will be used here for net removal of nutrients from stream water, including retention and mass efflux, after correction for dilution.

Denitrification is an important pathway by which inorganic N is removed from wet soils and stream waters (*e.g.*, Engler and Patrick 1974; Gambrell *et al.* 1975 a, b; Gilliam and Jacobs 1983; Duff *et al.* 1984), but biological uptake by decomposing litter may also be important (Qualls 1984). Phosphorus in wetland stream or flood waters is often removed quite effectively (Nichols 1983) by sedimentation, biological uptake, and soil fixation (Kuenzler *et al.* 1980; Richardson 1985). The data summarized in Nichols (1983) for several Northern wetlands shows decreasing efficiency of removal with loading rate and with duration of loading.

Management of nutrient inputs to the Albemarle-Pamlico System would be improved by information on rates of nutrient removal by swamps and on factors controlling removal processes. The objective of this study was to provide additional knowledge and understanding of nutrient removal rates below point sources by bottomland forest systems bordering our Coastal Plain streams. Knowledge of nutrient loading rates from the watershed, as affected by swamp removal, is necessary to forecast the rate of eutrophication in the Albemarle-Pamlico system. Understanding of the ability of riparian systems to remove nutrients will aid management decisions regarding the need for more intensive municipal waste treatment, for extension of Best Management Practices to more farms, and for protection of streams with functioning riparian zones from channelization or other destruction.

THE STUDY AREAS

Several riparian swamp and bottomland sites on the North Carolina Coastal Plain were selected by methods given below. This region is characterized by low elevations, gentle slopes, sandy-to-clayey soils, abundant rainfall, sluggish streams, high water tables, and abundant wetlands. Many municipalities have been permitted to discharge their wastewaters into streams bordered by forested bottomlands or swamps. There were differences among sites, but all were selected because their streams had substantial areas of forested wetlands.

The "extensive" study included seven sites, all but one of which (Clarkton) was in the Albemarle-Pamlico region (Fig. 1; Table 1). Four or five stations at each site were sampled quarterly for one year. At a typical site, one station was upstream of the wastewater outfall, another was at the outfall, and two or three were along the stream below the outfall. Watershed areas above the outfalls on these streams varied from