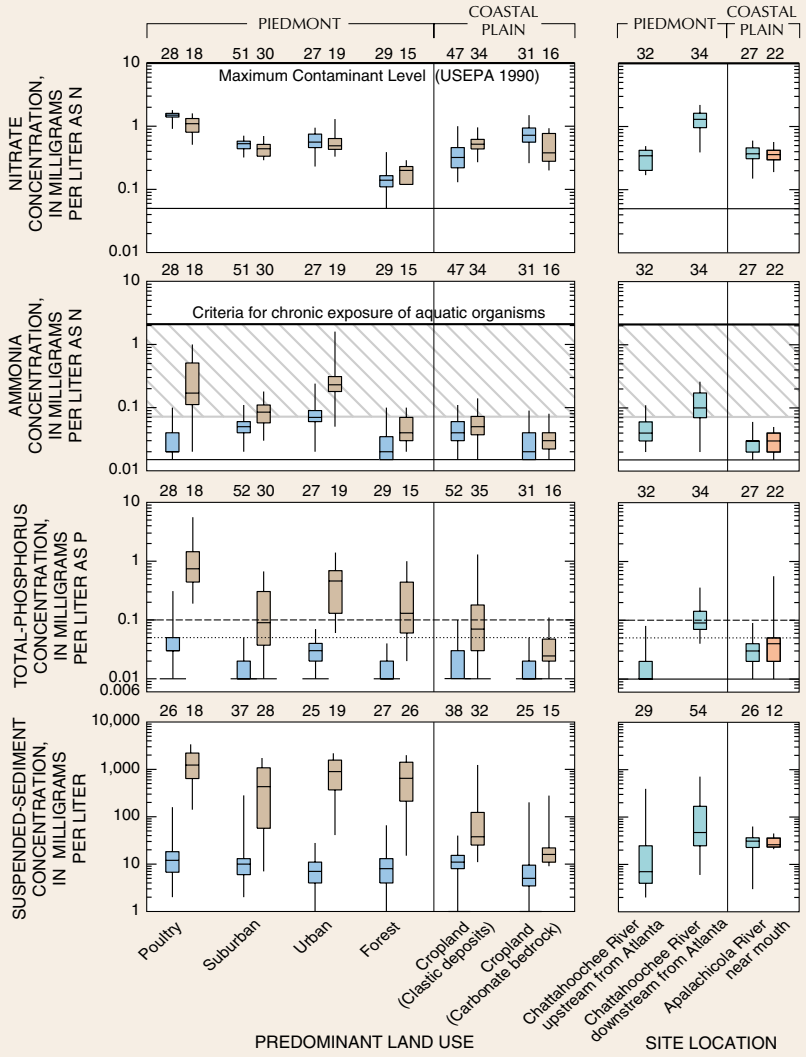
The land-use based design of the ACF River Basin NAWQA study provides an improved understanding of nutrient and suspended-sediment concentrations and yields in streams in the ACF River Basin. Differences in nutrient concentrations and yields among predominant land-use settings provide preliminary guidance for water-resource managers to focus efforts to control nutrients and suspended sediment in varying land-use settings.

Analysis of data for the years 1972 to 1990 from stream-water-quality monitoring networks provided a good understanding of the occurrence and distribution of nutrients in main-stem rivers and, to a lesser extent, in reservoirs and large tributaries (Frick and others, 1996). However, because these networks focused on regulatory compliance upstream from drinking-water-supply intakes and downstream from wastewater-treatment plant outfalls, some monitoring sites were affected by point sources that tend to mask land-use effects on water quality.

Nitrogen and phosphorus are essential nutrients for plant life but when present in water at high concentrations they accelerate eutrophication of rivers and lakes. High concentrations of ammonia are toxic to aquatic life, and high concentrations of nitrate, primarily in ground water, are toxic to humans and other animals.

Sources of nutrients in the ACF River Basin include:

- Point sources: municipal and industrial wastewater effluent, and sanitary and combined sewer overflows.
- Nonpoint sources: animal manure, primarily chicken litter; fertilizer; runoff from agricultural, urban, and suburban areas; septic systems; atmospheric deposition; and decomposition of organic matter.



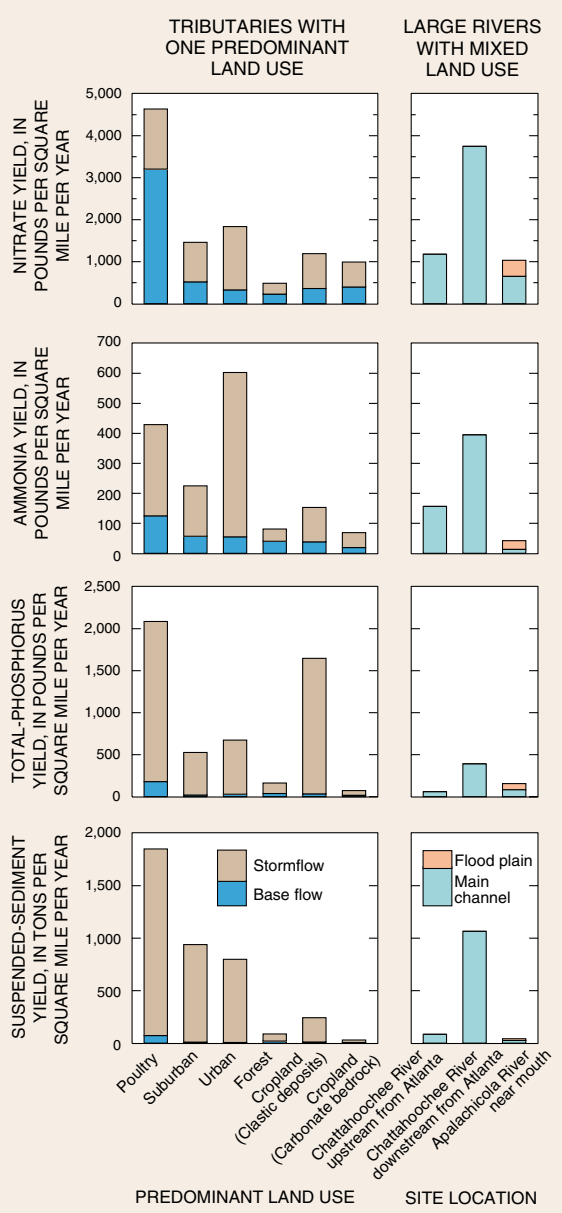
Concentrations during stormflows were significantly higher than during base flows for total phosphorus and suspended sediment at all tributary sites and for ammonia at poultry, suburban, and urban sites. Nitrate concentrations were highest in base-flow samples at the poultry site, indicating relatively high nitrate concentrations in ground water (page 17) that discharges to streams. Nutrient and suspended-sediment concentrations were significantly higher in the Chattahoochee River downstream than upstream from Atlanta. USEPA criteria for total phosphorus was most often exceeded during stormflow conditions at the poultry, urban, and suburban sites, and in the Chattahoochee River downstream from Atlanta. No ACF River Basin samples exceeded the ammonia criteria.

Since the early 1970's, substantial progress has been made toward reducing point sources of nutrients throughout much of the ACF River Basin (Frick and others, 1996). However, there are limited historical water-quality data from tributary streams to estimate nonpoint-source inputs of nutrients from individual land uses.

In streams, nutrient and suspended-sediment concentrations (page 14) and yields (page 15) are highly dependent on inputs from point and nonpoint sources, land-disturbing activities, and basin hydrology. The six Fixed Sites representing one predominant land use have no treated-wastewater outfalls upstream; however, there are two combined sewer overflows upstream from the urban site. During the study period, stormflow accounted for as low as 36 percent of annual volume of water at the poultry site, to as high as 82 percent at the urban site. Daily water releases from Lake Sidney Lanier account for much of the streamflow in the Chattahoochee River; therefore, streamflows were not separated into base flow and stormflow at sites upstream and downstream from Atlanta. Near the mouth of the Apalachicola River, approximately 40 percent of the flow is in the flood plain during high river stages.

The Basic Fixed Site at which poultry production was the predominant land use within the watershed had the highest concentrations and yields of nitrate, total phosphorus, and suspended sediment and the second highest concentrations and yield of ammonia of all Fixed Sites in the ACF River Basin. The primary nutrient source within this watershed and in most of the Chattahoochee River Basin upstream from Lake Sidney Lanier is poultry litter applied as fertilizer to pasture land (Frick and others, 1996). The base-flow component of nitrate yield at the poultry site is the only nutrient or suspended-sediment base-flow component that accounts for more than 50 percent of the annual yield. Water recharging shallow ground water in the area is enriched in nitrate primarily from poultry litter, which in turn enriches nitrate concentrations in ground water, the source of most base flow. In contrast to other nutrients and suspended sediment in various land-use settings, reducing nitrate yields in streams in watersheds characterized by poultry land use will involve reducing nitrate concentrations in ground water in addition to reducing concentrations in runoff during stormflow.

The predominantly urban and suburban sites and the Chattahoochee River downstream from Atlanta have relatively high nutrient concentrations and yields. Nutrient concentrations and yields at the suburban site are similar but slightly lower than at the urban site, with two exceptions. The first is that ammonia concentrations and yield are significantly lower at the suburban site because there are no combined sewer overflows. The second is that, although suspended-sediment concentrations are slightly lower at the suburban site, yield is slightly higher, probably as a result of more construction and development throughout the predominantly suburban watershed or construction at the sampling site, or both. High nitrate concentrations and yield in the Chattahoochee River downstream from Atlanta are primarily the result of nitrogen in wastewater effluent.

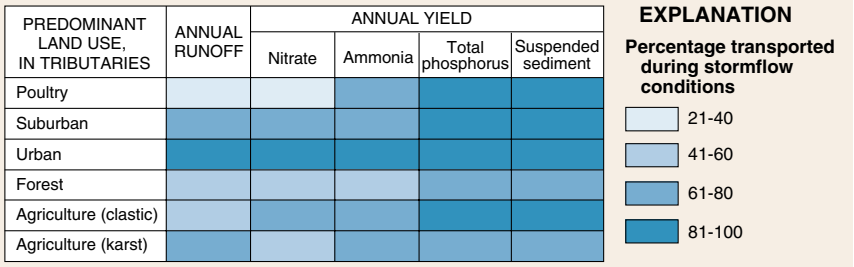


Yields are calculated by dividing the amount of a compound flowing out of a watershed by the drainage area to facilitate comparisons among watersheds of different sizes. Within the ACF River Basin, highest nitrate yields are primarily the result of elevated nitrate concentrations in ground water in the watershed characterized by poultry land use and wastewater effluent in the Chattahoochee River downstream from Atlanta. Highest ammonia yields are associated with discharges of untreated wastewater upstream from the urban site, high ammonia concentrations during stormflow upstream from the poultry site, and wastewater in the Chattahoochee River downstream from Atlanta. Highest total-phosphorus yields are primarily the result of total-phosphorus concentrations during stormflow at the poultry site, and phosphorus associated with organic detritus, rather than as forms that can be directly linked to fertilizer applications, at the cropland site (watershed underlain by clastic deposits).

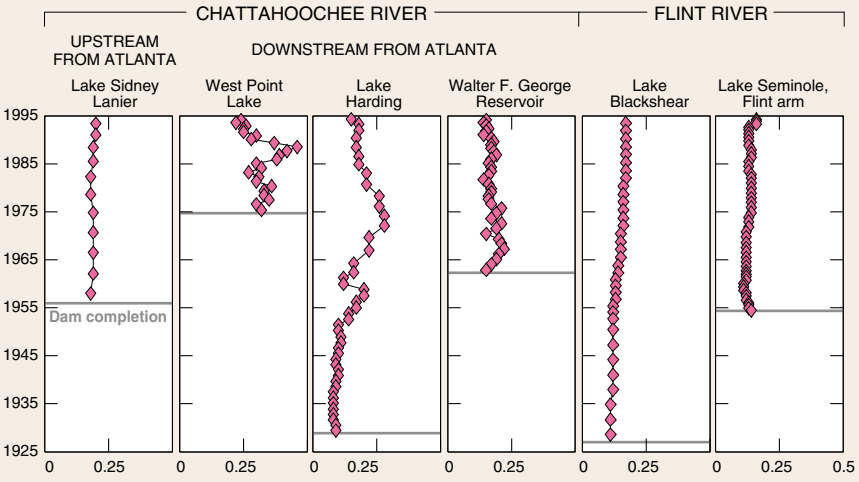
Data collected from March 1, 1993, through September 30, 1995, at Basic and Intensive Fixed Sites (pages 6 and 7). Load estimates based on computer program by Charles Crawford (USGS, written communication, 1998)

Low nutrient concentrations and yields at the forested and cropland sites, the Chattahoochee River upstream from Atlanta, and the Apalachicola River near its mouth are indicative of good water quality. Suspended-sediment concentrations at the forested site are similar to those at the urban site; however, the annual yield at the forested site is much lower because only 47 percent of the annual runoff occurs during stormflow compared with 82 percent of the annual runoff at the urban site. A large number of reservoirs upstream, relatively slow stream velocities, intact riparian vegetation in wide flood plains, long travel times from upstream nutrient and suspended-sediment sources, and low population densities all contribute to the good water quality near the mouth of the Apalachicola River.

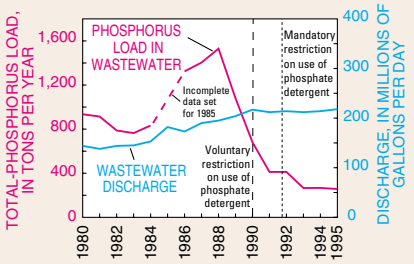
High nutrient and suspended-sediment yields from stormflows are indicative of primarily nonpoint sources of these constituents. Thus, more extensive control of stormwater runoff from poultry production, suburban, and urban areas would be needed to significantly reduce eutrophication of lakes and reservoirs in the ACF River Basin.



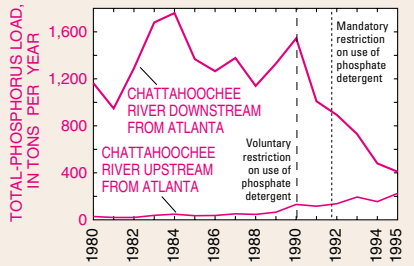
At tributary sites studied with one predominant land use, more than 60 percent of most nutrient yields occurs during stormflows. At the urban site, which has the highest percentage of impervious area in it's watershed, more than 80 percent of runoff and nutrient and suspended-sediment yields occur during stormflows. The predominance of stormflow transport is indicative of primarily nonpoint sources of nutrients and suspended sediment.



Although total-phosphorus concentrations of sediment deposited in reservoirs (page 21) throughout the ACF River Basin has increased slightly in the last half of the 20th century, the largest increases occurred downstream from Metropolitan Atlanta. Total-phosphorus concentrations of sediment in Lake Harding began declining after 1974 when West Point Lake was built upstream. Total-phosphorus concentrations in West Point Lake sediment increased until approximately 1988 when a relatively rapid decrease coincided with restrictions on (1) the use of phosphate detergents in Georgia, and (2) the concentration of phosphorus discharged by major wastewater-treatment facilities into the Chattahoochee River between Lake Sidney Lanier and West Point Lake.



Wastewater discharge to the Chattahoochee River from the six largest Metropolitan Atlanta wastewater-treatment facilities increased by about 50 percent from 1980 to 1995; however, the total-phosphorus load from these facilities decreased by about 83 percent from the largest load in 1988. Improved wastewater treatment accounts for about two-thirds of the decrease, and restrictions on phosphate detergents accounts for about one-third of the decrease (Hippe and others, 1997).



Total-phosphorus loads in the Chattahoochee River downstream from Metropolitan Atlanta decreased by about 77 percent from the highest level in 1984 because of reductions in point-source loads. However, point sources continue to contribute a major part of the phosphorus load to the river. Between Lake Sidney Lanier and the upstream site shown in the above graph, there are no municipal or industrial discharges greater than 1 million gallons per day. Therefore, most of the increase in phosphorus loads in the Chattahoochee River upstream from Atlanta are from increasing nonpoint-source loads.