominated by dense grasses and forbs with scattered low shrubs.

N - Nonpersistent. A single small area existed just north of location 100. It was dominated by Polygonum spp. with a border of persistent herbs including cattail, burreed (Sparganium americanum), Canada rush (Juncus canadensis), and sugarcane beardgrass (Erianthus giganteus).

3. Scrub-shrub wetland

Broad-leaved deciduous

C - Cephalanthus occidentalis - Salix spp. This community consisted of a dense shrub canopy dominated by buttonbush and willow near the mouth of Steel Creek.

A - Alnus serrulata. Alder (Alnus serrulata) was the dominant species on Steel Creek, although wax myrtle (Myrica cerifera) and willow (Salix spp.) were locally abundant. Beneath these shrubs, blackberry (Rubus spp.) was abundant over a diverse herbaceous flora of Hypericum spp., false nettle, goldenrod (Solidago canadensis), wapato, jewelweed (Impatiens capensis), Polygonum spp., Aneilema keisak, cut-grass, knotgrass, and Ludwigia virgata. These herbs also covered open areas along stream channels within this vegetation type and were the dominant ground cover in some of the other woody mapping units described below.

This community generally bordered the stream channels and, for most of the length of Steel Creek, extended nearly across the width of the floodplain. Narrow strips of young hardwood trees of other species bordering the upland were included in the boundary of this unit. The height of the shrubs was greater near the mouth of Steel Creek than near the L-Reactor outfall. The density varied from nearly impenetrable thickets between

locations 60 and 70 and locations 20 and 40 to sparser concentrations between locations 40 and 60.

4. Forested wetland

Broad-leaved deciduous

- S - Salix spp. Willows exceeding 5 meters in height were dominant near the mouth of Steel Creek and in a few locations near bridges and power lines farther upstream. Occasional hardwood species (e.g., sweetgum, red maple) also occurred in the canopy. Beneath the willow was a shrub layer of alder, wax myrtle, and blackberry with sparse herbaceous cover, which included some of the plants of the alder-dominated shrubland.
- M - Myrica cerifera - Alnus serrulata. Wax myrtle and alder (as high as 7 meters) were codominant, and grew in dense stands on most of the floodplain between transects 70 and 100. Willow was also abundant. This shrub canopy was broken by occasional hardwood trees (sycamore, sweet gum, red maple) on some of the more stable sandbars. Beneath the alder-wax myrtle canopy was dense blackberry and a sparse covering of the herbs listed in the alder-dominated scrub-shrub wetland description. These herbs were also dominant in old streambeds that lack abundant woody vegetation.
- H - Liquidambar styraciflua - Acer rubrum - Salix spp. Species of trees that are typical of the upland areas adjacent to Steel Creek had also become established on some of the more stable sandbars, at stream obstructions such as bridges and dikes, and along the Steel Creek upland border, especially upstream from L-Reactor. The most frequent canopy species included tulip tree (Liriodendron tulipifera), sycamore, red maple, and sweetgum. Saplings of these trees, wax myrtle, alder, blackberry, and groundsel tree (Baccharis halimifolia) were abundant in the understory. Although nearly half of the substrate surface was covered by leaf litter, many herbs and vines occur. Chief among the herbs were sensitive fern, false nettle, Hypericum spp., sericea (Lespedeza cuneata), and goldenrod. The most frequent vines included peppervine (Ampelopsis arborea) and honeysuckle (Lonicera japonica).

Mixed deciduous

- T - Taxodium distichum - Nyssa sylvatica var. biflora. This vegetation type was dominated by cypress (Taxodium distichum) intermixed with some water gum (Nyssa sylvatica var. biflora) on parts of the Steel Creek corridor. In the Savannah River swamp, cypress and water tupelo (N. aquatica) dominated the canopy.

North of location 30, Steel Creek is narrow, bordered by alder and confined between steep banks that rise nearly 5 meters above the floodplain. Sandbars covered by persistent emergent herbs and forested wetland dominated by sweetgum, red maple, and willow occurred where the stream meanders.

Between locations 30 and 70, the stream border was dominated by dense alder 3 to 5 meters tall with a patchy ground cover. More upland areas were dominated by alder intermixed with wax myrtle and willow. Open areas dominated by blackberry and herbaceous flora occurred in partially filled remnant stream channels. This vegetation was dense where total sunlight was available, but formed a sparse ground cover beneath shrubs. Hardwood saplings bordered the upland.

From locations 70 to 110, the elevation of the Steel Creek floodplains was approximately 0.6 meter lower than the upland hardwoods. A dense growth of the wax myrtle-alder-dominated scrub-shrub wetland extended from within 10 meters of the upland to approximately 3 meters from the active stream channel. Willow was locally dominant in some areas of this corridor segment. The channel was bordered by a zone of low persistent herbs dominated by wapato, cut-grass, and Aneilema keisak. Remnant-braided stream channels and open areas elevated slightly above the stream beds were dominated by species characteristic of the alder-dominated scrub-shrub wetland. These species also formed the ground cover beneath the shrub thickets.

The vegetative composition of the lower segment of Steel Creek (from location 110 to the delta) was similar to that found in the delta. The persistent emergent wetland species described for the delta dominated the western portion of the creek. Willow and buttonbush increased in density toward the eastern bank.

C.2.2 Steel Creek delta

The Steel Creek delta, which is adjoined by the Savannah River swamp near the mouth of Steel Creek, contained several vegetative associations, four of which are differentiated by the degree of previous reactor impact and the hydrologic regime (Figure C-4). Impacted zones that have experienced structural reductions of the canopy include deepwater habitats and deltaic fan. Bottomland and upland hardwoods comprised the nonimpacted zones. Since the shutdown of L-Reactor in 1968, patterns of vegetative recovery have varied according to the hydrologic regime. The distribution of the principal plant communities was associated almost exclusively with these various zones.

The deltaic fan zone, which was formed by the deposition of sediments at the mouth of Steel Creek, consisted of a raised substrate composed primarily of organic and alluvial deposits over sand. It measured approximately 500 by 1200 meters, was stabilized by vegetation, and was traversed by many old streambeds less than 1 meter deep. The more successional advanced vegetation stages that occurred here included (1) broad-leaved deciduous forest (Salix spp.), (2) scrub-shrub wetland (Cephalanthus occidentalis - Salix spp.), and (3) persistent emergent wetland (Leersia spp.).

The impacted deepwater zone extended as an arc on the periphery of the deltaic fan. Most of the trees in this zone were destroyed during reactor operation. The zone was characterized by scattered cypress, an abundance of stumps bearing shrubs, and submergent and nonpersistent aquatic herbs. The main channel of Steel Creek flowed through this zone after passing through the delta. The rooted vascular aquatic bed, nonpersistent emergent wetland, mixed forest/

scrub-shrub wetland, and mixed scrub-shrub/rooted vascular wetland associations were well developed.

The nonimpacted deepwater zone contained mixed deciduous forest that was typical of the swamp before reactor operations began on the Savannah River Plant. The underlying substrate near the impacted zone was composed of fine particulate material less than 0.5 meter deep (Ruby et al., 1981).

The bottomland hardwood zone is generally flooded in the spring, but not during the growing season. Two types of broad-leaved deciduous forest were found exclusively in this zone: (1) areas dominated by laurel oak (Quercus laurifolia) are inundated only during the river flood stage; (2) those intermixed with overcup oak (Q. lyrata), water hickory (Carya aquatica), and water tupelo (Nyssa aquatica), might retain standing water until early in the growing season.

Figure C-5 shows the distribution of the principal plant communities of the Steel Creek delta, determined from 1978 aerial photography and field studies conducted during the summer of 1981; the classification and mapping terminology follow Cowardin et al. (1979), with minor modifications (Smith et al., 1981). All categories are termed palustrine, which includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, or emergent mosses or lichens.

Approximately one-fourth of the delta area was covered by shrub communities that were dominated by buttonbush and willow (Table C-4). Five habitat types (P, S, Qly, C/N, and T/C) were similar in area of coverage, and three minor habitat types also occurred. Forested areas dominated by cypress and water tupelo bordered the delta; their coverage was not measured. More than 123 species of plants representing 66 families were listed during the 1981 field studies. Tables C-5 and C-6 list basal areas of trees and shrubs and biomass for herbaceous flora. The following list describes the plant associations of the Steel Creek delta:

1. Aquatic bed

Rooted vascular

R - Myriophyllum brasiliense. In the impacted deepwater zone where the main flow of Steel Creek courses northeasterly, the open water, which is approximately 2 meters deep, predominates beneath scattered live bald cypress trees that are remnants from the pre-SRP swamp. Scattered stumps of dead trees supported shrubs (e.g., buttonbush (Cephalanthus occidentalis), Virginia willow (Itea virginica)), young trees (e.g., water ash (Fraxinus caroliniana), water elm (Planera aquatica)), and herbs (e.g., false nettle (Boehmeria cylindrica), marsh St.-Johnswort (Hypericum walteri)). Patches of duckweed (Lemna perpusilla) inhabit mats of submerged vascular plants such as hornwort (Ceratophyllum demersum) and parrotfeather (Myriophyllum brasiliense), which root on subsurface logs and on tree and stump bases. Where the water flow is slow, Polygonum spp. formed dense colonies.

2. Emergent wetland

Persistent

P - Leersia spp. Persistent emergent monocots dominated a large area (17.7 percent of the delta) of the deltaic fan. Except during extreme drought, the water level during the growing season was 10 to 50 centimeters deep (excluding old stream channels that are as deep as 1 meter).

Although the dominant herbaceous species varied with water depth and location on the deltaic fan, scattered shrubs (buttonbush and willow) were usually present. Cut-grass (Leersia spp.) was dominant, with redtop panicgrass (Panicum agrostoides) forming an abundant ground cover except under dense woody vegetation and in the deeper stream channels.

These grasses were usually overtopped by knotgrass (Scirpus cyperinus), that was approximately 2.5 meters tall. There were also several nearly monotypic stands of cattail (Typha latifolia). The many old stream channels that crossed the deltaic fan were dominated by the herbaceous species characteristic of the nonpersistent emergent wetland.

Nonpersistent

N - Hydrolea quadrivalvis. In this classification, emergent vascular plants that die back to the ground and leave a winter aspect of open water are considered to be nonpersistent. This characteristic was verified by a comparison of multispectral scanner images taken in March with autumn photographs; the comparison showed open-water areas with small patches of dead vegetation in the early spring and herbaceous dominance in the fall. Patches of open water as deep as 1 meter with slight, if any, flow were common here. The substrate was a deep, fine particulate mud. With the exception of the old stream channels, this vegetation type occurred only in the impacted deepwater zone.

This community contained relatively monospecific, as well as mixed, colonies of hydrolea (Hydrolea quadrivalvis), Aneilema keisak, waterpepper (Polygonum hydropiperoides), water purslane (Ludwigia palustris), and wapato (Sagittaria latifolia). These characteristic, nonpersistent species were also common in old stream beds throughout the deltaic fan in the persistent emergent and scrub-shrub wetland types.

The many standing dead trees and stumps bear such characteristic stump community vegetation as buttonbush, water ash, water elm, false nettle, and marsh St.-Johnswort.

3. Scrub-shrub wetland

Broad-leaved deciduous

- C - Cephalanthus occidentalis - Salix spp. Most of the deltaic fan was dominated by shrub and low trees. This community was heterogeneous and exhibited considerable variation in water regimes across the entire delta. It occurred in both of the impacted deltaic deepwater zones.

In the deltaic fan, where the water was less than 50 centimeters deep, buttonbush or willow dominated the uppermost layer. Buttonbush dominated the canopy in some areas and formed the understory at sites dominated by willow. Knotgrass joined the woody species in the upper stratum whereas cut-grass covered most of the ground. Redtop panicgrass, beggarticks (Bidens frondosa), false nettle, and marsh St.-Johnswort were common in many places. Climbing hemp (Mikania scandens) and peppervine (Ampelopsis arborea) were frequently found vines in the shrubland. The scrub-shrub wetland also had open areas of persistent emergent wetland and old stream channels dominated by herbs.

The scrub-shrub wetland intergraded with the persistent emergent wetland where the shrubs were sparse, and with the broad-leaved deciduous forest vegetation where willows were more than 5 meters tall and dominant.

The scrub-shrub wetland areas located in the impacted deepwater zone differed from those in the deltaic fan zone in water regime, substrate, and ground cover. The summer water depth was approximately 0.5 to 1 meter and overlaid a substrate of decomposing vegetation and fine inorganic sediment that was about 0.5 meter deep. Buttonbush was dominant above the ground-cover species described for the nonpersistent emergent wetland.

4. Mixed scrub-shrub/nonpersistent emergent wetland

- C/N - Cephalanthus occidentalis - Polygonum spp. In the impacted deepwater zone, shrubs and young trees (buttonbush, Virginia willow, water elm, water ash) were restricted to the many stumps remaining from the original forest. Scattered live bald cypress (up to 20 meters tall) were present. The stump bases had the characteristic stump-community herbs (false nettle and marsh St.-Johnswort) and several vines including poison ivy (Rhus radicans), peppervine, and wisteria (Wisteria frutescens).

Water depths here ranged from 0.5 to 2.0 meters during the typical growing season. Some of the main flow of Steel Creek coursed swiftly through this area. Lateral to this flow, the water moved sluggishly, allowing the establishment of rooted vascular plants. More than 50 percent of the surface was dominated by Polygonum spp., erect, deeply rooted, emergent annuals that die back in the winter. Nonpersistent emergent wetland species (e.g., waterpepper and Aneilema keisak) were common; submerged

aquatics, such as hornwort and parrotfeather, were abundant. In places, this herbaceous cover at the edges of the stump communities extended as a dense mat beneath the scrub-shrub canopy.

5. Forested wetland

Broad-leaved deciduous

S - Salix spp. Willow that is up to 5 meters tall with an understory of buttonbush dominated the more elevated portions of the deltaic fan. The ground was dry or flooded by less than 15 centimeters of water. The herbaceous vegetation was relatively sparse due to the dense canopy. Small patches of herbs included redtop panicgrass, waterpepper, false nettle, marsh St.-Johnswort, and sensitive fern (Onoclea sensibilis). The vines--climbing hemp and peppervine--were also common. Some small areas contained species that are typical of the persistent emergent wetland on the most shallow sites and of the nonpersistent emergent wetland in the old stream channels. Although drier and of a different species composition than the pre-SRP swamp, this was the most successional advanced vegetation type on the deltaic fan.

Qly - Quercus lyrata - Carya aquatica - Nyssa aquatica. Adjacent to and slightly higher in substrate elevation than the cypress-tupelo swamp was an area of broad-leaved deciduous trees. Although dry during most of the growing season, this area was subject to seasonal flooding of longer duration than areas on the deltaic fan. Several of the more common species in this vegetation type leaf out late in the season and can withstand flooding that lasts as late as July (Whitlow and Harris, 1979). Water marks on the trees indicated that the water was approximately 1.5 meters above the substrate at flood stage. The substrate consisted of a thin (approximately 2 centimeters) humus layer over an apparent clay-loam soil.

No single species clearly dominated this community. Some of the more consistently common species of the canopy and understory were water hickory, sycamore (Platanus occidentalis), red maple (Acer rubrum), white ash (Fraxinus americana), sweetgum (Liquidambar styraciflua), and bald cypress. Although apparently not being replaced, overcup oak and water tupelo were abundant canopy components.

The shrub layer included a sparse growth of possum haw (Ilex decidua), swamp privet (Forestiera acuminata), and hawthorn (Crataegus sp.). Rattan vine (Berchemia scandens) and bristly greenbrier (Smilax hispida) were the most common vines.

The duration and magnitude of seasonal flooding prevents persistent herbaceous ground cover. This vegetative layer was sparse except for occasional dense patches in low areas. Herbs found in widely scattered spots included dayflower (Commelina virginica), false nettle, and ladies tresses (Spiranthes sp.).

Q - Quercus laurifolia. This community occurred only on islands in the swamp that were slightly higher in elevation than the surrounding swamp and, therefore, were inundated for shorter periods. The canopy (more than 20 meters high) contained laurel oak, overcup oak, swamp chestnut oak (Q. michauxii), red maple, and water hickory. In addition, the subcanopy contained sweetgum, American elm (Ulmus americana), hackberry (Celtis laevigata), and ironwood (Carpinus caroliniana). Shrubs, including palmetto (Sabal minor), possum haw, and hawthorn, were widely scattered. Dense vines such as rattan vine, coral greenbrier (Smilax walteri), catbrier (Smilax rotundifolia), muscadine (Vitis rotundifolia), summer grape (Vitis aestivalis), pepper-vine, and poison ivy occurred in some areas. The ground was covered by leaf litter with widely scattered herbaceous plants including marsh fleabane (Pluchea rosea) and several grasses and sedges.

Mixed deciduous

T - Taxodium distichum - Nyssa aquatica. The cypress-tupelo swamp typical of pre-SRP conditions extended beyond the impacted deep-water zone to the Savannah River. Water as deep as 2 meters flowed slowly over a shallow substrate (less than 0.5 meter deep) composed of organic and fine particulate material. During the growing season, flooding is controlled by the regulation of reservoir levels upstream on the Savannah River and by the flow from Four Mile Creek and Pen Branch.

The canopy, which has more than 80-percent closure, was dominated by 20- to 30-meter-tall water tupelo and bald cypress; both can occur either as fairly monospecific stands or as mixtures of the two. Tree bases provided the primary substrate for a sparse growth of shrubs and herbs, as described above for the stump communities of the scrub-shrub/nonpersistent emergent wetland. Occasional patches of submergent and emergent plants, as described in the description of the rooted vascular aquatic bed, were found in association with submerged tree bases or debris.

T/C - Mixed forested/scrub-shrub wetland

Taxodium distichum - Cephalanthus occidentalis. This mapping unit occupied part of the impacted deepwater zone to the west of the deltaic fan. A patchy canopy of bald cypress (more than 20 meters tall) covered about 50 percent of the zone. The understory was a mixture of buttonbush, water ash, and water elm. Cut-grass dominated the ground cover; marsh St.-Johnswort and beggarticks were abundant. Where the cypress canopy was sparse, open areas were dominated by species of the nonpersistent emergent wetland intermixed with many stumps bearing woody growth.

The water depth varied from 50 to 80 centimeters (except in channels) over a deep (more than 50 centimeters) substrate of organic and fine inorganic sediment.

Smith et al. (1982b) presents a revised vegetative map of the Steel Creek delta based on more recent (1981) aerial photography. The principal difference between this map and Figure C-5 is that buttonbush and willow shrub communities have expanded into areas previously occupied by emergent grasses and other herbaceous species. Additionally, community classification was modified slightly due to a different ordination analysis. These changes are subtle and are not duplicated herein.

C.3 WILDLIFE

The abundance and diversity of wildlife that inhabits the Savannah River Plant reflect the interspersed and heterogeneity of the habitats occurring there. Emphasis was given to "important" species as defined previously, especially those fauna that inhabit Steel Creek and the Savannah River swamp, which are potentially affected by the direct discharge (reference case) and the preferred cooling-water alternative (see Appendix L).

C.3.1 Amphibians and reptiles

Because of its temperate climate and numerous aquatic habitats, the SRP site contains a diversified and abundant herpetofauna. Species having zoogeographic ranges that include the Savannah River Plant include 17 salamanders, 26 frogs and toads, 10 turtles, 1 crocodilian, 9 lizards, and 31 snakes (Conant, 1975). Many additional species have ranges that are peripheral to the site, and could also occur here. Gibbons and Patterson (1978) provide an overview of the herpetofauna of the entire Savannah River Plant, including comments on relative abundance and peripheral species accounts.

Based on field studies in 1981 and 1982, more than 1560 individuals representing 65 species were collected or observed in the Steel Creek area (Smith et al., 1981, 1982b). Ranked in order of decreasing relative abundance, frogs and toads, turtles, and salamanders comprised more than 85 percent of the species enumerated. Five habitat types were examined during the surveys: (1) the stream channel below and above the delta, (2) the delta, (3) islands, (4) floodplain, and (5) the swamp forest. Of these habitats, twice as many species were collected on the floodplain than in the other habitats; this was due in part to a greater diversity of terrestrial and aquatic microhabitats present there, and also because the floodplain is the characteristic habitat type of Steel Creek.

The most frequently captured terrestrial salamander was the slimy salamander (Plethodon glutinosus). Additionally, three species of Ambystoma were found at Steel Creek, of which the marbled salamander (A. opacum) was the most frequently captured species. The mole salamander (A. talpoideum) and the spotted salamander (A. maculatum) were uncommon. The tiger salamander (A. tigrinum), which is a winter breeder, is expected to inhabit Steel Creek but none were collected. Three species, the two-toed amphiuma (Amphiuma means), the greater siren (Siren lacertina), and the lesser siren (Siren intermedia) were the only species to be collected that are entirely aquatic throughout their life cycle.

Of the 26 species of frogs and toads that could inhabit Steel Creek, 14 were confirmed during the 1981 and 1982 surveys. Additional species will undoubtedly be obtained from future surveys planned for the breeding season. Based on their frequency of capture, the southern toad (Bufo terrestris) was the most abundant of the terrestrial species and the southern leopard frog (Rana utricularia) ranked first in relative abundance for the aquatic species.

More than half of the species of snakes documented on the Savannah River Plant also inhabit Steel Creek (Gibbons and Patterson, 1978). Based on relative abundance values, the poisonous eastern cottonmouth (Agkistrodon piscivorus) was the most common species. Watersnakes (genus Nerodia) were also abundant in aquatic habitats. Other venomous reptiles observed near Steel Creek were the canebrake rattlesnake (Crotalus horridus) and the southern copperhead (Agkistrodon contortrix).

Nine species of lizard were collected at Steel Creek. The six-lined race-runner (Cnemidophorus sexlineatus), broad-headed skink (Eumeces laticeps), five-lined skink (Eumeces fasciatus), and anole (Anolis carolinensis) ranked as the most abundant species. The glass lizards (Ophisaurus attenuatus and O. ventralis) were encountered less frequently, due perhaps to habitat restrictions.

Of the nine species of turtles documented on the Savannah River Plant, all but the spiny softshell (Trionyx spiniferus) were collected in the Steel Creek area. Turtles were found in all aquatic areas, but most abundantly in the delta and floodplain. Turtles inhabiting the swamp forest were either the more terrestrial species (e.g., box turtles) or were nesting females of aquatic species. Pseudemys scripta, a turtle ubiquitous in southeastern aquatic areas, was the most common; more than 200 individuals were captured, marked, and released during the summer. Several river cooters (P. concinna) were captured in the delta and in the stream channel between the delta and the Savannah River. This riparian species has never been reported from lentic habitats on the Savannah River Plant and is not expected to be common in the delta or in upstream areas. The relative abundance of eastern mud turtles (Kinosternon subrubrum) and musk turtles (Sternotherus odoratus), when compared with other species, was similar to that observed in other aquatic areas on the site. The striped mud turtle (Kinosternon bauri) has been collected in the Steel Creek system. Populations of these species probably occur throughout the Steel Creek ecosystem.

Alligator

The American alligator, an inhabitant of wetland ecosystems in the Southeast, was threatened with extinction in the 1950s and 1960s. It is listed as endangered by the Federal Government (USDOI, 1983), and threatened by the State of South Carolina. The SRP is near the northern limit of the alligator's range; in this region, winter temperatures probably restrict its distribution.

Earlier studies of the fauna of the SRP site (Freeman, 1955; Jenkins and Provost, 1964) indicate that the alligator has always been a resident of the area. Its abundance probably increased following closure of the area to the public. This isolation afforded protection from hunting for several years before such protection was provided legally.

Murphy (1981) reported sightings of alligators in the Savannah River swamp and in the major SRP streams. Alligator breeding habitat with documented nests

exists along the backwater lakes and in the swamp associated with Beaver Dam Creek, which enters the swamp several kilometers upstream from Steel Creek.

Although much of Steel Creek and the Savannah River swamp do not contain vast areas of optimum alligator habitat, patches of quality habitat are present. There are beaver ponds and Carolina bays near the river swamp or creek floodplain margins, open-water oxbow lakes, and open-canopied, marshy areas typical of productive alligator habitat described by Joanen (1969), Joanen and McNease (1970), and Smith et al. (1981, 1982a).

Studies of the American alligator in the Steel Creek ecosystem were begun in 1981 and have included censuses by foot, boat, and air, capture and release, and radiotelemetry (Smith et al., 1981, 1982a,b). These investigations have confirmed that alligators utilize the Steel Creek ecosystem from the L-Reactor outfall to the Steel Creek delta and swamps, including other areas near Steel Creek such as Carolina bays, backwater lagoons, and beaver ponds. The population of alligators in the Steel Creek ecosystem was estimated to range between 23 and 35 individuals (Smith et al., 1982b). Sex ratios and size data suggest a higher reproductive potential in Steel Creek than is known for Par Pond, where nearly 80 percent of the adults are males (Murphy, 1977).

Studies of the wintering behavior and movements of alligators in the Steel Creek ecosystem were initiated in 1981 (Smith et al., 1982a). Generally, it was found that alligators on the SRP site do not utilize over-wintering dens, but remain active whenever winter temperatures are suitable. Alligators were able to survive with a body temperature as low as 3.3°C, the coldest ever recorded for a free-ranging alligator. Based on studies using three individuals, alligators move between the lagoons near S.C. Highway 125, and utilize the swamp forest below the Steel Creek delta (Smith et al., 1982b). A single alligator nest was located at the edge of the Steel Creek delta, but hatching was unsuccessful. No additional nests have been subsequently found.

AB-4 | These studies were based on the direct discharge alternative. After DOE selected the 1000-acre lake as the preferred cooling water alternative, new studies were conducted and a new biological assessment was transmitted to FWS (Sires, 1984a). Temperatures in 50% of the lake and in Steel Creek below the embankment would be less than 32.2°C, and the critical thermal maximum temperature for alligators is 38°C. DOE is awaiting a decision on its conclusion that operation of L-Reactor under the preferred alternative would not jeopardize the continued existence of the species.

C.3.2 Avifauna

The avifauna of the Steel Creek ecosystem are among the most mobile of the vertebrates. Some species, termed resident, inhabit SRP environs year round. Others, termed migrants, use the area enroute to their breeding and wintering grounds. Several species either winter or breed in the area. Habitat affinities of birds range from cavity-nesters such as wood ducks to red-winged black-birds, which typically nest among emergent cattails. These species-specific attributes, the isolation of the SRP site from the public, and its proximity to the Atlantic Flyway, all contribute to an abundant and diversified avifauna.

The SRP avifauna have been studied by several investigators. Norris (1963) surveyed the Savannah River Plant but presented little information about Steel Creek. Fendley (1978) initiated a study of the wood duck in the Steel Creek drainage system in 1973 that continues to date. Angerman (1979, 1980) listed 59 species on the Savannah River Plant during Christmas bird counts, but did not include specific observations along Steel Creek.

Birds of the Steel Creek ecosystem were investigated in summer 1981 at eight locations using a combination of strip censuses, mist nets, and aerial surveys. A total of 1062 birds representing 59 species was tabulated during the survey (Smith et al., 1981). These data reflect only summer populations, and winter surveys would undoubtedly augment this listing. Avifauna that potentially winter on the Savannah River Plant are listed by Smith et al. (1981).

The avifauna listed along Steel Creek in the summer of 1981 also probably breed there. Active nests of the Bachman's sparrow, parula warbler, and red-headed woodpecker were observed, as were juveniles of 22 other species. The white-eyed vireo was the most abundant species based on all census techniques, followed closely by the Carolina wren. The frequency of observation or capture of the other species was relatively similar, and no single species dominated the census results.

Waterfowl

Waterfowl are among the most important members of the Steel Creek avifauna. Because of the interspersed habitats and isolation from the public, the Steel Creek delta and Savannah River swamp provide an important regional sanctuary and refuge for waterfowl.

Based on ground counts and aerial surveys, nine species of waterfowl have been observed in the Steel Creek delta area. The wood duck is the only species of waterfowl to breed commonly in the SRP region, and is present throughout the year. Wintering populations are larger than summer populations because of the influx of migratory wood ducks from the north. Wood ducks banded in the fall on the SRP site have been recovered in Minnesota, Wisconsin, and Ontario, as well as in South Carolina. In general, the remaining species are present only during the fall and/or winter months, although hooded mergansers may occasionally breed on the SRP site. In previous years, shovelers (Athya clypeata) and lesser scaup (A. affinis) have also been observed in the Steel Creek delta area (Angerman, 1979, 1980).

The mallard and wood duck dominated the Steel Creek delta area waterfowl community (Figure C-6). The frequency distribution of the number of each species observed was rather consistent, with mallards being dominant in all three years and wood ducks ranking second in two of three years. These two species also comprise the largest proportion of the hunter's bag in South Carolina. Use of the Steel Creek delta area by other species was generally low. Flocks of 50 green-winged teal, 25 American widgeon, 20 hooded mergansers, 1 pintail, and 1 bufflehead were observed during the fall and winter of 1981 and 1982.

Waterfowl used the Steel Creek delta extensively for both feeding and roosting (Figure C-7). Typically, they moved at dusk from the feeding grounds to a common roosting area where they spent the night. The roost area, which was

characterized by dense buttonbush, provides good overhead protection from predators. In addition to numerous feeding areas in the delta (Figure C-7), waterfowl also fed extensively in the adjoining cypress-typelo forest.

Approximately 100 mallard were observed roosting in the Steel Creek delta in November and early December 1982 (Figure C-8). By mid-December, this number increased to 700. A minimum of 600 mallards roosted in the Steel Creek delta until March when numbers declined. The maximum number of mallards observed was slightly more than 1100 individuals on February 17, 1983.

The wood duck also roosted in the Steel Creek delta (Figure C-9) but in lesser numbers than mallards. Over 400 wood ducks were observed in January 1983 using the Steel Creek delta roosting area. Numbers declined in late January and leveled out through February and March.

Wood ducks have responded rapidly to the long-term nesting box program in the Steel Creek area. Studies have shown a general decline in the quality of nesting habitat in the Steel Creek area, but excellent brood habitat is present (Smith et al., 1981, 1982b).

Aerial surveys (Figure C-10) over the Steel Creek delta area, Pen Branch delta, Four Mile delta area, and Beaver Dam Creek revealed substantial use by mallards. However, waterfowl were never observed in Pen Branch delta. Mallard use of the Four Mile delta area in 1982 was generally higher than that of Steel Creek (Figure C-11). Mallards in the Four Mile delta area were associated with open channels that branch off the main delta at a 90° angle (Figure C-10). Mallards were observed in these channels whether C-Reactor was up or down except during the December 30 and January 5 surveys when C-Reactor was operating and the swamp water level reached a peak. During this period, the Savannah River had breached its levee and normal water flow across Four Mile delta was disrupted.

Hot water normally flows in a southwesterly direction across the delta toward the river and does not flow directly into the open channels. However, during peak water levels, hot water was probably diverted directly into the open channels making them unsuitable for use by waterfowl. Thus, the open channels associated with Four Mile delta were heavily used by waterfowl except during periods when normal water flow is disrupted.

During 1983, however, the number of mallards utilizing the Steel Creek delta area was markedly higher than Four Mile or Beaver Dam Creek (Figure C-11). This was attributable to consistently higher water levels and the greater availability of food.

These open channels exist because of the area's topography. Hardwood islands prevent the flow of hot water directly into these channels during periods of normal water levels. Around Pen Branch, similar open channels have not developed because of the different orientation of the hardwood islands. Although two hardwood islands are present in Steel Creek delta it is unlikely that suitable waterfowl habitat will develop between them after L-Reactor restart because flow from Steel Creek moves directly between the islands.

Wood stork

The wood stork, which is the only "true" stork to nest in the United States, has experienced a 75-percent decline in its population since the 1930s. It is classified as endangered by the State of South Carolina and the U.S. Fish and Wildlife Service (Federal Register, 1984).

AD-3

Although the wood stork once nested throughout the coastal region of the southeastern United States from Texas to South Carolina, (Palmer, 1962) they currently nest only in Florida and Georgia. The most northern rookery in the United States, the Birdsville rookery, is in Jenkins County, Georgia; it was discovered in July 1980. The cypress swamp surrounding the Birdsville colony is privately owned. At present the Georgia Department of Natural Resources leases the land and patrols the stork colony.

AD-1,
AD-3,
AY-2

Two wood storks were observed in the Savannah River swamp in 1981; one bird was sighted between Pen Branch and Four Mile Creek deltas, and one was observed between Steel Creek and Pen Branch deltas. Since these sightings were recorded, more intensive surveys using aerial censuses and habitat analysis have been conducted by the Savannah River Ecology Laboratory.

Wood storks were sighted on 14 different dates between May 31 and September 3, 1982 (Table C-7). Of the 53 individuals that were observed flying and foraging, all but 3 observations occurred in the Steel Creek delta.

AD-1,
AD-3,
AY-2

A total of 478 wood stork observations were made on the SRP site in summer 1983. These surveys showed that large concentrations of wood storks foraged in the swamp near Steel Creek and Beaver Dam Creek deltas (Table C-7). Small numbers were also recorded for Four Mile Creek and Pen Branch deltas. Wood storks have been followed from the Birdsville rookery to the Savannah River Plant, a distance of 45 kilometers, where they foraged in the swamp.

The sightings of wood storks in Steel Creek delta corresponded closely with wood stork activity at the Birdsville rookery. In July 1980, 200 nesting wood storks were present at this rookery (Georgia Department of Natural Resources, 1980), and more than 20 wood storks were seen at one time over Steel Creek delta. In 1981, wood storks at the Birdsville rookery did not complete the nesting cycle, and by June 6, 1981, only three storks remained there (Georgia DNR, 1981). Only four wood stork sightings were made in 1981. However, approximately 115 to 130 adult wood storks were present at the Birdsville rookery from April through July 1982, and nests were observed to contain feathered young. In 1983, a total of 238 breeding adults was present at the Birdsville rookery; this corresponded to the maximum number of 478 recorded observations at the Savannah River Plant.

The Birdsville rookery produced more than two wood storks per nest in 1983 (Table C-8). A productivity of 1.7 storks per nest is considered adequate to maintain stork population levels (Ogden and Patty, 1981). Many of the nests at Birdsville in 1983 contained three young (one contained four), which indicates that food resources were abundant at feeding areas.

AD-1,
AD-3,
AY-4

Foraging sites in the SRP Savannah River swamp system ranked significantly higher ($P < 0.05$) than other sites when comparing the mean number of storks

Table C-7. Date, number, and locations of wood storks observed on the Savannah River Plant site, 1982 and 1983^a

Date	Number observed	Location
1982		
May 31	2	Bulldog Bay
June 11	1	Steel Creek delta
June 15	1	Steel Creek delta
June 18	1	P-Reactor
June 23	1	Steel Creek delta
June 25	1	Steel Creek delta
June 29	5	Steel Creek delta
July 1	1	Steel Creek delta
July 20	1	Steel Creek delta
July 22	1	Steel Creek delta
August 6	2	Steel Creek delta
August 27	14	Steel Creek delta
September 2	11	Steel Creek delta
September 3	11	Steel Creek delta
1983		
June 23	5	Pen Branch swamp
June 25	2	Four Mile swamp
June 28	2	Steel Creek delta
June 30	23	Steel Creek delta
July 1	29	Steel Creek delta
July 1	28	Beaver Dam Creek swamp
July 2	32	Beaver Dam Creek swamp
July 2	36	Pen Branch swamp
July 11	43	Steel Creek delta
July 12	17	Beaver Dam Creek swamp
July 12	5	Steel Creek delta
July 12	3	Pen Branch delta
July 13	195	Beaver Dam Creek swamp
July 14	30	Beaver Dam Creek swamp
July 25	1	Beaver Dam Creek swamp
July 27	1	Beaver Dam Creek swamp
July 27	2	Four Mile Creek swamp
July 28	1	Four Mile Creek swamp
July 30	3	Pen Branch swamp
August 1	11	Beaver Dam Creek swamp
August 3	9	Four Mile Creek swamp

^aAdapted from Smith et al. (1982a, 1983).

TC

Table C-8. Results of wood stork nest survey, Birdsville, Georgia

Year	Number of active nests	Mean number of young per nest ^a
1980	100 ^b	2 ^b
1981	failed	0
1982	60 ^b	no data
1983	113 ^c	2.19 ^c

^aYoung at least 5 weeks old.

^bEstimated from ground or aerial surveys.

^cActual count from 26 nest trees.

observed at all SRP sites (29.8) with those observed at other sites (8.4) before fledging (Table C-9). After fledging, juveniles and adults were recorded foraging at non-SRP sites. Juveniles did not use SRP foraging sites. Foraging sites at the Steel Creek delta attracted an average of 19.3 storks, which was not statistically higher ($P > 0.05$) than the average of 8.4 storks observed at other sites not located on the SRP.

After July 12, 1983, wood storks were not recorded in the Steel Creek delta, even though they were present at other SRP sites (Table C-7). On this date or soon thereafter, the water depth at site 012 in the Steel Creek delta increased to 48 centimeters (from 18 centimeters) due to cold-flow testing at L-Reactor. Depths at site 012 remained between 44 and 48 centimeters through September 1983. High water resulting from SRP reactor testing prevented storks from feeding because the fish that were originally concentrated in shallow pools had dispersed.

A majority of the wood stork's foraging sites (39 percent) were within 10 kilometers of the Birdsville colony. Surveys indicated that only a few sites were found greater than 50 kilometers from the colony. However, 24 percent of the sites were located between 40 and 50 kilometers from Birdsville. This includes the foraging sites at SRP swamps. These results indicate that the Savannah River Swamp, particularly the deltas of Beaver Dam Creek and Steel Creek, represent important feeding habitat for wood storks of the Birdsville rookery.

A recent biological assessment on the wood stork was submitted to FWS for their consideration (Sires, 1984b). The assessment concluded that the proposed L-Reactor operation and 1000-acre lake construction and operation would not jeopardize the continued existence of the wood stork.

AD-1,
AD-3,
AY-2

Table C-9. Mean number of wood storks observed foraging at SRP sites and other sites before and after fledging of young from the Birdsville, Georgia, colony

Site	Number of sites	Mean ^a	S.D.
SRP SAVANNAH RIVER SWAMP SYSTEM SITES ^b			
Beaver Dam Creek	5	37.2	30.3
Pen Branch	1	24.0	--
Steel Creek	3	19.3	15.5
All SRP sites	9	29.8	24.5
OTHER SITES (NOT LOCATED ON SRP)			
Before fledging	18	8.4	7.1
After fledging	23	14.3	14.6
Total sites	50	14.5	16.4

^aMean based on maximum number of storks observed at each site.

^bStorks foraged at SRP swamps only before fledging (July 25 to 28, 1983).

C.3.3 Mammals

More than 40 species of mammals have zoogeographic ranges that include the Savannah River Plant (Burt and Grossenheider, 1976; Golley, 1966); 25 of these are known to occur near Steel Creek (Smith et al., 1981). The presence of two additional species, the muskrat (Ondatra zibethica) and the black bear (Ursus americanus), was confirmed near Steel Creek, even though their documented ranges do not include Savannah River Plant. Transient occurrences along the river floodplains by the black bear are not considered uncommon.

Based on the use of drift fences, pitfall traps, and the board transects during the summer of 1981, the short-tailed shrew (Blarina brevicauda), the least shrew (Cryptotis parva), and the southeastern shrew (Sorex longirostris) were determined to be the most frequently captured small mammals. The Steel Creek delta provided habitat for the rice rat (Oryzomys palustris), and the eastern wood rat (Neotoma floridana) and hispid cotton rat (Sigmodon hispidus) also occur there. The gray squirrel (Sciurus carolinensis), fox squirrel (Sciurus niger), and southern flying squirrel (Glaucomys volans) were common in the upland and lowland forests along Steel Creek. Large mammals, such as the feral pig (Sus scrofa) and the white-tailed deer (Odocoileus virginianus), were common on the Steel Creek floodplain and delta. Other inhabitants of the floodplain and delta included the raccoon (Procyon lotor), opossum (Didelphis

marsupialis), and gray fox (Urocyon cinereoargenteus). Signs of the beaver (Castor canadensis) were common along the length of Steel Creek and one dead individual was observed between Road A and Cypress Bridge.

C.4 AQUATIC BIOTA

Six major aquatic habitat types occur on the SRP site: small ponds, Carolina bays, reservoirs, streams, and the Savannah River and its associated floodplain swamp. The standing waters vary in size from less than 1 acre to about 2800 acres. Flows in the various streams range from less than 0.028 to 11 cubic meters per second.

The floodplain swamp, which includes the Steel Creek delta, bordering the river is the least known aquatic habitat on the Savannah River Plant. Its possible use as spawning and rearing grounds and as nutrient sink are largely unknown. It is quite diverse as distinct water courses alternate with braided channels and broad flats of barely perceptible water movement. It is also one of the most variable habitats, experiencing depth fluctuations of 4 meters or more and, also, the input of thermal effluent from three SRP sources.

C.4.1 Aquatic flora

In running-water environments like the Savannah River, attached algae (periphyton) are the predominant primary producers. Much of the phytoplankton (floating algae) community consists of true planktonic forms as well as detached periphytic forms that are discharged from upstream reservoirs and from backwaters and tributary streams.

The algal flora of the Savannah River are dominated by diatoms, although blue-green algae are at times an important component, particularly at upstream locations that are subject to organic enrichment from municipal effluents from the communities of Augusta and Horse Creek Valley. The greatest algal diversity consistently occurs during the summer, coincident with low river flow and decreased turbidity, which allows greater light penetration.

Approximately 400 species of algae have been identified from the Savannah River near the Savannah River Plant (Patrick et al., 1967). Since 1951, when algal studies began, diversity has decreased. Patrick et al. (1967) suggested that this reflects an increase of organic loading to the river from the area above the Savannah River Plant (ANSP, 1961; 1974).

Aquatic macrophytes in the river, most of which are rooted, are limited to shallow areas of reduced current and along the shallow margins of tributaries. Eight species of vascular plants have been identified from the river adjacent to the Savannah River Plant, the most abundant being water milfoil, hornwort, alligatorweed, waterweed, and duck potato (Georgia Power Company, 1974).

In the SRP streams that receive thermal effluents, the flora are greatly reduced, reflecting the influence of high flows and elevated (greater than 40°C)

water temperatures. In these areas, thermophilic bacteria and blue-green algae thrive where no other aquatic life occurs.

Vegetation mapping of the Steel Creek delta and swamp conducted by the Savannah River Ecology Laboratory (Smith et al., 1981) revealed a deepwater zone where the main flow of Steel Creek courses toward the Savannah River and the hardwood canopy is reduced. In this area, the vegetation was dominated by submerged and emergent macrophytes. Patches of duckweed (*Lemna perpusilla*) collected on mats of submerged vascular plants such as hornwort (*Ceratophyllum demersum*) and parrotfeather (*Myriophyllum brasiliense*) that root on subsurface logs, trees, and stumpbases. Where the water flow was slow-moving, *Polygonum* spp. formed dense colonies.

C.4.2 Aquatic fauna

C.4.2.1 Macroinvertebrates

Shallow areas and quiet backwaters of the Savannah River near the SRP site supported diverse aquatic invertebrate assemblages; however, the bottom substrate of most open portions of the river consisted of shifting sand that does not provide optimum habitat for bottom-dwelling organisms. The total number of invertebrate species occurring in the river decreased sharply during the 1950s which has been attributed primarily to the effects of dredging (Patrick et al., 1967). The stabilization of river discharges and the elimination of habitat caused by the reduction in flooding of backwater areas, as well as organic loading above Savannah River Plant, might also have contributed to the decline. Some recovery occurred during the early 1960s, but complete recovery has not taken place. The groups most affected were those sensitive to the effects of siltation and substrate instability. Of the insect fauna, mayflies and dragonflies had the largest number of species in earlier surveys. Since the decline in species between 1955 and 1960, dipterans (true-flies) have been represented by the most species.

To evaluate the effects of thermal loading to SRP streams, Howell and Gentry (1974) compared the aquatic insect populations of Upper Three Runs Creek (natural stream), Pen Branch (thermal stream), and Steel Creek (post-thermal stream). The Pen Branch stream had overflowed its banks with heated water, causing a floodplain in which the trees had been killed. This led to exposure of the stream to direct sunlight. There was also considerable siltation. The macroinvertebrate associations in Pen Branch were characterized by low diversity and low evenness. The absence of caddisflies, stoneflies, and mayflies in this stream indicated that a significant portion of the natural aquatic insect community had been eliminated by thermal effects. The few remaining insect populations were large, which is indicative of thermal influence.

Between March 13 and August 29, 1982, the macroinvertebrate drift community was sampled as part of the Biological Measurement Program in the Savannah River (ECS, 1983b). Sample sites included the Savannah River, the pumphouse intake canals, as well as the mouths of Upper Three Runs Creek, Four Mile Creek and Steel Creek. A total of 131,815 macroinvertebrates was collected representing 47 insect families and 6 non-insect groups.

The most abundant insect family collected was the true-fly family, chironomidae (midges), which comprised 66.2 percent of the total macroinvertebrates collected. Macroinvertebrate drift communities with a predominance of true-flies are typical of riverine habitats.

Other abundant taxa included mayflies, caddisflies, scuds, water mites and nematode worms. When the invertebrate community was examined with respect to functional feeding groups, insect collectors (which feed on small organic particles in the water) were found to be the most abundant functional group, accounting for 64 to 85 percent of the organisms collected. Non-insect piercers (which feed by sucking plant juices), consisting entirely of water mites; these were very abundant in the canals, and comprised 13 to 18 percent of the invertebrate fauna. Snails were infrequently found in the drift samples, although they are abundant in the river.

In general, samples from the pumphouse intake canals and the creeks contained significantly fewer taxa than did the river samples. The mean density of macroinvertebrates was also less in the canals and Upper Three Runs Creek and Steel Creek than in the river.

There were fewer true-flies and caddisflies in the canals and more beetles and water mites, based on qualitative collections. True-flies were less abundant in creeks than the river. Upper Three Runs Creek had higher percentages of mayflies, caddisflies, beetles and stoneflies than river collections, but no scuds. Four Mile Creek, which is thermally affected, had a high percentage of mayflies, mostly Caenidae, but low percentage of caddisflies, beetles and water mites. Steel Creek, which has heated water from Pen Branch in its lower one kilometer, had more abundant scuds than the river transects.

An investigation of the aquatic invertebrate communities living on wood substrates and submerged macrophytes in the Steel Creek stream-swamp ecosystem was conducted by the Savannah River Ecology Laboratory in the upper and lower reaches of Steel Creek and in the floodplain swamp (Smith et al., 1982b). The habitats were selected based on preliminary investigations and current literature that showed them to be the most diverse, to have the highest productivity and to be the most closely associated with fish trophic dynamics in the swamp.

Sampling sites of snags were located along a continuum from the rapidly flowing sections of Steel Creek above the floodplain swamp, through the swamp to the lower portion of the creek, which flows rapidly from the swamp to the Savannah River. Results of collections revealed significant differences between sampling sites in terms of species density, richness and colonization patterns. Many of the same invertebrate taxa occurred at the sampling sites in upper and lower Steel Creek, although organism density and diversity were much higher in the upper reach than in the lower reach and were lowest in the swamp. An abundant macroinvertebrate population was also associated with macrophyte beds in the swamp. Abundance varied significantly between plant species and was generally dominated by amphipods. These invertebrate populations on macrophytes may form a significant source of fish food in the swamp.