WATER FACT SHEET

U.S. GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR

WATER QUALITY IN THE TIDAL POTOMAC RIVER AND ESTUARY

THE TIDAL POTOMAC RIVER AND ESTUARY

The tidal Potomac River and Estuary extend 116 miles from Chain Bridge in the Washington, D.C., metropolitan area to Point Lookout, Md. The tidal river from Chain Bridge to Quantico, Va., is characterized by freshwater flows and riverine chemistry. This reach contains spawning and nursery areas for anadromous fish and is the zone receiving major municipal wastewater discharges. The 51-year average freshwater inflow to the tidal river is 11,400 ft^3/s (cubic feet per second). The inflow is generally hard to moderately-hard water suitable for human consumption and most other uses with minimal treatment, containing about 2 mg/L of nitrogen compounds and 0.5 mg/L of phosphate. The inflow carries an average daily load of 50 to 100 tons of nitrogen compounds, 16 to 20 tons of phosphate, and 4,000 tons of suspended sediment, most of which never reaches Chesapeake Bay.

The transition zone of the estuary, from Quantico, Va., to the U.S. Highway 301 Bridge, represents a zone of mixing between the fresh water of the Potomac River and the salt water of the Chesapeake Bay, and is a region of variable biological productivity and diversity. The remainder of the estuary, extending from the U.S. Highway 301 Bridge to the Chesapeake Bay, is characterized by brackish water and estuarine and marine organisms. The tidal Potomac River and Estuary are a potential source of water and a prime recreational resource for the 3 million people living in the Washington, D.C., metropolitan area. The area includes shipping and seafood industries, and shellfish and finfish are harvested in the river and estuary.

The processes taking place in this complex physical, chemical, and biological environment are influenced by changes in river inflow, tides, and weather, as well as human activities. The U.S. Geological Survey (USGS) conducted an interdisciplinary water quality study of the tidal Potomac River and Estuary between 1977 and 1982, and USGS scientists continue to study and monitor the various processes in the water column and sediment that affect the water quality of this resource.

WHAT ARE THE MAJOR WATER QUALITY PROBLEMS?

The tidal Potomac River and Estuary, like many of the Nation's estuaries, are experiencing ever-increasing stress from human needs for food, water, waste disposal, and industrial and agricultural production. Five closely related water-quality problems affect water users in the area.

(1) Nutrient Enrichment

The discharge of nutrients (primarily organic carbon, phosphorus, and nitrogen) from sewage treatment plants and from nonpoint sources can deplete dissolved oxygen and promote the growth of blue-green algae in the tidal river and estuary. Organic-carbon compounds are converted to carbon dioxide and water by bacterial processes that use oxygen. Nitrogen and phosphorus stimulate algal growth which affects the dissolved-oxygen content, nutrient balance, and pH of the tidal river and estuary. Although most of the particulate phosphorus and nitrogen compounds settle out immediately adjacent to their source, high river flows resuspend and redistribute particulate material downstream. Nutrients also are released to the water column by natural processes occurring in the bottom sediments.

(2) Algal Blooms

Algal blooms have a profound effect on the recreational use of the tidal river. Blue-green algae can develop enough biomass in nutrient-enriched waters to cover the entire water surface with algal mats and leave windrows of algae along the shoreline. The decomposition of dead algae creates an oxygen demand that reduces dissolved-oxygen concentrations. Some species of blue-green algae excrete waste products that are toxic and foul smelling. From the 1950's through the early 1970's, the tidal river and transition zone were occasionally covered by massive blooms of blue-green algae consisting mainly of the genus *Anacystis*. With elevated summer temperatures and low river flows, the blue-green alga *Microcystis* bloomed in the lower tidal river below Marshall Hall in 1983, 1984, and 1985.

(3) Dissolved Oxygen

Low dissolved-oxygen concentrations during the warm summer months can harm sport fish populations. In recent decades, low dissolved-oxygen concentrations (3 mg/L and lower) have occurred in the vicinity of the Woodrow Wilson Bridge during warm weather, and have persisted down river to the vicinity of Marshall Hall, Md. The severity of local declines in dissolved-oxygen concentration near sewage treatment plants varies with the waste loading to the river and with the river flow. Low dissolved-oxygen concentrations also are found in the bottom waters of the Potomac Estuary between Cobb Island and Point Lookout, Md. The processes causing these conditions are currently being studied by USGS scientists.

(4) Sedimentation

Since colonial times, erosion resulting from land clearing, farming, mining, and urbanization in the Potomac River basin has generated ever-increasing amounts of sediment that has filled navigation channels and harbors and degraded the environment for fish and shellfish. The USGS recently estimated that the tidal Potomac River and Estuary receive about 250,000 tons of sediment annually from streams tributary to the Potomac River. More than twice as much additional sediment is transported into the tidal Potomac River and Estuary from all other upland sources draining into the Potomac River above Chain Bridge.

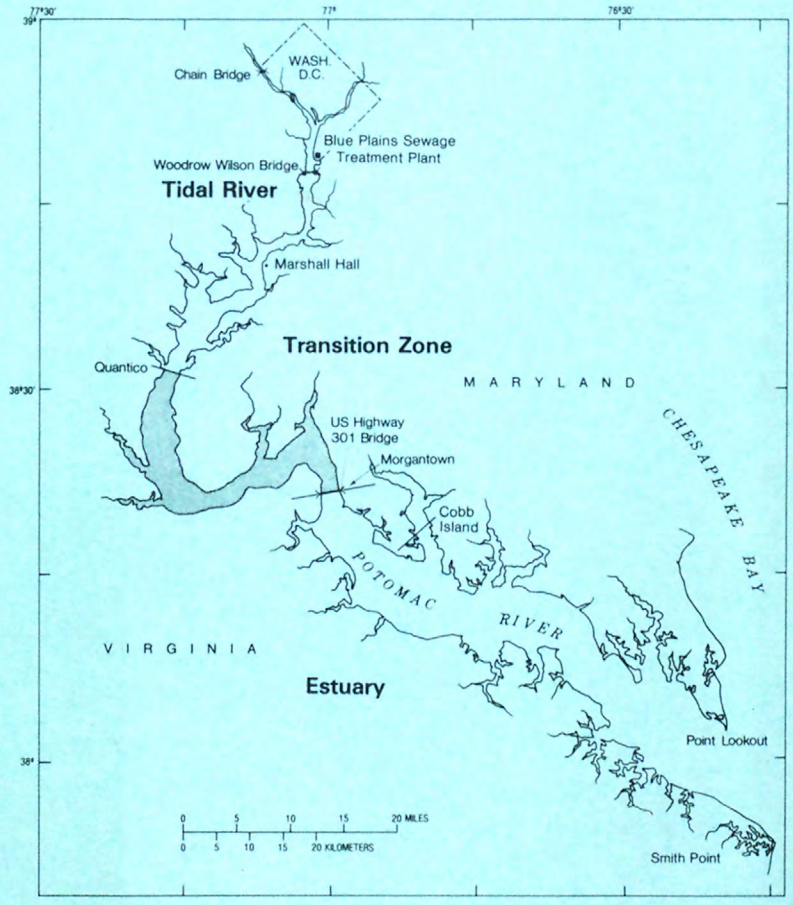
(5) Animal and Plant Resources

The complex environments of the tidal Potomac River and Estuary contain a variety of plants and animals that are ecological and commercial assets. The living resources require a delicate balance among the dynamic physical and chemical processes that alter their habitats and affect their distribution. Imbalances in the tidal Potomac River ecosystem have led to algal blooms, low dissolved-oxygen concentrations, fish kills, changes in fish species, decreases in numbers of waterfowl, and declines in submersed aquatic plants during the last 30 to 50 years. For example, in the 19th centuary, 2.5 to 3 million pounds of American shad were harvested annually; between 1972 and 1976, only 200,000 pounds were harvested annually.

HAVE THERE BEEN ANY RECENT CHANGES?

The occurrence and severity of blue-green algae blooms are a function of processes, such as river discharge during spring and summer, water temperature, wind speed and direction, and number of sunny days. When discharge is low and water temperature is high, sunlight stimulates the growth of algae in the nutrient-rich waters of the tidal river and estuary. As the algae photosynthesize during the day, using up available nitrogen and phosphorus, the pH increases to 9 or 10, and additional nutrients are released from the bottom sediments. Blooms of algae that aggregate and float on the surface may be unavailable to benthic-invertebrate grazers, such as clams. When the algae become too thick, they shade themselves from the sunlight, thus reducing the growth rate and imposing an upper limit to growth.

A series of steps have been taken to reduce nutrient loading in the tidal Potomac River. In 1960, the Blue Plains Sewage Treatment Plant converted to secondary sewage treatment to remove more carbon and, in 1974, tertiary treatment was begun using chemical precipitation to remove phosphorus. In 1980, the Blue Plains plant added advanced wastewater treatment in which ammonia is converted to nitrate (nitrification) and additional phosphorus and carbon are removed. This reduces the amount of oxygen previously used in the river to oxidize ammonia to nitrate, thus raising dissolved-oxygen levels immediately in the vicinity of the sewage treatment plant. The loading of phosphorus has steadily decreased (from 5.0 tons per day in 1960 to 2.7 tons per day in 1980) and the loading of nitrogen has slowly but steadily increased (from 19 tons per day in 1960 to 30.1 tons per day in 1980) from the Blue Plains plant. Sewage plants with advanced wastewater treatment added approximately one-third the quantity of nitrogen and one-half the quantity of phosphorus that the river itself contributed to the upper reach of the tidal Potomac River. There have been no seriously low dissolved-oxygen concentrations in the tidal river during the 1980's; low dissolved-oxygen concentrations are still present in the deep water of the estuary during summer months. Further reduction in nutrient loading from the sewage treatment plants may not prevent algal blooms because of the regeneration of nutrients from the sediments.



RETURN OF SUBMERSED AQUATIC PLANTS SUGGESTS IMPROVED WATER QUALITY

From 1978 to 1981 the tidal river and estuary contained virtually no submersed aquatic vegetation, but large, healthy populations were growing in the transition zone. In 1983, thirteen species of submersed plants including hydrilla *(Hydrilla verticillata*, a plant from southeast Asia), appeared in the tidal river above Marshall Hall, Md., after an absence of decades. Populations of all submersed vegetation increased greatly in 1984 and 1985, but the rapid increase in hydrilla has caused concern that it might outcompete native species. Hydrilla itself grows so densely in shallow water that it can interfere with the recreational use of the water. With the return of the submersed Aquatic plants, water clarity has improved in the upper tidal river. Sport fishing also has improved, and waterfowl have returned in increasing numbers, feeding on the hydrilla and other submersed plants and on small invertebrates that use the plants for shelter.

The USGS has recently completed an interdisciplinary study of the tidal Potomac River and Estuary. Information from that study, as well as from ongoing hydrologic and ecologic research related to the Potomac River, has been and will continue to be made available to regulatory agencies at the Federal, State, and local levels to help ensure that this ecological resource is maintained.

For further information, contact:
Chief, Branch of Regional Research, Northeastern Region
Water Resources Division
U.S. Geological Survey
432 National Center
Reston, Virginia 22092

Open-File Report 86-145

Virginia Carter
July 1986