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GREAT AMERICAN MEGABASIN: CHESAPEAKE AND DELAWARE





The Great American Megabasin

Chesapeake and Delaware

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Linked by hydrology at the crossroads of American history, the Chesapeake and Delaware megabasin stretches 400 miles along the Atlantic seaboard in the most populous watershed in the United States (Figure 1). The American Revolutionary War and Civil War were fought along its rivers and John F. Kennedy, Richard M. Nixon and Barack H. Obama adopted federal programs to protect its rivers and watersheds.

While sharing similar geography and climate, these contiguous mid-Atlantic basins have contrasting demographic characteristics (see Table 1 on page 9). The Chesapeake and Delaware megabasin covers just 2% of the contiguous United States, yet is home to 8% of the nation's population and the nation's fifth- and seventh-largest metropolitan economies, the U.S. Capitol and five state capitals.

The Chesapeake watershed (64,000 square miles) is four times larger than the Delaware watershed (13,500 square miles), which suggests the challenges of governing the nation's largest estuary are correspondingly complex. The Chesapeake is home to 16 million people — twice that of the Delaware basin — but the Chesapeake's population density (250 people per square mile) is less than the

Delaware basin (590 people per square mile), which suggests less pressure per unit area from human pollution and water withdrawals.

Though each river is more than 300 miles long, the Chesapeake/Susquehanna and Delaware are merely the 42nd and 55th longest rivers in the United States. The Chesapeake is the longest estuary in the country (194 miles) and the Delaware estuary (96 miles) is the nation's third-longest navigable tidal river. Both estuaries are drowned river systems that evolved from rising sea levels that began 20,000 years ago during the end of the last ice age. While both estuaries have similar ratios of watershed to estuary surface area (18:1), the hydraulic retention time (HRT), measured by volume divided by median flow, is quite different. The approximate HRT of the Chesapeake is 812 days and that of the Delaware Bay is 443 days.



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Median inflow to the Chesapeake is about three to four times as great as inflow to Delaware Estuary. Tidal energy in the Delaware system is greater than that of the Chesapeake. The Delaware Estuary has a very large tidal prism, or the volume of water in between mean high tide and mean low tide. The Coriolis effect from the Earth's rotation causes a clockwise tidal cycle where cleaner ocean water washes north up the western shore of the bays and more turbid river runoff flows south along the eastern shore.

Water pollution control programs have improved dissolved oxygen (DO) levels in the Delaware basin while levels continue to decline in the Chesapeake. Both basins have recovering American shad fisheries, although juvenile abundance has declined lately due to increased striped bass populations who forage for the young shad. It is good to know that 2017 was a record year for shad in the Delaware basin.

Land use patterns in these adjacent watersheds are similar, as the I-95 corridor cuts through urban downstream reaches of each basin while agriculture and forests increase north to the headwaters. The Delaware basin is more urbanized, with 14% developed land, compared to the Chesapeake, with 8% developed land. Both basins are covered by similar proportions of agriculture (22% to 26%) and forests (55% to 60%). Known for fisheries productivity, the Chesapeake is rimmed by twice the area of wetlands (9%) compared to the Delaware (5%) basin, but the Delaware Estuary has the most contiguous wetlands of any estuary (John Teal).

Basin governance

Each of these multistate basins is managed with varying emphasis on

governance, ranging from voluntary federal-state agreements in the Chesapeake Bay to a compulsory Federal-state basin compact for the Delaware River.

The Chesapeake Bay cleanup was driven by a voluntary Federal-state partnership coupled with two river basin commissions in the headwaters, but cleanup is now being driven by a mandate from the EPA to deduce sediment and nutrient input through a Total Maximum Daily Load (TMDL) regulation. The EPA supports the Chesapeake Bay Program through the Clean Water Act and the Great Waters Program. In the upper basin, the bay's two largest tributaries are governed by the Susquehanna River Basin Commission (between Maryland, New York, Pennsylvania and the United States) and the Interstate Commission for the Potomac River Basin (between Maryland, Pennsylvania, Virginia and the United States). The bay has a long history of activism through nonprofits such as the Alliance for the Chesapeake Bay (established in 1972) and the Chesapeake Bay Foundation (established in the 1960s).

The Delaware is the only basin governed entirely by an interstate compact by a single coordinating entity. In 1961, John F. Kennedy signed the Delaware River Basin Commission (DRBC) compact as the first Federal-state watershed accord to govern a basin as a single administrative agency. The DRBC has five commissioners — the governors of Delaware, New Jersey, New York and Pennsylvania, and an officer in the U.S. Army Corps of Engineers representing the President of the United States. Each has an equal vote. Over 300 river miles in the Delaware Basin are protected by the National Park Service through the National Wild and Scenic Rivers Act.

The Chesapeake

Known by the Algonquian people as the "village at a big river," the *Chesepiooc* is the largest of 130 estuaries in the United States and stretches from Havre de Grace, Maryland, at the mouth of the Susquehanna River to Virginia Beach, Virginia, at the Atlantic Ocean. The 4,480-square-mile bay is long (194 miles), narrow (3 to 30 miles wide) and shallow (average depth 21 feet) — and the shoreline (12,000 miles) is longer than the mainland Pacific Coast of the United States. The bay is flushed with 50% saltwater from the Atlantic Ocean and 50% freshwater from the Susquehanna, Potomac and Rappahannock rivers and other streams.

The 64,000-square-mile Chesapeake watershed extends 400 miles from Cooperstown, New York, to the Atlantic Ocean and drains parts of six states and the District of Columbia. In 2010, 16 million people lived in the bay watershed (double the population recorded in 1950). Every year, 200,000 people move to the bay to work in the Washington, Baltimore, Richmond and Harrisburg metro areas. The Blue Ribbon Finance Panel in 2003 reported the socioeconomic value of the Chesapeake Bay watershed is worth \$1 trillion from fishery, recreation, tourism and agriculture benefits.

In 1880, 20 million bushels of oysters were harvested by 7,600 boats berthed in Maryland and Virginia. By 1890, Joppatowne Port near Baltimore was closed due to siltation from the deforested watershed. In 1924, the governors of Maryland and Virginia held a joint meeting to manage the Chesapeake blue crab fishery. In 1933, the U.S. Bureau of Fisheries held a conference in Baltimore to recommend an interstate bay crab fishery management plan. In 1937, 30 boxcars a



Figure 1. The Great American megabasin: Chesapeake and Delaware.

day full of oysters left Baltimore for Chicago.

During the 1950s, bay water quality was good as Maryland's Bernie Fowler saw his white sneakers wading six feet deep in the Patuxent River. In the late 1950s, Chesapeake oysters were decimated by MSX and Dermo disease. In 1965, Lyndon Baines Johnson declared in his State of the Union address that the Potomac River will be a "model of beauty and recreation" for the nation.

In 1970, Richard M. Nixon and governors of New York, Pennsylvania and Maryland signed the Susquehanna River Basin Compact to manage the upper half of the Chesapeake Bay watershed. In 1980, the Maryland, Virginia and Washington, D.C. legislatures formed the Chesapeake Bay Commission. In 1983, Maryland, Pennsylvania, Virginia, Washington, D.C. and the EPA signed the voluntary Chesapeake Bay Agreement as the first estuary restoration program in the United States. The states and the EPA signed the 1987 Chesapeake Bay Agreement to reduce nitrogen and phosphorus by 40% by 2000. In 1988, Maryland State Senator Fowler waded into the muddy Patuxent River and barely saw his sneakers just a foot deep. In 1997, *Pfiesteria piscicida* toxins caused by high nutrient loads caused fish kills and rashes on bay watermen.

During 2000, the Clinton EPA signed the Chesapeake Bay Agreement that set goals to reduce nutrient and sediment loads by 40% by 2010.

In May 2009, President Barack Obama issued Executive Order 13508, directing federal agencies to restore the Chesapeake as a national treasure; and in 2010, EPA Administrator Lisa Jackson ordered states to reduce pollutants 40% by 2017 and 100% by 2025 to restore the bay to Clean Water Act fishable and swimmable standards. In December 2010, the EPA approved state watershed improvement plans (WIPs) that ushered in a new era of Federal/state cooperation in restoring the nation's largest estuary. There is still a long way to go to meet the 2025 state goals.

The Delaware

The Delaware is the longest undammed river east of the Mississippi, extending 342 miles from the Catskill Mountains in New York to the mouth of the Delaware Bay at Cape May. The river is fed by 216 tributaries including the largest — the Schuylkill and Lehigh Rivers. The basin contains 13,539 square miles, draining parts of Pennsylvania (51%), New Jersey (23%), New York (18%) and Delaware (8%). About 16 million people (5% of the nation's population) draw drinking water from a watershed that

drains only 0.4% of the coterminous United States. New York City draws 50% of its drinking water from three Catskill mountain reservoirs in the Delaware headwaters. The river is the largest freshwater port in the world (a \$19 billion/year economy), yet sustains a recovering shad and striped bass fishery. Once the caviar capital of the United States, it again has propagating sturgeon.

Concerned about polluted drinking water, in 1790 Ben Franklin willed funds to Philadelphia to build the first municipal water system in the nation at a water works on the Schuylkill near the Philadelphia Art Museum.

In 1905, the American shad fishery in the Delaware crashed as three million pounds were harvested, down from 16 million pounds in 1900. The collapse of the Atlantic sturgeon fishery left Caviar, New Jersey, a ghost town.

During the Roaring '20s, the Schuylkill was so dirty that Philadelphians joked that people emerged from their tubs blacker than they had entered them. In 1930, Philadelphia discharged sewage in layers 12 feet thick that unveiled sulfur fumes and drove sailors to sleep in port rather than in their berths.

In 1936, the three states created the Interstate Commission on the Delaware River Basin (INCodel) to clean up pollution. During World War II, INCodel called the Delaware River "one of the most grossly polluted areas in the United States."

Navy pilots flying a mile overhead were instructed to ignore the sulfur stench from the Delaware River. President Roosevelt ordered an investigation in 1941 to determine if pollution was hampering the U.S. war effort.

In 1946, pollution from war industries led to the U.S. Fish and Wildlife Service recording all-time worse anoxia from shore to shore. In 1949, only 38,000 pounds of shad were caught, leading to a Pennsylvania law to preserve shad from extinction.

In 1954, the Supreme Court issued a decree that permitted New York City to withdraw 800 mgd from the Catskill headwaters provided the city released sufficient water from three reservoirs to benefit downstream states. This set up a continuing analysis and regulation of river flows. In 1961, John F. Kennedy, Jr. signed the Delaware River Basin Compact as the first Federal/state water accord.

In the multi-year drought of the 1960s, the Delaware River suffered through the driest spell in 100 years and DO between Wilmington and Philadelphia reached zero during the summer. In 1968, the DRBC issued waste load allocations to 90 Delaware River dischargers to standards

more stringent than later required by the Clean Water Act.

By 1987, dissolved oxygen levels had risen to 5 milligrams per liter, and in 1993, fisheries biologists found increased American shad, striped bass and white perch landings correlated with improved water quality in the Delaware. William D. Ruckelshaus, Nixon's first EPA Administrator, remarked: "Looking back, the DRBC was the vanguard in the Johnny-come-lately march to manage water resources on a watershed basis."

In 2003, the Lehigh River, the second largest tributary of the Delaware, was "cleaner than it had been in the last 150 years" due to acid mine cleanup programs. In 2005, 200,000 shad were caught at Lambertville, New Jersey, and Delaware recreational anglers landed 20,000 striped bass.

By 2010, the Delaware continued its revival with a \$7 million blue crab shellfishery. For the first time in 50 years, Delaware fisheries biologists caught a 7-inch juvenile Atlantic sturgeon in the river off Wilmington. Fifty bald eagle pairs flocked to cleaner Delaware waters, even nesting in South Philadelphia. By 2011, Congress designated 300 river miles in the Delaware Basin to the National Wild

& Scenic River system. DRBC initiated their Special Protection Water Program for the non-tidal river to "keep the clean water clean." The Partnership for the Delaware Estuary provides a science-based approach to the tidal Delaware as one of the 28 congressionally designated estuaries in the National Estuary Program. In addition to regulatory actions, a major initiative involving over 50 NGOs is improving watersheds impacted by agricultural and suburban runoff and protecting the critical forested lands where water quality is very good.

America was born near these historic East Coast waters, and after a precipitous decline, these rivers and bays are alive once again. ■

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Table 1. Comparative Qualities of the Chesapeake and Delaware Basins

Quality	Chesapeake	Delaware
Founded	1570, Father Segura	1609, Henry Hudson
Basin Area (mi ²)	64,000	13,600
Population (million)	16	8
Metropolitan Economy (Rank)	5th	7th
States	DE, MD, PA, NY, VA, WV, D.C.	DE, NJ, NY, PA
Major Cities	Baltimore	Philadelphia
Capitals	Washington, D. C., Annapolis, Richmond, Harrisburg	Trenton, Dover
Urban/suburban, Agriculture Wooded, Wetlands	9%, 22%, 58%, 9%	14%, 26%, 55%, 5%
Luminaries	Captain John Smith, Thomas Jefferson, Richard Nixon, Barack Obama	William Penn, Ben Franklin, George Washington, John F. Kennedy
Governance	EPA Chesapeake Bay Program, Susquehanna River Basin Comm., Interstate Comm. Potomac, Chesapeake Bay Commission and the Basin States	Delaware River Basin Commission, the Basin States and EPA
River Length ¹ (mi)	449	342
Tidal Length ¹ (mi)	194	96
Annual Discharge (cfs)	70,000	15,000
Bay Mouth (mi)	13	11
Hydraulic Retention Time	Approx. 800 days	Approx. 443 days