A River Runs Through it:
The Brandywine as a Flourishing Flora and Fauna Factory

A Presentation to the Brandywine Zoo

April 23, 2023

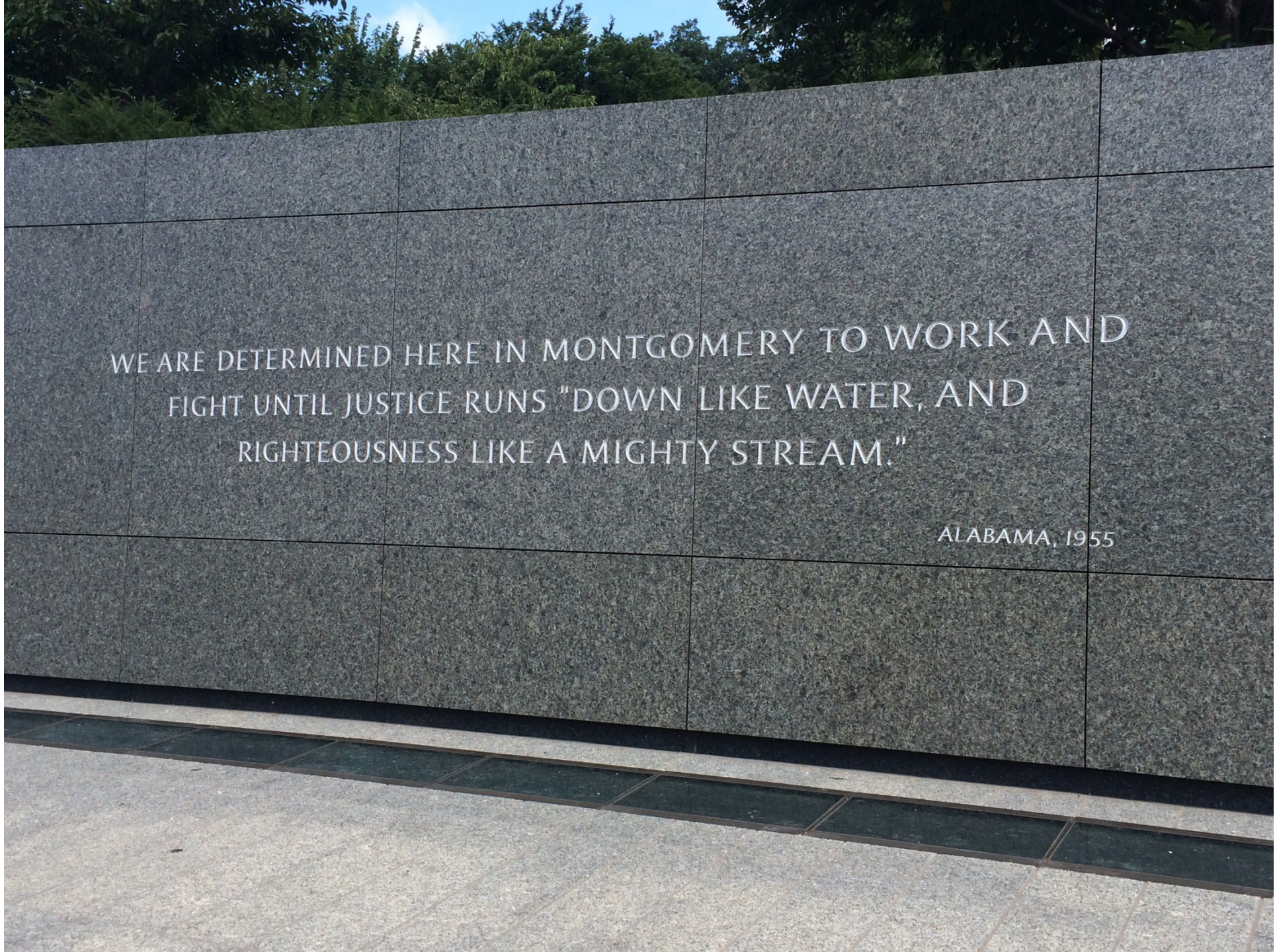
Gerald Joseph McAdams Kauffman, Jr.
Director and Associate Professor
University of Delaware
Water Resources Center
Biden School of Public Policy & Administration
Newark, Del. 19716

A River Runs Through it: The Brandywine as a Flourishing Flora and Fauna Factory

Gerald Joseph McAdams Kauffman, Jr., Ph.D.
Director and Associate Professor
University of Delaware - Water Resources Center
Biden School of Public Policy and Administration
Newark, Del.

The Brandywine River, or Wawaset as known by the Lenape and Brannvin by the Swedes, is historically and internationally known for its ecological unique tidal and freshwater habitat for plant and animal species that is a flourishing flora and fauna factory. This talk will cover the centuries and even millennia long history of the Brandywine Valley beginning with the aboriginal people who cultivated, hunted, and fished here over 30 centuries ago to the Vikings, Swedes, Dutch, and English colonization with European settlement in the 17th century and through the American Revolution to the Industrial Revolution and to its modern history as the largest water supply in Delaware, worldwide significance for the Brandywine style of art, and the reemergence of the American shad, America's founding fish. Our agenda is organized as follows:

12:30	History of the Brandywine River, 12,000 AD – present.	Brandywine Zoo
1:15	Flora and Fauna of the Brandywine	Josephine Fountain
1:30	Seine for spawning American shad, herring, and striped bass	Riverside, Rose Garden
2:30	Parting Remarks	Adjourn


WE ARE DETERMINED HERE IN MONTGOMERY TO WORK AND
FIGHT UNTIL JUSTICE RUNS "DOWN LIKE WATER, AND
RIGHTEOUSNESS LIKE A MIGHTY STREAM."
ALABAMA, 1955


National Park Service
U. S. Department of the Interior
First State
National Monument


The Network of Water Resources Research Institutes
Univ. of Alaska
Washington State Univ.
Oregon State Univ.
Univ. of Idaho
Montana State Univ.
North Dakota State Univ.
Univ. of Minnesota
South Dakota State Univ.
Univ. of Wisconsin
Michigan State Univ.
Univ. of Maine
Univ. of Vermont
Univ. of New Hampshire
Univ. of Massachusetts
Univ. of Connecticut
Univ. of Rhode Island
Rutgers Univ.
Univ. of Delaware
Univ. of Maryland
Univ. of the District of Columbia
Va. Polytechnic Institute & State Univ.
Cornell Univ.
Pennsylvania State Univ.
Ohio State Univ.
Univ. of Illinois
Purdue Univ.
West Virginia Univ.
Univ. of Kentucky
Univ. of Tennessee
North Carolina State Univ.
Clemson Univ.
Georgia Institute of Technology
Auburn Univ.
Mississippi State Univ.
Louisiana State Univ.
University of Florida
Univ. of Wyoming
Utah State Univ.
Desert Research Institute
Univ. of California
Colorado State Univ.
Univ. of Nebraska
Iowa State Univ.
Kansas State Univ.
Univ. of Missouri
Oklahoma State Univ.
Univ. of Arkansas
Univ. of Arizona
New Mexico State Univ.
Texas A & M Univ.
Univ. of Hawai'i
Univ. of Guam
Univ. of the Virgin Islands
Univ. of Puerto Rico

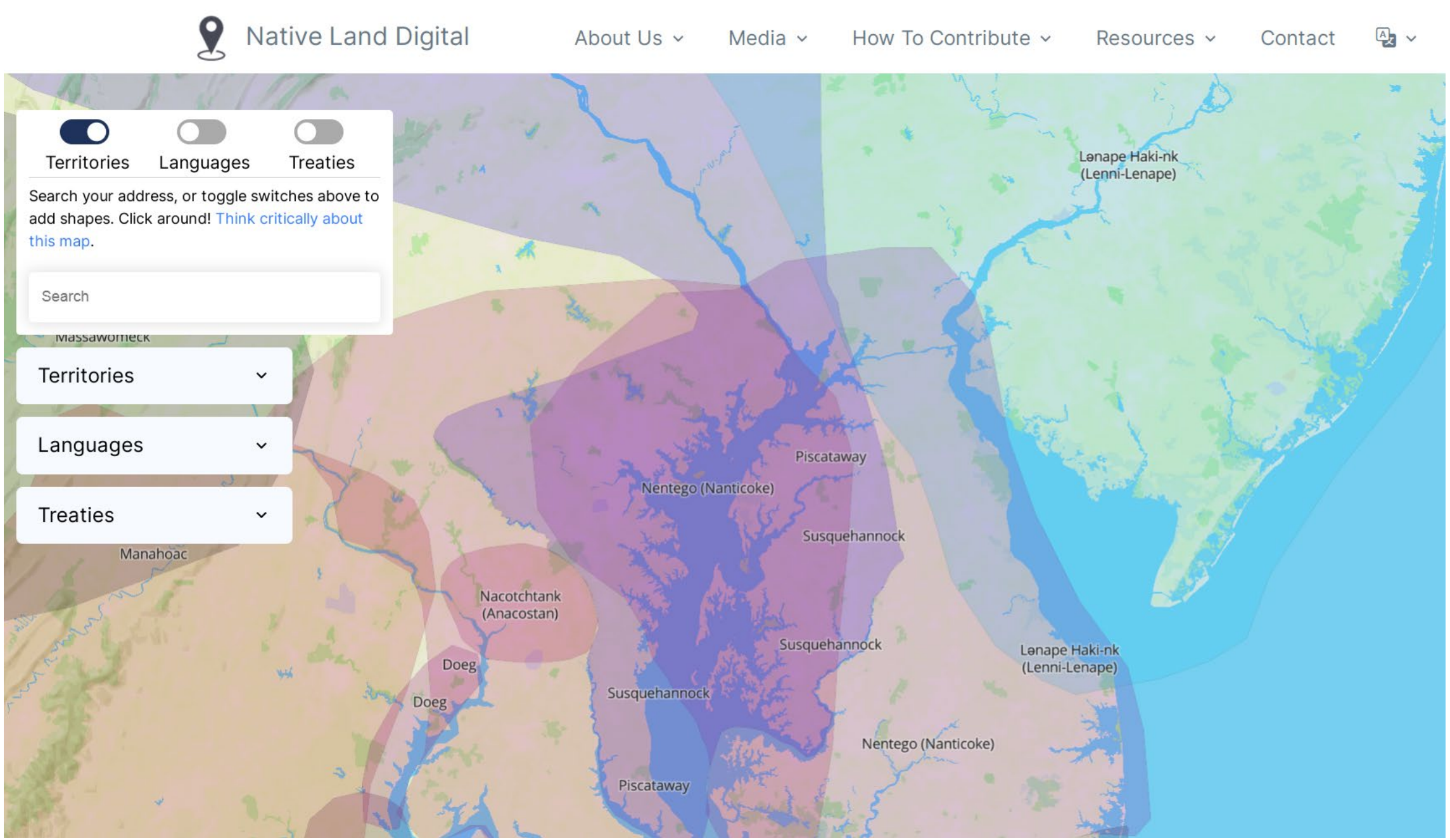


Figure 1. Native lands in Delaware (Native Land Digital 2021)

Queonemysing (Reed and Wallace 2019)

- Indigenous villages found at Clyde Farm at Churchman's Marsh, Crane Hook on Delaware River, Naamans Creek, and Brandywine River at **DuPont Eleutherian Mills** at Hagley.
- Lenape village of **Queonemysing: 1683** agreement between Lenape Sachem Seketarius and William Penn, land between Upland (Chester) and Christina creeks.
- **Queonemysing**, "place where there are long fish," was a seasonal fishing village.
- In **1683** Penn's William Markham entered into agreement with Sachem Seketarius of Queonemysing and Minguanan (Machaloha) on White Clay Creek.
- In **1684**, Penn identified one mile on either side of Brandywine for Lenape continued seasonal occupation of Queonemysin from mouth to west branch.
- In **1725**, Alphonsus Kirk and Samuel Hollingsworth, land reserved for Brandywine Indians. Kirk remembered: "above thirty years Since he saw two Papers which Saccatarius or some other of the Chiefs of the Indians on Brandywine had in their possession.
- …the Indians were to retain their "Town on Brandywine." (Queonemysing).
- In **1778**, the Lenape (the Delaware) was the first nation to sign a treaty with the new U.S. government and the Continental Congress.

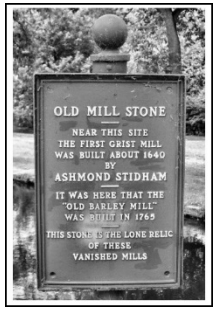
First Fish Festival (Dunlap and Weslager 1960)

- A annual fish festival held on Vandever land on ground now known as Brandywine Village in the spring
- “Their encampment may be said to have bad a general course or range of north west and south east from nearly opposite the present lower dam down to the shipyard and within an average distance of one hundred yards of the creek.”
- The Indian therefore never failed to indulge his habit in coming down to "fish and turtle" after planting his corn, beans, and other vegetables.
- “In the afternoon they would be seen usually returning to their encampment laden down with fish and loggerheads, and upon their arrival would always find a large blazing fire prepared for cooking their fish, the squaws and children having made it up in their absence round a rock or fallen tree.
- …the several groups of returned fishermen would go to their respective campfires, throwing in their fish and placing the great loggerhead in the midst of the coals on his back, keeping him down with stones and watching him preserving the lower shell for a bowl.
- These festivals generally terminated in five or six weeks, or until they thought their truck should be attended to, when they broke up their camp and returned home.

Brannvin (Heck et al. 1966)

- **Suspecough:** “at the muddy pond”.
- **Wawaset:** "near the winding bend“.
- **Tancopanican:** "stream of the little tubers," the ground nut or Indian potato found on the banks of the river
- **Fiskiekjilenin:** “fishkill.”
- **Brannvin:** A potato or barley liquor after the Old Barley Mill built by a 17th century Swedish surgeon near present day Market Street in Wilmington.
- Brandywine Kill, **Brandewyne** Creek, Brande Wine Creek, Brandywine River, Brainwend Kill, Fiske Creek, Fiskiekjilen, Visscherskil, Suspecough, Tancopanian, Wawaset, Wawassan, Wawasiungh.

Old Barley Mill on the Brandywine
Shaw 1904



Bulletin of the
SOCIETY FOR PENNSYLVANIA ARCHAEOLOGY, INC.

ISSN: 0031-4358

Printed by:
Prestige Color
Lancaster, Pennsylvania

Volume 76 Fall 2006 No. 2

Table of Contents

Table 1. Fish Resources Seasonally Available to the Lenape.

Species	Months of Availability: Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
American eel* *Anguilla rostrata* (C)	x	x	x	x	x	x	x					x
Alewife *Alosa pseudoharengus* (A)		x	x	x	x	x	x					
Sea lamprey *Petromyzon marinus* (A) - LR			x	x	x							
American shad *Alosa sapidissima* (A) - LR			x	x	x							
Striped bass *Marone saxatilus* (A)				x	x	x	x					
Atlantic sturgeon *Acipenser oxyrhynchus* (A)				x	x	x	x					
Blueback herring *Alosa aestivalis* (A)				x	x	x						
S.N. sturgeon *Acipenser brevirostrum* (Am)						x	x	x	x			
Atlantic menhaden *Brevoortia tyrannus* (Am)						x	x	x	x			
Weakfish *Cynoscion regalis* (E)							x	x	x	x		

Abbreviations and footnotes:
A = Anadromous: Fish living in salt water but spawning in fresh water.
C = Catadromous: Fish living in fresh water but spawning in salt water.
Am = Amphidromous: Fish with a variable lifecycle
E = Estuarine: Fish living in salt water but spawning in brackish estuaries (also white perch, white catfish, etc.).
LR = Long Run: Anadromous fish that spawn in feeder streams of the Delaware River as far as the Lehigh and beyond, with some spawning in present New York State. In contrast "short run" anadromous fish spawn only as far up the Delaware as Tohiccon Creek, as discussed later in this report.
S.N. = Short Nose as in
X = Heaviest part of
x = Lighter density o
* The American eel (Ang
maturity they migrate to
to the streams from whic
represent a stage in a clin

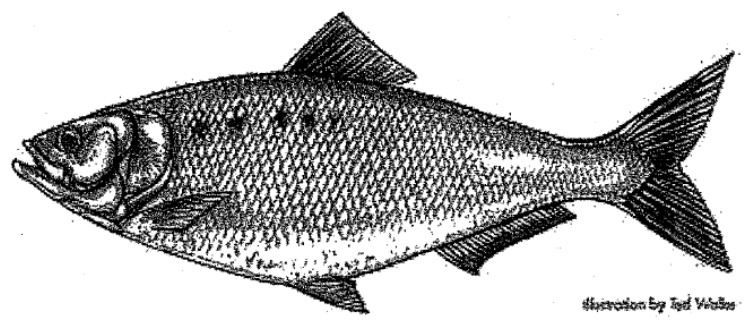
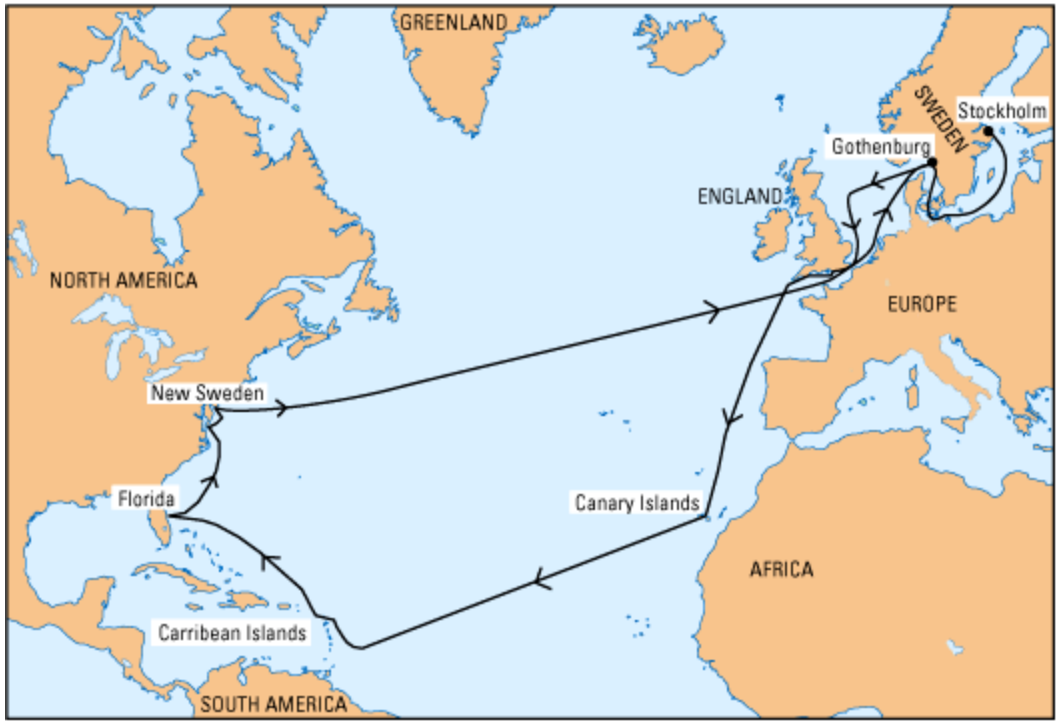


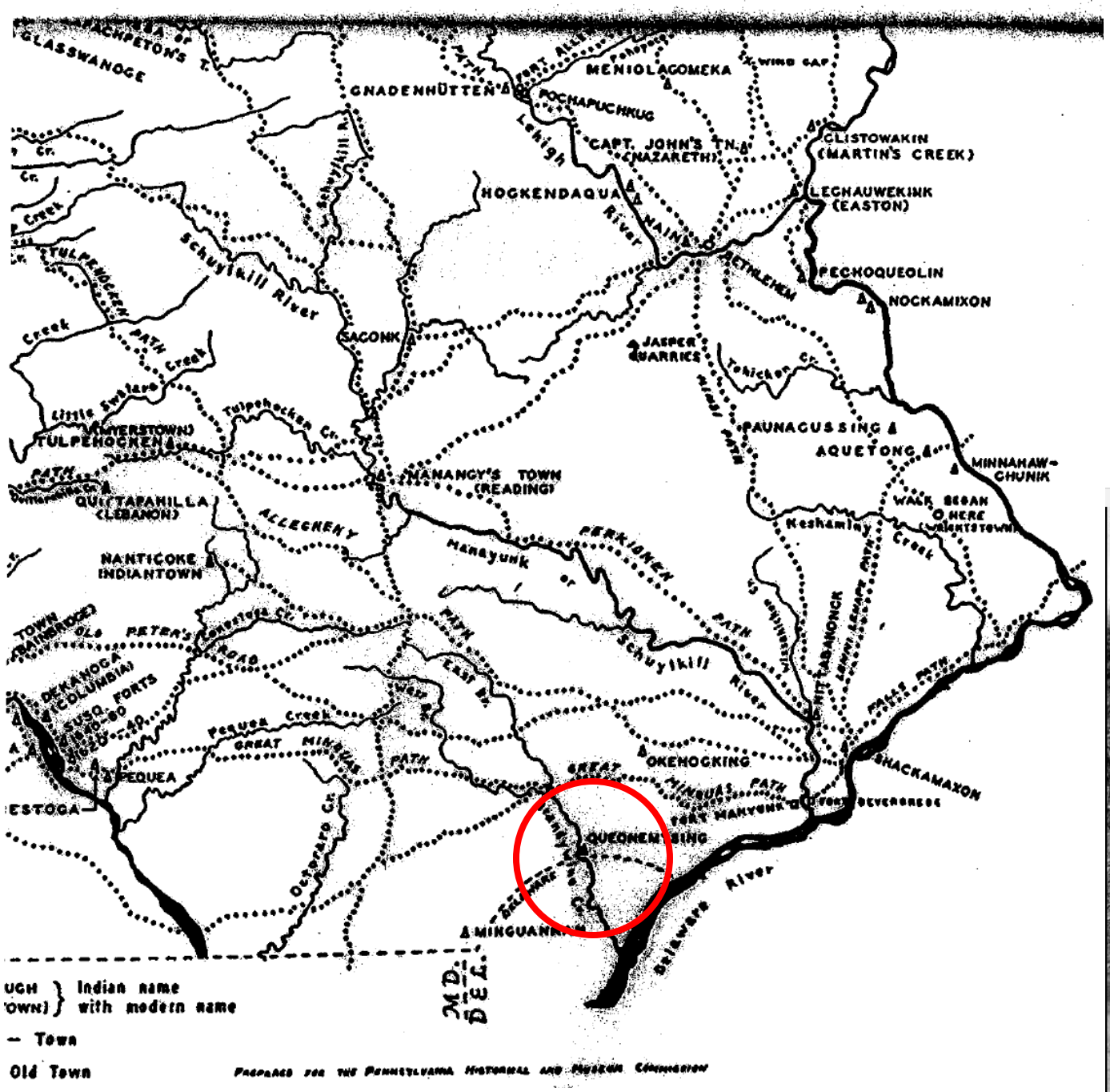
Figure 2. An American Shad (illustration by Ted Wake), one of m y fish available to the Lenape.

New Sweden, first permanent European settlement in Delaware and Delaware Valley
1638 AD



Swedes settle at mouth of Christinakill
1638 AD

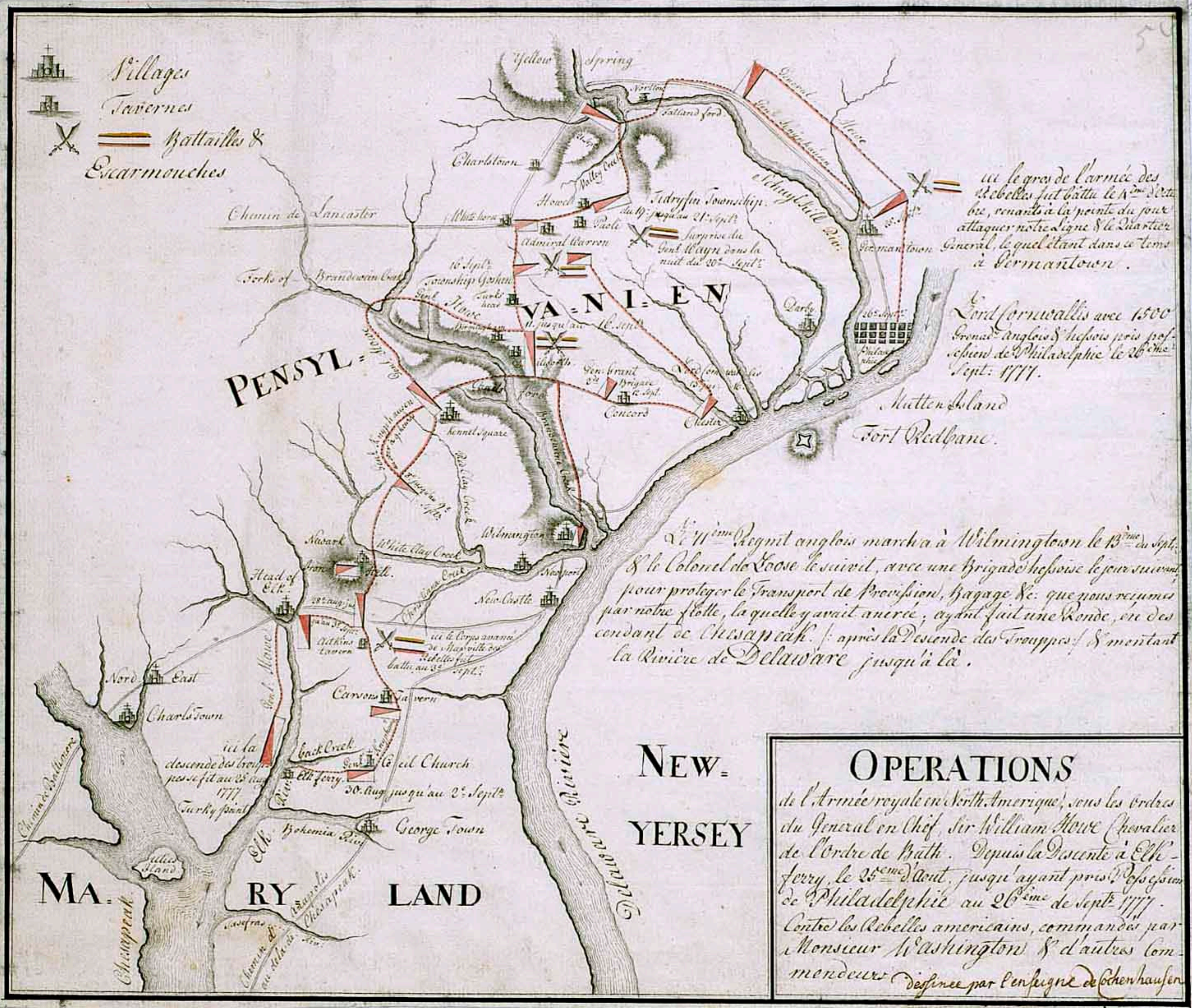
Brandy Wine flows into Christian Creek and the Dellaware River 1687 AD



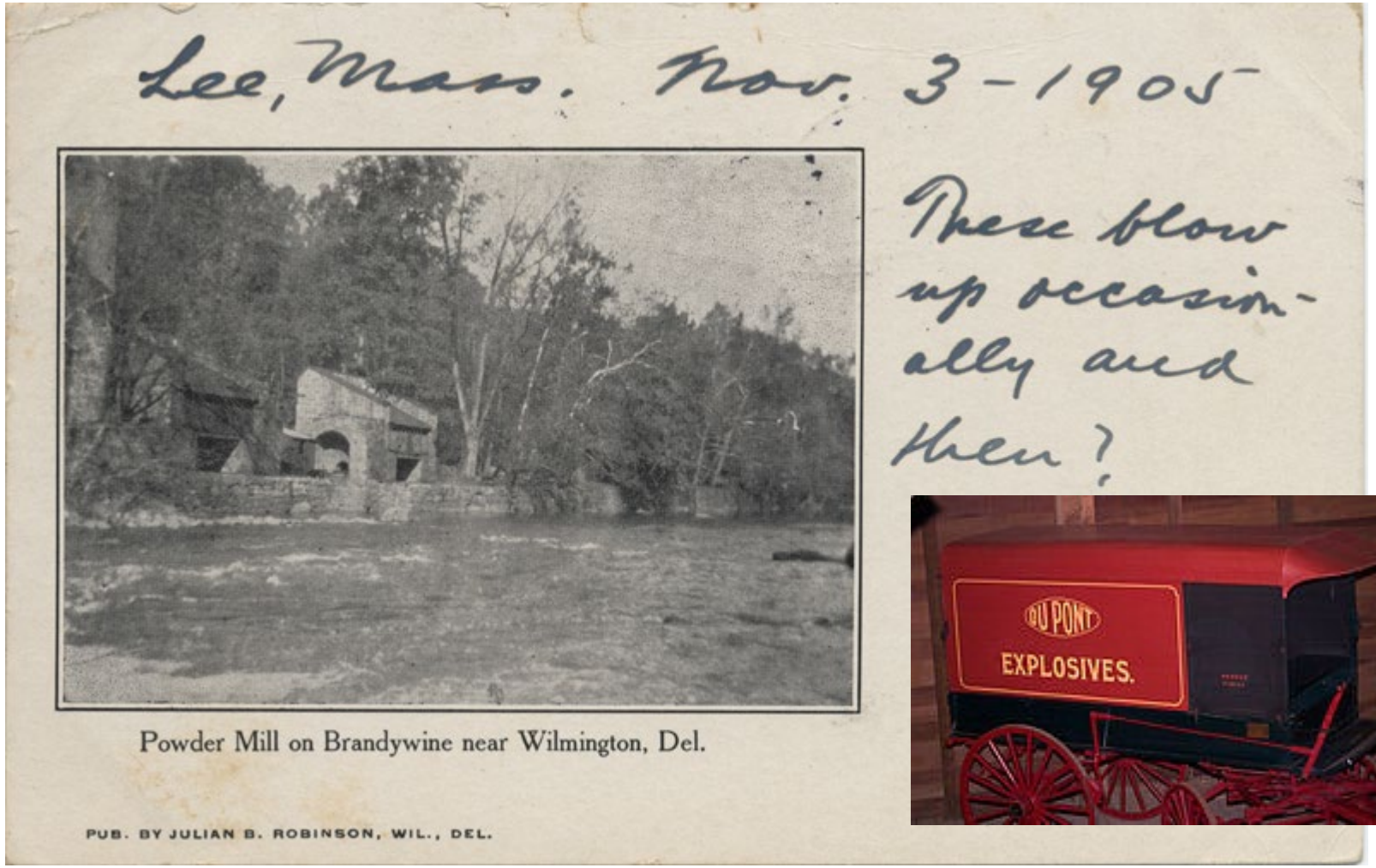
1688
Queonemysing

3 Lower Counties of Pennsylvania 1749 AD

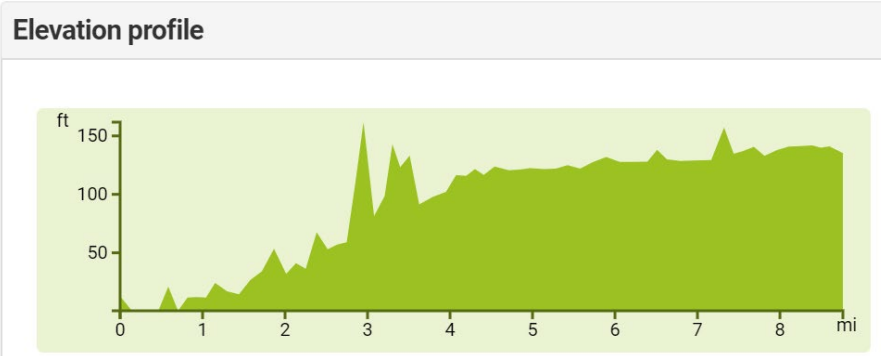
“Nation Makers”
H. Pyle
Battle of the Brandywine
1777 AD


OPERATIONS
de l'Armée royale en North Amerique, sous les ordres du General en Chef, Sir William Howe Chevalier de l'Ordre de Bath. Depuis la Descente à Elk-ferry, le 25ème d'Aout, jusqu'ayant pris Possession de Philadelphie au 26ème de Sept. 1777. Contre les Rebelles americains, commandés par Monsieur Washington & d'autres Commendeurs
dessinée par l'enseigne de Cochenhausen
Villages
Tavernes
Battailles & Escarmouches
ici le gros de l'armée des Rebelles fut battu le 4ème d'Octobre, venants à la pointe du jour attaquer notre Ligne & le Quartier General, le quel étant dans ce tems à Germantown.
Lord Cornwallis avec 1500 Grenad. anglois & hessois pris possession de Philadelphie le 26ème Sept. 1777.
Le 71ème Regmt anglois marcha à Wilmingtown le 13ème du Sept. & le Colonel de Loose le suivit, avec une Brigade hessoise le jour suivant, pour proteger le Transport de Provision, Bagage &c. que nous reçumes par notre flotte, la quelle y avait ancrée, ayant fait une Ronde, en descendant de Chesapeak, après la Descende des Trouppes, & montant la Riviere de Delaware jusqu'à là.
PENSYL-VANIEN
NEW-YERSEY
MA-RY-LAND
Yellow Spring
Charlstown
Chemin de Lancaster
White horse
Admiral Warren
Paoli
Tidryfin Township
Germantown
Darby
Forks of Brandewin Creek
Township Goshen
Kennel Square
Concord
Chester
Mutten Island
Fort Redbane
Wilmington
Newport
New-Castle
White Clay Creek
Newark
Head of Elk
Aithins Tavern
Carsons Tavern
Cecil Church
Back Creek
Elk ferry
George Town
Bohemia
Nord East
Charls Town
Turky point
Delaware Riviere
Chesapeak
Schuylkill Riv.

DuPont Mills
1802 AD



Brandywine Falls are higher than Niagara Falls



Underground Railroad between the Brandywine and Christina at Wilmington, Harriet Tubman 1830-1865 AD

1864 AD

Wilmington
1874 AD

Bird's-eye view of Wilmington, H. H. Bailey, 1874.

Frederick Law Olmsted designed Central Park in NYC and his firm designed Brandywine Park in Wilmington, Del. during the 19th century

Brandywine Plant
1929 AD

Brandywine Plant from the air, 1929.

Brandywine Creek
1940 AD

Brandywine Creek above city dam, 1940.

FISH PASSAGE AT BRANDYWINE CREEK DAMS 2, 4, 5 AND 6

City of Wilmington, Brandywine and Christiana Hundreds, New Castle County, Delaware

PREPARED FOR:

Brandywine Shad 2020
28 Brandywine Falls
Wilmington, Delaware 19806

and

Kleinschmidt
141 Main Street
Pittsfield, Maine 04967

December 2021

RICHARD GRUBB & ASSOCIATES

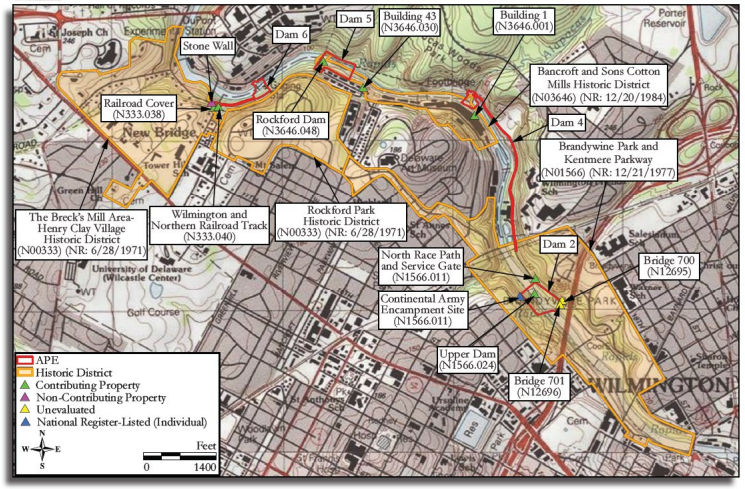


Figure 1.4: U.S.G.S. map showing historic properties within and adjacent to the APE.

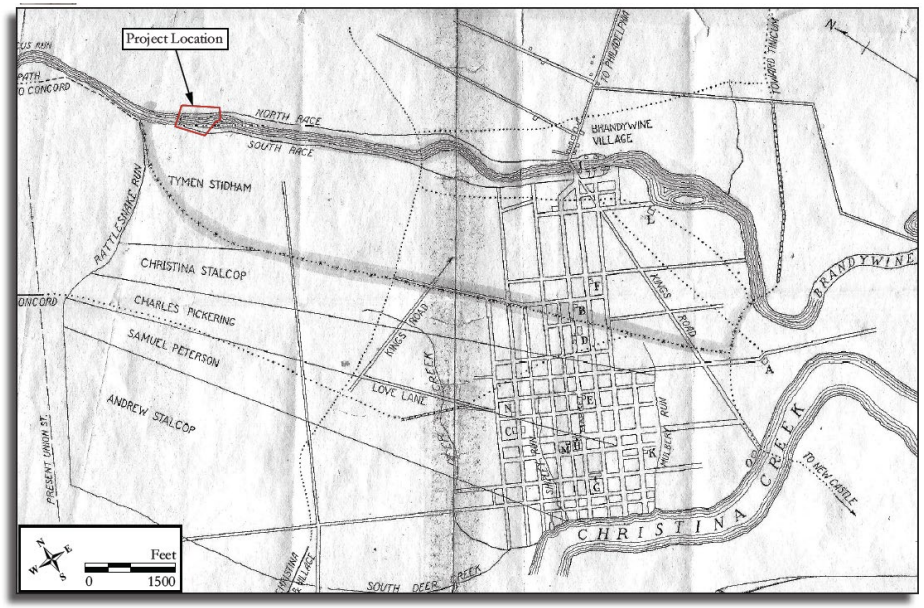


Figure 4.2: 1772 Anonymous, *Map of Wilmington as of 1772.*

Figure 4.9: Third dam on Brandywine, from across race, Wilmington, DE in 1885 (Morris 1885).

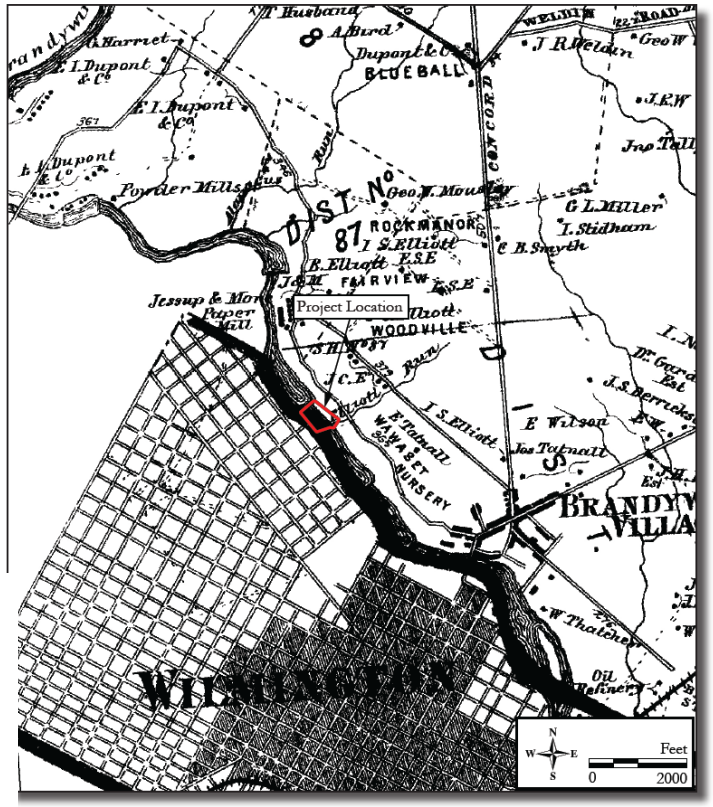


Figure 4.7a: 1868 D.G. Beers, *Brandywine, New Castle Co Del.*

MID-ATLANTIC HISTORIC BUILDINGS AND LANDSCAPES SURVEY

Phase II Architectural Investigations for the Fish Passage at the Lower Brandywine River Dams 2, 3, 4, 5, and 6

By
Catherine Morrissey, M.A., (Principal Investigator)
Michael J. Emmons, Jr., M.A.
Kimberley Showell

Prepared For

Brandywine Shad 2020

Center for Historic Architecture & Design (CHAD)
Biden School of Public Policy & Administration
University of Delaware

April 2022

Figure 7. *View on the Brandywine River: Gilpin's Paper Mill*, Thomas Doughty, 1825-1830.

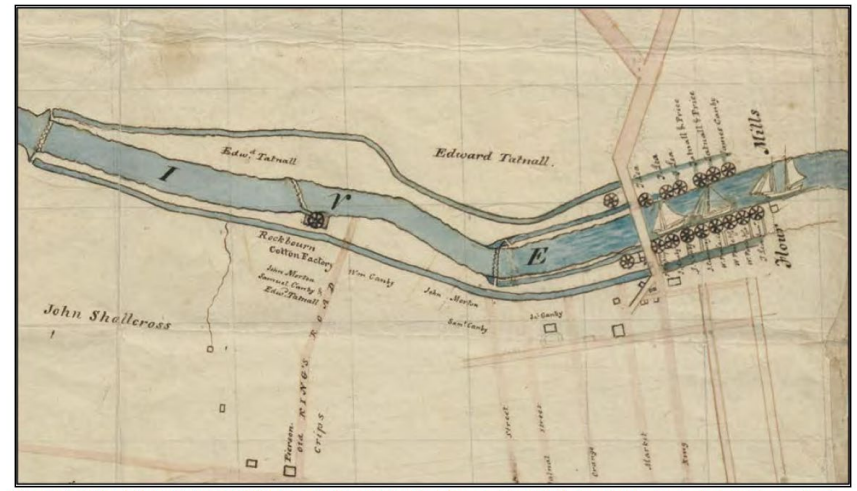


Figure 34. Fairlamb & Read's 1816 *Mill Seats on the Brandywine River* (cropped for detail), showing the dense cluster of flour mills at Brandywine Village, as well as Upper Dam (Dam 2) at the far left and its northern and southern long races, powering the mills downstream.

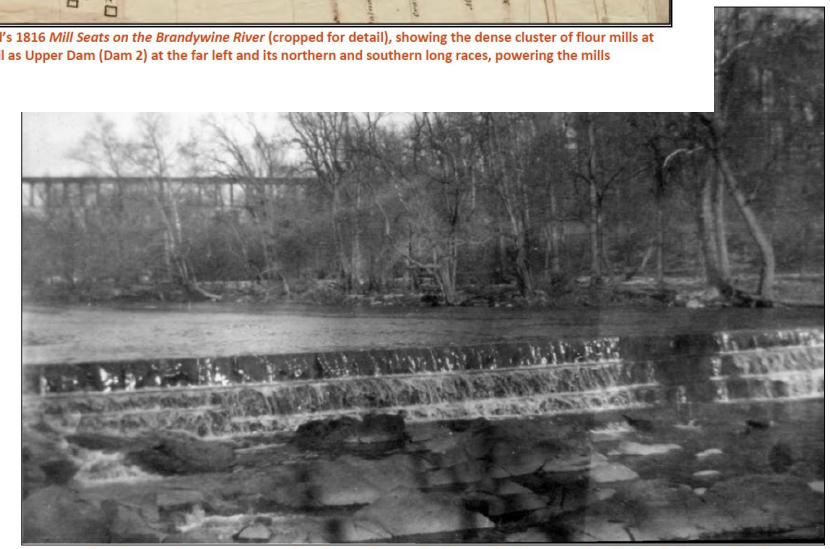


Figure 20. View of stepped concrete construction of Dam 2 in 1904, looking north with B&O Railroad bridge in distance. (Frank R. Zebley photograph albums, Hagley Museum and Library)

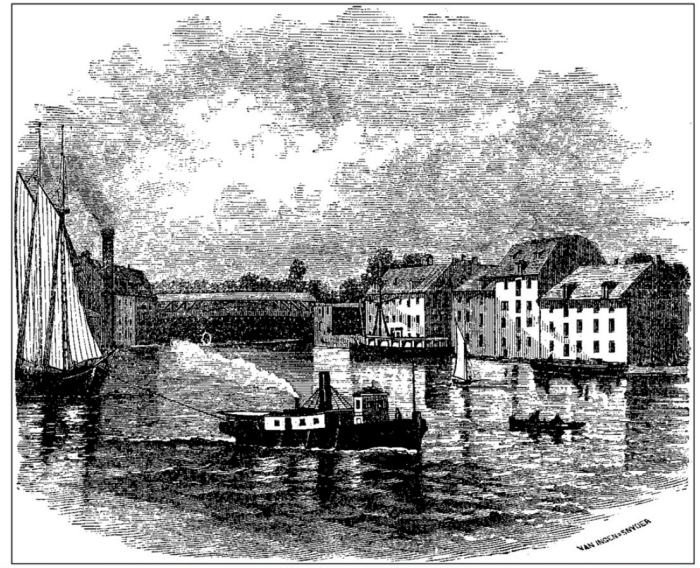


Figure 35. Wood cut of the "Brandywine merchant mills," April 1873. (Lippincott's Magazine of Popular Literature and Science XI)

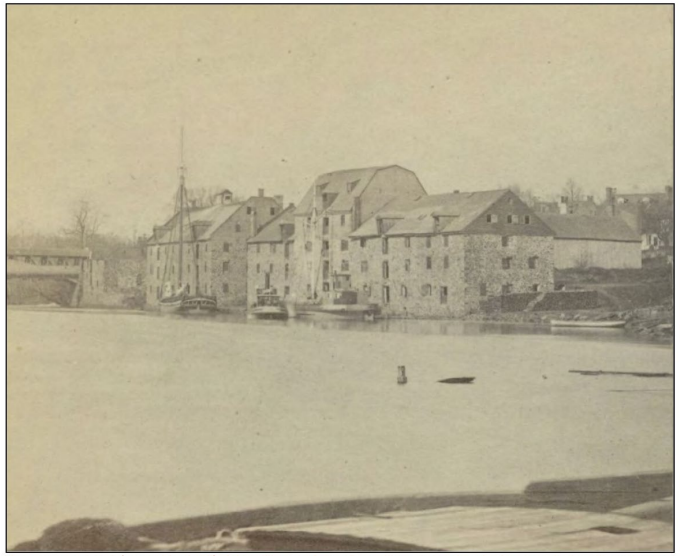


Figure 36. Stereograph (cropped for detail) of the William Lea & Sons flour mills on the northern banks at Brandywine Village, c. 1868 (Lammot du Pont, Sr. prints and photographs, Hagley Museum and Library)

Figure 5. *Brandywine Mills*, Bass Otis, c. 1820. (Delaware Historical Society)

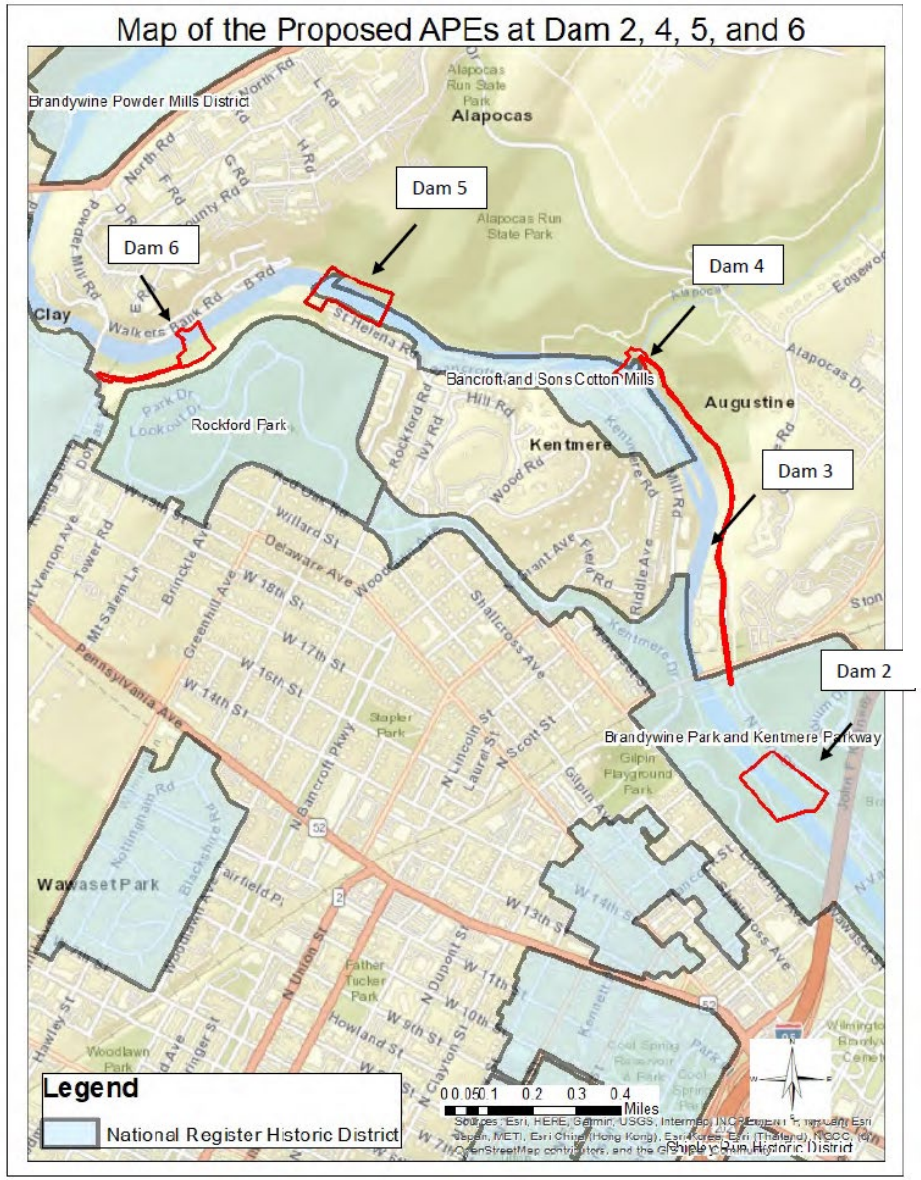
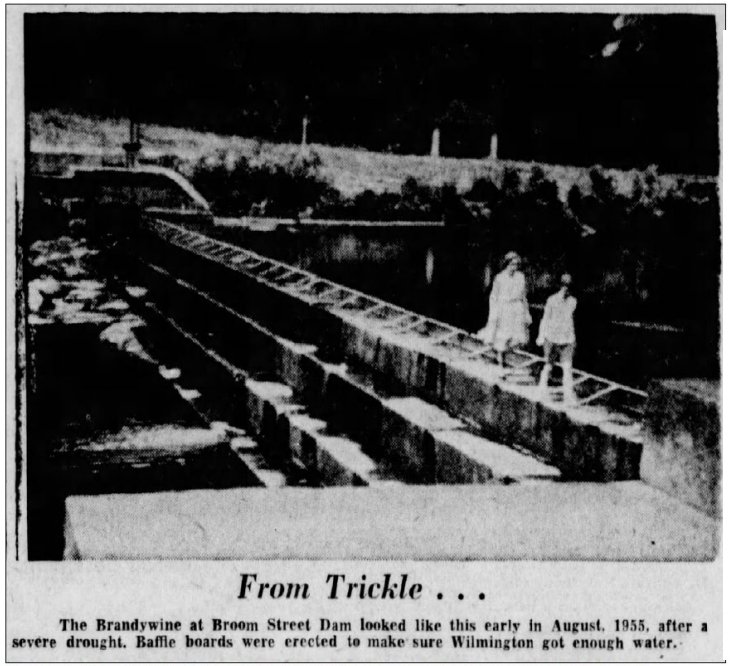


Figure 1. Map showing the location of Dams 2-6, as well as the location of the proposed APEs for Dams 2, 4, 5, and 6. (Center for Historic Architecture and Design)



From Trickle . . .

The Brandywine at Broom Street Dam looked like this early in August, 1955, after a severe drought. Baffle boards were erected to make sure Wilmington got enough water.

Figure 21. August 1955 view of Dam 2 showing stepped concrete construction. (*Journal-Every Evening*, February 7, 1959)

Figure 22. View of Dam 2 during low water flow, showing stepped concrete construction, looking north, 2002. (Water Resources Center, University of Delaware)

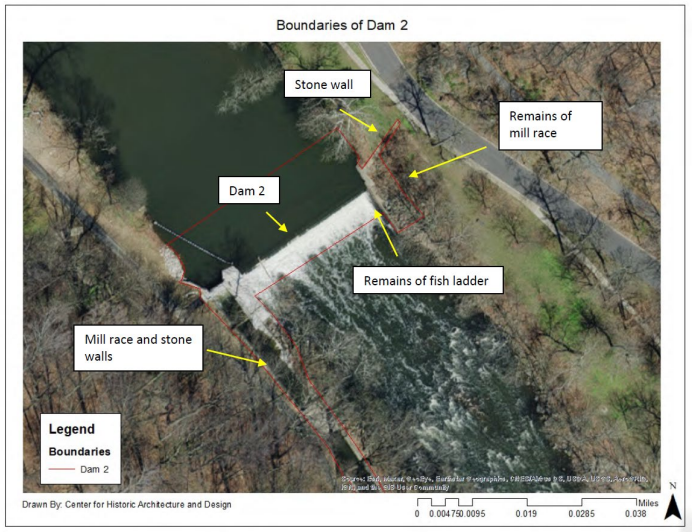
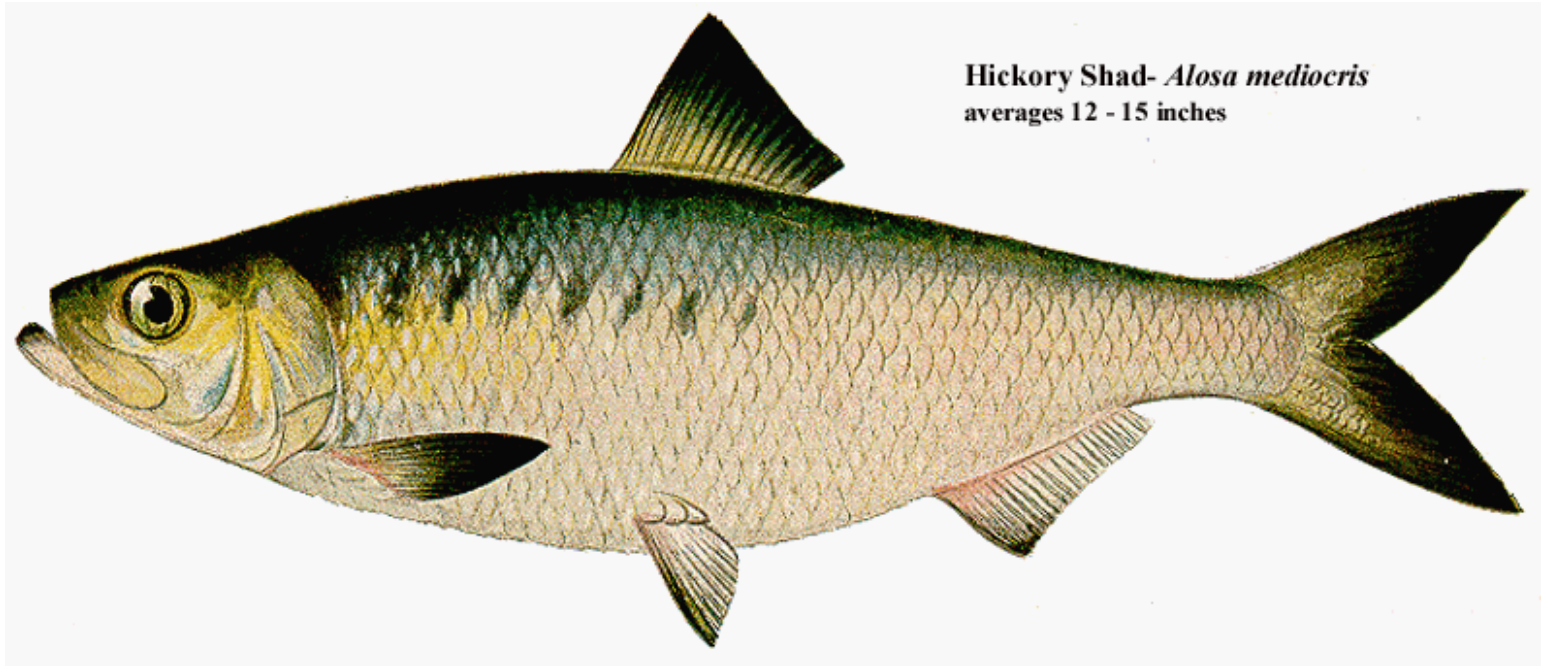


Figure 38. Detail boundary map for Dam 2.

26. View of Dam 2, showing the southern mill race in the foreground, looking north, 2021. (Center for Historic Architecture and)

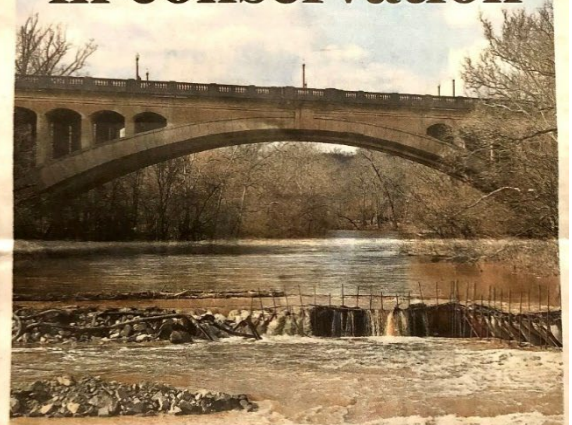
America's Founding Fish



THE NEWS JOURNAL
PART OF THE USA TODAY NETWORK

BRANDYWINE DAM REMOVAL

Making strides in conservation



Demolishing historic Brandywine dams could make for healthier future

Maddy Lauria Delaware News Journal | USA TODAY NETWORK

Wilmington residents Hunter Lott and Jim Shanahan have a simple vision for the future of the Brandywine River.

In a few years, they imagine young public school students pressing their noses to the side of a classroom tank, watching fish grow from microscopic zygotes. Then the students might return their swimming friends to the Brandywine to help spawn the next generation of Delaware born and bred fish.

For that vision to become reality, a series of historical dams that date back hundreds of years must be removed, from Market Street in Wilmington into Pennsylvania.

Demolition continues on the dam and replacement of a water main across the Brandywine in Wilmington, just downstream from the Washington Street Bridge. WILLIAM BRETZGER/THE NEWS JOURNAL

See BRANDYWINE, Page 9A

Brandywine

Continued from Page 1A

These sometimes-scenic relics hail from a time when mills were used to power flour, paper, cotton and gunpowder production.

"If we are successful – when we are successful – in this removal of the dams, it would have been 300 years since the fish have been able to swim freely up into the Brandywine and into their historical breeding grounds," Lott said.

The Brandywine Shad 2020 dam removal plan, spearheaded with research by the University of Delaware, is one of 25 conservation projects in Delaware, New Jersey, New York and Pennsylvania that have been awarded more than $4 million in federal funding. All are within the Delaware River basin.

"Not only is it good for fish ... it's good for conservation in general, it's good for the habitat, it's really good for the economy," said Wendi Weber, northeast regional director for the U.S. Fish & Wildlife Service at the grants announcement on Friday. "It's good for the health of the people in the watershed."

Wilmington residents and visitors may have noticed heavy equipment already working on the river banks near Market Street in recent months. Dam No. 1 there will be the first to go, for reasons more than just freeing the waterway's historic roots, city officials said.

In 1914, the concrete dam now surrounded by construction was built to encase the city's water mains. Today, they provide fresh drinking water to more than 100,000 customers every day, officials said.

"They literally brought clean water from one side of the river to the other side of the river," said Kelly Williams, Wilmington's public works commissioner.

Now, the time has come to upgrade and replace those mains, and the city is spending $2.7 million to do so and remove the dam, Williams said.

New water mains are being laid below the bedrock under the creek. Once they're online, the old mains that make up the dam will be removed, she said.

Fish that migrate, such as the American shad and river herring, which live in saltwater but breed in upstream freshwater, will benefit from the dam's removal. Hardened structures are like roadblocks when the fish are trying to swim upstream, said Gerald Kauffman, director of the Water Resources Center at the University of Delaware.

"Now the river is getting healthier, so much so that the fish are returning," Kauffman said. "The obstacles that remain are these 19th and 18th century dams."

The shad that instinctively want to swim upstream to breed the next generation literally get bruises on their noses from bumping into the concrete, Weber said.

Just a few decades ago, those fish couldn't even reach the dams, though, because industrial pollution created dead zones in places like the mouth of the Delaware River. But things have changed, Kauffman said.

Crews are relocating a water main under Brandywine Creek as they remove a dam that has been blocking fish passage for 200 years. PHOTOS BY JENNIFER CORBETT/THE NEWS JOURNAL

Removal of the dam is part of the work that is underway on the Brandywine River in Wilmington to restore the waterway to its historic roots.

He and his colleagues now will use $241,000 in federal funding to lay the groundwork needed to remove the dams along 17.6 miles of the Brandywine River.

They will match that money with private funds to study the feasibility of removing most of the remaining intact Brandywine dams left in Delaware. One dam near Hagley Museum will likely remain intact for historical purposes while Dam No. 2 will continue operating as a source of drinking water. That means scientists will have to find another way to help fish get by those obstacles, he said.

Once the remaining dams are removed, area residents could see fewer flooding problems, have additional access to the river through new boat ramps and maybe even enjoy a whitewater rafting experience, Kauffman said.

Four years ago, he also was part of the push to remove a colonial-era dam on White Clay Creek that dated back to 1777 when George Washington was marching through, around the time he was planning the Battle of the Brandywine.

"Now we're finding the fish are swimming up and spawning, after two centuries," he said. "It's about fish and it's about history, but it's also about water, too. If the quality of the water is good enough for these sensitive fish, that's great news because that's the water we drink."

However, even after Dam No. 1 is removed, the fish will still be blocked by several others that dot the river from Delaware and into Pennsylvania. That includes Dam No. 2, near the headgates of the Brandywine Raceway, which creates the pooling necessary to provide drinking water to people living in the area.

North of the Delaware-Pennsylvania state line, experts have located at least three dams that will need to be studied for removal in a future project, Kauffman said.

Other complications are likely to stymie the romantic story of reconnecting these native creatures to their centuries-old breeding grounds. Some of the larger dams, like Brandywine Falls at Alapocas Run State Park, are beloved scenic features that some residents may want to keep just as they are.

"You're going to get that push back, there's no question," Lott said, noting that an argument was made against removing Dam No. 1. It had historical value by providing a pool of water that would freeze in the winter to create an all-natural ice-skating rink.

"There will be a certain amount of people used to looking at a pool of flat water," said Shanahan, who said he frequently swims in the Brandywine like it's his own backyard pool. "But it's only been like that for 100 years and the river's been there for thousands of years."

The plan to remove the Brandywine's series of Delaware dams is an effort to remove human interference from the Industrial Age and restore the ecology of the river, Shanahan said.

"That abstract, pure aspect of bringing the river back actually has a larger appeal than I anticipated," he said. "Just to bring it back to its natural state really tugs at heartstrings."

The Brandywine Shad 2020 projects and 24 other projects will be partially funded by the Delaware River Basin Conservation Act. It's a relatively new grant and technical assistance program, introduced by Delaware Sens. Tom Carper and Chris Coons, as well as then-Congressman John Carney.

Beyond the Brandywine, that $4.1 million in federal funding, matched by $7.5 million in private funds, will go to projects such as forest management on 1,400 acres, 630 acres of restored wetlands, 550 acres of restored floodplain and more than 1,800 acres of public access that is key to recreation, said Holly Bamford, chief conservation officer for the National Fish and Wildlife Foundation.

Those projects include tidal marsh restoration at the John Heinz National Wildlife Refuge near Philadelphia, shorebird and horseshoe crab restoration in New Jersey and a plan to reduce microplastics in the watershed.

"This protects the river, it provides water quality, water quantity and also protects the community and their economy," Bamford said.

Contact reporter Maddy Lauria at (302) 345-0608, mlauria@delawareonline.com or on Twitter @MaddyinMilford.

Want to know more?

For more, including the full list of projects, go to www.delriverwatershed.org.

Serviceberry (Shadbush) UD Rain Garden
April 20, 2015

UD Shad in Schools

Examining the Recovery of Diadromous Fishes in the Brandywine River, DE from 2020-2022

Authors:
Edward A. Hale, Ph.D.
Assistant Professor, Delaware Sea Grant, School of Marine Science & Policy, College of Earth, Ocean & Environment, University of Delaware

Abstract:

Recent coastwide assessments of multiple alosine species including Alewife, Blueback Herring and American Shad have suggested that low levels of abundance persist coastwide for these fishes. However, the relative abundance of these species remains unknown in many small tributaries along the Atlantic coast that contribute to a broader coastwide stock. Further, impediments to fish passage along many of these tributaries, particularly in the northeastern United States including both historic, nonfunctional and currently used dams prevent passage of diadromous fishes that rely on freshwater reaches to successfully reproduce. In order to assess relative juvenile abundance as it relates to dam removal of American Shad in Brandywine Creek, a subtributary of the Christina River and the Delaware River, I led a volunteer-based haul seine survey at multiple locations in Brandywine River above the site of a recently removed dam for three years. Our findings demonstrated juvenile and adult American Shad have utilized habitat above the site of a former impediment only one year after dam removal. Further, these results suggest that as impediments to fish passage are removed, successful recolonization of historic habitat is occurring for multiple diadromous fishes (*Alosa sapidissima* and *Alosa pseudoharengus*) demonstrating the need for removal of more barriers in order to enhance currently depressed levels of abundance along the coast by providing additional spawning habitat.

Picture 3. Sampling at the Brandywine River downriver sampling location on July 28, 2020. Photo credit: Mrs. Kim Hachadoorian of The Nature Conservancy.

Picture 1. An adult American Shad collected at the Brandywine River downriver sampling location in 2020. Photo credit: Mrs. Kim Hachadoorian of The Nature Conservancy.

Picture 2. A juvenile American Shad collected at the Brandywine River downriver sampling location in 2020. Photo credit: Mrs. Kim Hachadoorian of The Nature Conservancy.

This is one of our tagged fish from 2021.

A69-9007-15557	520	0.472	M	5/11/2021

Further, we heard from 12 of the 14 fish we tagged in 2022. Two of the fish we heard from (32457 and 32458 were tagged using gastrointestinal insertion, retained tags for > 2 weeks). So we now know that method is viable too.

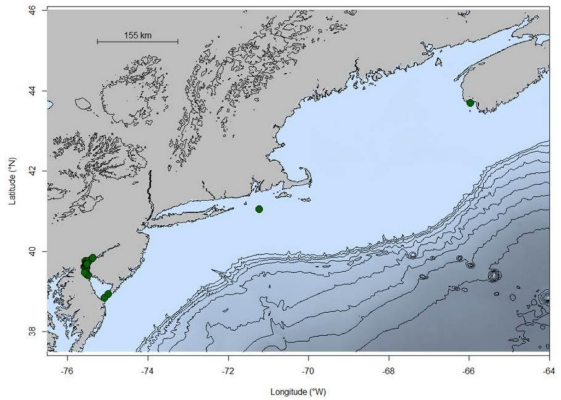


Table 3. Species and number observed during the Brandywine River survey in 2020, 2021 and 2022. Tows with no species listed are indicative of a haul that landed no species.

Date	Time	Station	Tow	Species	Common Name	Stage	Count
7/14/2020	10:00	Dam 2-UR	1	*Lepomis macrochirus*	Bluegill		2
7/14/2020	10:00	Dam 2-UR	1	*Lepomis auritus*	Redbreast Sunfish		5
7/14/2020	10:15	Dam 2-UR	2	*Lepomis auritus*	Redbreast Sunfish		3
7/14/2020	10:15	Dam 2-UR	2	*Anguilla rostrata*	American Eel		1
7/14/2020	10:15	Dam 2-UR	2	*Etheostoma olmstedi*	Tesselated Darter		2
7/14/2020	10:15	Dam 2-DR	1	*Notropis hudsonius*	Spottail Shiner		12
7/14/2020	10:40	Dam 2-DR	2	*Alosa sapidissima*	American Shad	Adult	5
7/14/2020	10:40	Dam 2-DR	2	*Notropis hudsonius*	Spottail Shiner		1
7/28/2020	10:10	Dam 2-UR	1	*Lepomis macrochirus*	Bluegill		5
7/28/2020	10:10	Dam 2-UR	1	*Lepomis auritus*	Redbreast Sunfish		4
7/28/2020	10:10	Dam 2-UR	1	*Micropterus salmoides*	Largemouth Bass		1
7/28/2020	10:30	Dam 2-UR	2	*Lepomis macrochirus*	Bluegill		3
7/28/2020	10:30	Dam 2-UR	2	*Lepomis auritus*	Redbreast Sunfish		2
7/28/2020	10:30	Dam 2-UR	2	*Micropterus salmoides*	Largemouth Bass		1
7/28/2020	11:00	Dam 2-DR	1				
7/28/2020	11:15	Dam 2-DR	2	*Alosa sapidissima*	American Shad	Adult	3
7/28/2020	11:25	Dam 2-DR	2	*Alosa sapidissima*	American Shad	Juvenile	159
2020	10:00	Dam 2-UR	1	*Lepomis macrochirus*	Bluegill		2
2020	10:00	Dam 2-UR	1	*Lepomis auritus*	Redbreast Sunfish		5
2020	10:00	Dam 2-UR	1	*Micropterus salmoides*	Largemouth Bass		3

Final Performance Report

Project Number: F20AF00154-03 (F-47-R-30)

Project Title: Anadromous Species Investigations, Study 2: Shad and Herring Research, Activity 4: Adult alosine abundance, juvenile alosine abundance and American Shad nursery habitat evaluation in the Christina system

Grant Period: 01/01/2021 – 12/31/2021

Reporting Period: 01/01/2021 – 12/31/2021

Prepared By: Ian Park

Approved By: Michael Stangl

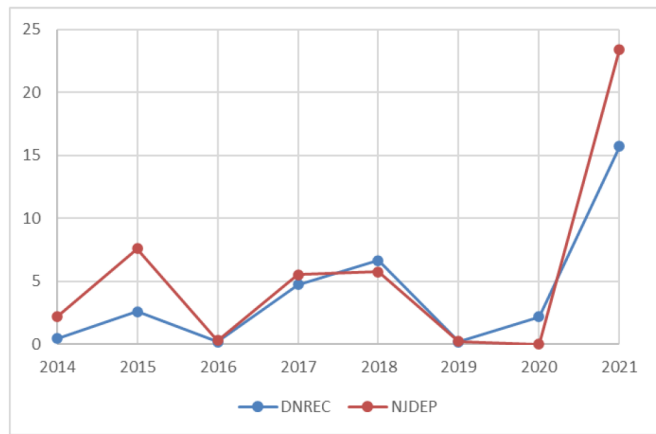
This project was funded under the Sport Fish Restoration Program administered by the Wildlife and Sport Fish Restoration Program of the U.S. Fish and Wildlife Service. This project was conducted by the Delaware Division of Fish & Wildlife, 89 Kings Highway, Dover, Delaware 19901.

Figure 1. Christina River haul seine site locations

Table 2. Species and the number observed during Christina River haul seine in 2021.

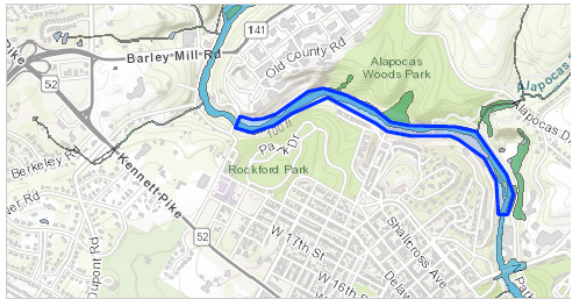
Family	Scientific Name	Common Name	Number Captured
Achiridae	*Trinectes maculatus*	Hogchocker	9
Anguillidae	*Anguilla rostrata*	American Eel	1
Atherinopsidae	*Menidia beryllina*	Inland Silverside	19
Catostomidae	*Catostomus commersonii*	White Sucker	6
	Hypentelium nigricans	Northern Hogsucker	1
Centrarchidae	*Lepomis auritus*	Redbreast Sunfish	11
	Lepomis gibbosus	Pumpkinseed	4
	Lepomis machrochirus	Bluegill	9
	Micropterus salmoides	Largemouth Bass	25
	Micropterus dolomieu	Smallmouth Bass	1
	Pomoxis nigromaculatus	Black Crappie	3
Clupeidae	*Alosa aestivalis*	Blueback Herring	1003
	Alosa pseudoharengus	Alewife	44
	Alosa sapidissima	American Shad	1948
	Brevoortia tyrannus	Atlantic Menhaden	6034
	Dorosoma cepedianum	Gizzard Shad	114
Cyprinidae	*Cyprinella analostana*	Satinfin Shiner	14
	Cyprinus carpio	Common Carp	5
	Hybognathus regius	Eastern Silvery Minnow	394
	Notropis hudsonius	Spottail Shiner	98
	Notemigonus crysoleucas	Golden Shiner	
	Semotilus corporalis	Fallfish	
Engraulidae	*Anchoa mitchilli*	Bay Anchovy	
Fundulidae	*Fundulus diaphanus*	Banded Killifish	
	Fundulus heteroclitus	Mummichog	
Ictaluridae	*Ictalurus punctatus*	Channel Catfish	
Moronidae	*Morone americana*	White Perch	
	Morone saxatilis	Striped Bass	
Percidae	*Etheostoma olmstedi*	Tessellated Darter	
	Perca flavescens	Yellow Perch	
Portunidae	*Callinectes sapidus*	Blue Crab	
Sciaenidae	*Leiostomus xanthurus*	Spot	
	Micropogonias undulates	Atlantic Croaker	

Figure 2. The geometric mean number taken per haul of American Shad in the Christina River and Brandywine Creek and the geometric mean number taken per haul of American Shad in the NJDEP Striped Bass survey.



Brandywine Shad 2020: Removal of Brandywine River Dams 3, 4, and 6 for passage of anadromous fish

Brandywine Shad 2020 has submitted a Section 404 CWA permit application to the US Army Corps of Engineers for the removal of Dams No. 3, 4, and 6 to restore passage of anadromous fish and improve ecological function along the Brandywine River in the



LOCATION New Castle County, Delaware

CREATED August 21, 2020

Resources

This project potentially impacts 11 resources managed or regulated by the U.S. Fish and Wildlife Service.

- 2 endangered species
- 8 migratory birds
- Known wetlands

What's next?

ENDANGERED SPECIES REVIEW

Review this project's effect on listed species[1] pursuant to the Endangered Species Act, as part of the overall regulatory review.

1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.

SPECIES LIST

An official species list was generated 2 minutes ago (8/21/2020, 10:32:48 AM). Species lists are considered valid for 90 days.

Local office

Chesapeake Bay Ecological Services Field Office

(410) 573-4599
(410) 266-9127

177 Admiral Cochrane Drive
Annapolis, MD 21401-7307

http://www.fws.gov/chesapeakebay/
http://www.fws.gov/chesapeakebay/endsppweb/ProjectReview/Index.html

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
RICHARDSON & ROBBINS BUILDING
89 KINGS HIGHWAY
DOVER, DELAWARE 19901

OFFICE OF THE SECRETARY

PHONE
(302) 739-9000

October 1, 2020

Gerald Kauffman, Jr.
University of Delaware Water Resources Center
Institute for Public Administration
Joseph R. Biden, Jr. School of Public Policy & Administration
DGS Annex, 261 Academy St.
Newark, DE 19711

Re: U of DE 2020 Brandywine River Dam Removal (3, 4, & 6)

Dear Mr. Kaufman,

Thank you for contacting the Species Conservation and Research Program (SCRP) about information on rare, threatened and endangered species, unique natural communities, and other significant natural resources as they relate to the above referenced project.

State Natural Heritage Site
A review of our database indicates that there are currently no records of state-rare or federally listed plants, animals, or natural communities at this project site. As a result, this project does not presently lie within a State Natural Heritage Site, nor does it lie within a Delaware National Estuarine Research Reserve – two criteria that are used to identify "Designated Critical Resource Waters" in the Army Corps of Engineers (ACOE) Nationwide Permit General Condition No. 22. A copy of this letter shall be included in any permit application or pre-construction notification submitted to the Army Corps of Engineers for activities on this property.

Fisheries
According to our records and recent sampling occurrences, a population of Smallmouth Bass (*Micropterus dolomieu*) inhabits the Brandywine River within the project impact areas. Smallmouth Bass are recreationally valuable species as they are targeted by local anglers. To avoid impacts to this species, our Fisheries section biologists request that no in-water work occurs between **April 1st and June 30th** to protect nesting Smallmouth Bass during their spawning season.

Herptiles
Our records indicate that copperhead snakes (*Agkistrodon contortrix*) occur at or within the proposed access area for Dam 4. To protect both the snakes and project personnel, our Division herpetologist, Nate Nazdrowicz, requests that no work take place in this area from **April 1st to October 14th**. Due to the dangers that venomous copperhead snakes pose to project personnel, this time-of-year-restriction

Delaware's Endangered Species

Listen

Fish and Wildlife

Home

Contact Us

I'm an Angler

I'm a Hunter

I'm a Boater

Conserving Wildlife

Managing Fisheries

Mosquitos and Ticks

Law Enforcement

Native wildlife species that are in danger of becoming extinct in Delaware may be as Endangered by the Division of Fish and Wildlife.

To help prevent species from becoming endangered, Delaware currently has a Wildlife Action Plan in plac restoring and maintaining important habitats and dwindling populations of the state's wildlife species.

Birds

Pied-billed Grebe[BR] (*Podilymbus podiceps*)

Northern Harrier[BR] (*Circus cyaneus*)

Broad-winged Hawk[BR] (*Buteo platypterus*)

Black-Crowned Night-Heron (*Nycticorax nycticorax*)

Yellow-Crowned Night-Heron (*Nyctanassa violacea*)

American Kestrel (*Falco sparverius*)

Red Knot (*Calidris canutus*)

Piping Plover (*Charadrius melodus*)

Short-eared Owl[BR] (*Asio flammeus*)

American Oystercatcher (*Haematopus palliatus*)

Black Rail (*Laterallus jamaicensis*)

Upland Sandpiper (*Bartramia longicauda*)

Black Skimmer (*Rynchops niger*)

Henslow's Sparrow (*Ammodramus henslowii*)

Common Tern[BR] (*Sterna hirundo*)

Forster's Tern[BR] (*Sterna forsteri*)

Least Tern (*Sterna antillarum*)

Cerulean Warbler (*Setophaga cerulea*)

Hooded Warbler[BR] (*Setophaga citrina*)

Swainson's Warbler(*Limnothlypis swainsonii*)

Sedge Wren (*Cistothorus platensis*)

[BR] Breeding population only

Reptiles

Leatherback Sea Turtle (*Dermochelys coriacea*)

Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)

Green Sea Turtle (*Chelonia mydas*)

Loggerhead Sea Turtle (*Caretta caretta*)

Bog Turtle (Glyptemys *muhlenbergii*)

Red Cornsnake (Pantherophis guttatus)

Scarletsnake (*Cemophora coccinea*)

Plain-bellied Watersnake (*Nerodia erythrogaster*)

Amphibians

Mud Salamander (*Pseudotriton montanus*)

Eastern Tiger Salamander (*Ambystoma tigrinum*)

Barking Treefrog (*Hyla gratiosa*)

Mammals

Little Brown Bat (*Myotis lucifugus*)

Northern Long-eared Bat (*Myotis septentrionalis*)

Delmarva Fox Squirrel (*Sciurus niger cinereus*)

Blue Whale (*Balaenoptera musculus*)

Fin Whale (*Balaenoptera physalus*)

Humpback Whale (*Megaptera novaengliae*)

North Atlantic Right Whale (*Eubalaena glacialis*)

Sei Whale (*Balaenoptera borealis*)

Sperm Whale (*Physeter macrocephalus*)

Fish

Glassy Darter(*Etheostoma vitreum*)

Blueridge Sculpin (*Cottus caeruleomentum*)

Bridled Shiner (*Notropis bifrenatus*)

Ironcolor Shiner (*Notropis chalybaeus*)

Atlantic Sturgeon (*Acipenser oxyrhynchus*)

Shortnose Sturgeon (*Acipenser brevirostrum*)

Blackbanded Sunfish (*Enneacanthus chaetodon*)

American Eel

An American eel. Photo by the DRBC.

American eels, *Anguilla rostrata*, are a species of fish that are found in various freshwater and estuarine waterways in the Delaware River Basin, from rivers and creeks to lakes and ponds.

American eels are catadromous, which means they are born in the ocean, live as adults in freshwater and return to the ocean to reproduce. All eels reproduce/are born in the same place - the Sargasso Sea, which is a part of the Atlantic Ocean.

The Delaware River is home to an abundant eel population because there are no dams on its mainstem to prevent the eel's upriver migration.

American Eel Life Cycle:

After hatching in the Sargasso Sea, American eel larvae travel on ocean currents to the U.S. eastern seaboard. These larvae are called glass eels because of their translucent bodies.

As they travel up estuaries and into rivers, they continue to grow and change color, from translucent to gray (called elvers) to yellow to silver. Maturity can take up to 20 years!

Once mature and the weather starts to turn colder, American eels will begin their journey down rivers and into the Atlantic Ocean, back to the Sargasso Sea.

Learn more about American eel

American Shad

An American shad. Photo: DRBC archives.

American shad, *Alosa sapidissima*, are the largest North American member of the herring family. Adults commonly reach four to eight pounds. They fill an important role in the food chain as predator and prey.

They are an anadromous fish, which means they are born in freshwater, like the Delaware River, live for several years in the ocean and return to the river in which they were born to spawn (lay their eggs).

Female shad are called *roes*; males *bucks*.

Shad Life Cycle:

After hatching in the spring, the young shad (called "fry") grow rapidly, feeding on freshwater plankton and aquatic insects.

Decreasing water temperatures in the late summer and early fall trigger a mass migration downriver to the ocean.

Once in the ocean, where they live most of their lives, shad will migrate up and down the coast, from their winter range off the mid-Atlantic to their summer range in the Bay of Fundy, off Nova Scotia.

After three-to-five years at sea, American shad will return in the spring to the river of their birth to spawn. They feed heavily prior to spawning and do not eat during their trip "home."

Other DRB Creatures

Beaver by John Fallon

Fox by John Fallon

Bears by Delaware River Sojourn

Great Blue Heron by Scott Sharadin

Brown Thrasher by Carla Kelly Mackey

Osprey by Barry Blust

Atlantic Sturgeon

Atlantic Sturgeon. Image courtesy of fisheries.noaa.gov.

Atlantic sturgeon, *Acipenser oxyrinchus,* belong to a category of ancient bony fishes, which may live up to 60 years, reach lengths up to 14 feet and weigh over 800 pounds.

Atlantic sturgeon are anadromous, which means they are born in freshwater, like the Delaware River, live in the ocean until they reach maturity and return to the river in which they were born to spawn (lay their eggs).

In the Delaware River, they spawn in the freshwater portion of the estuary, on the river's bottom. Juveniles will spend several years in the river before moving out to the Atlantic Ocean.

After spawning, sturgeon will return the ocean; they can make multiple spawning runs during their lifetimes.

Delaware River sturgeon were once the largest population on the Atlantic Coast. They were very popular for their eggs. In the late 1800s, Philadelphia was considered the "caviar capital of North America;" subsequent over-fishing, habitat loss and water quality issues led to their decline.

In 2012, the federal government listed all five distinct population segments of Atlantic sturgeon as endangered or threatened; the Delaware River is part of the "New York Bight" and is considered endangered.

Mortality from shipping traffic strikes, impaired habitat and water quality all threaten current populations. While recent Delaware River Basin-specific surveys have indicated some spawning success, additional research is needed for future predictions on species recovery.

Learn more about Atlantic sturgeon

Bald Eagles

A bald eagle catches a meal. Photo by Michael Porter.

Today, Bald eagles, *Haliaeetus leucocephalus*, are found in every state in the Delaware River Basin.

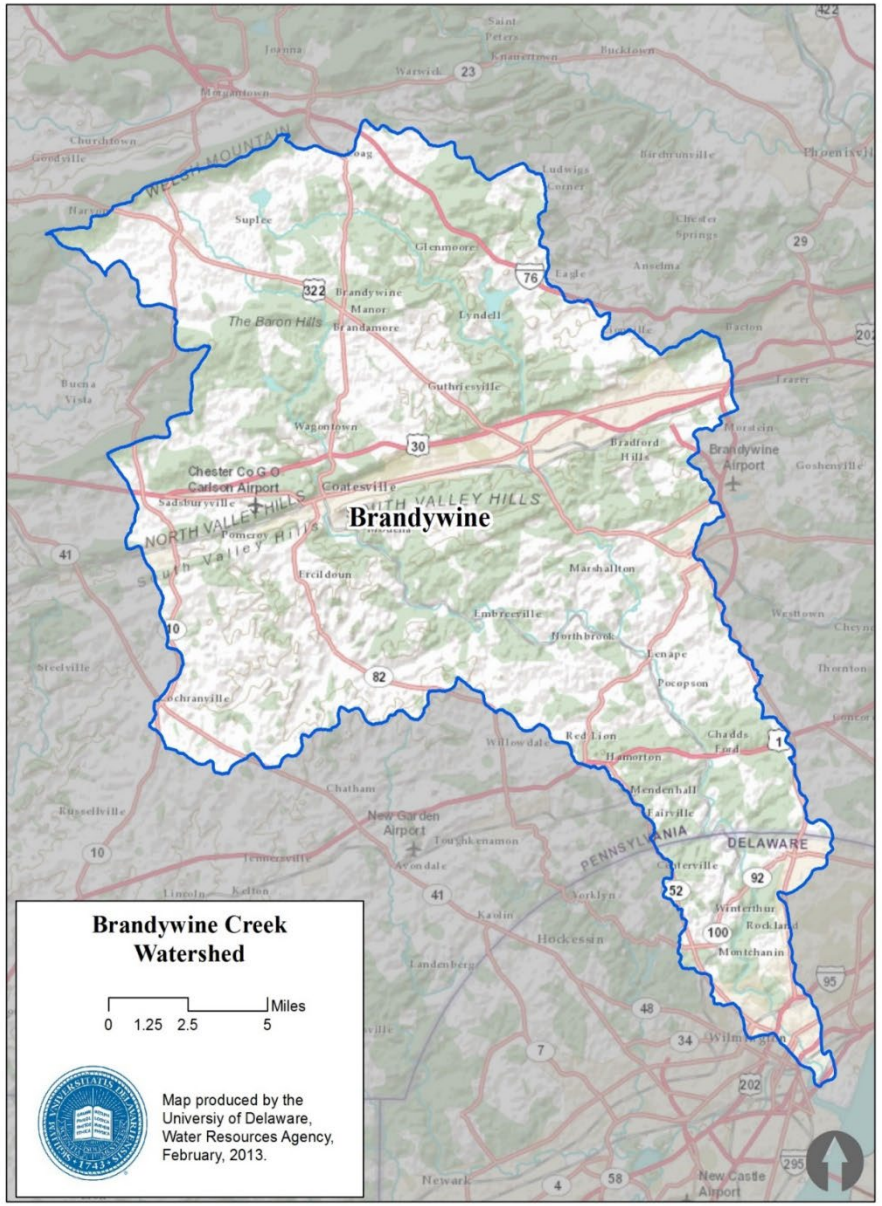
One very important reason for the return of the eagle was the federal government's decision in 1972 to ban the manufacturing of DDT in the United States.

Programs by the DRBC and other agencies and organizations to keep the river and its tributaries clean, the fish abundant, and the habitat undisturbed also have been a big help in the recovery of the bald eagle population throughout the basin.

Predominantly fish eaters, bald eagles typically build their nests and live near water.

In addition to its resident populations, the basin also is home to wintering bald eagles, those that spend the winter here to fish in waters that aren't frozen all season long.

The Billion Dollar Brandywine ($2013)

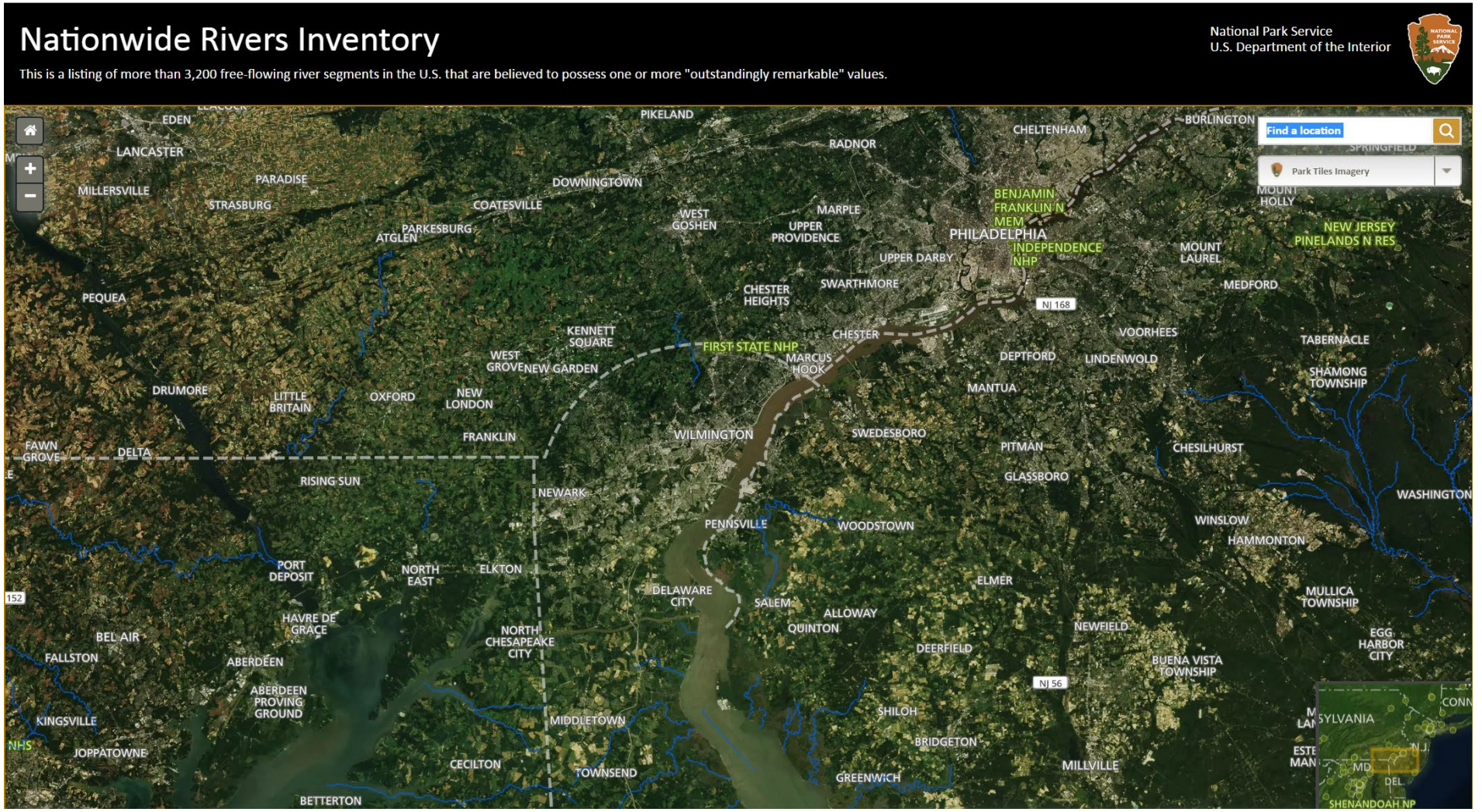


The water, natural resources, and ecosystems in the Brandywine Creek watershed contribute an economic value of **$560 million to $2 billion** annually to the Pennsylvania and Delaware economies.

1. The Brandywine Creek watershed contributes over **$890 million** in annual economic activity from water quality, water supply, fish/wildlife, recreation, agriculture, forests, and public parks benefits.

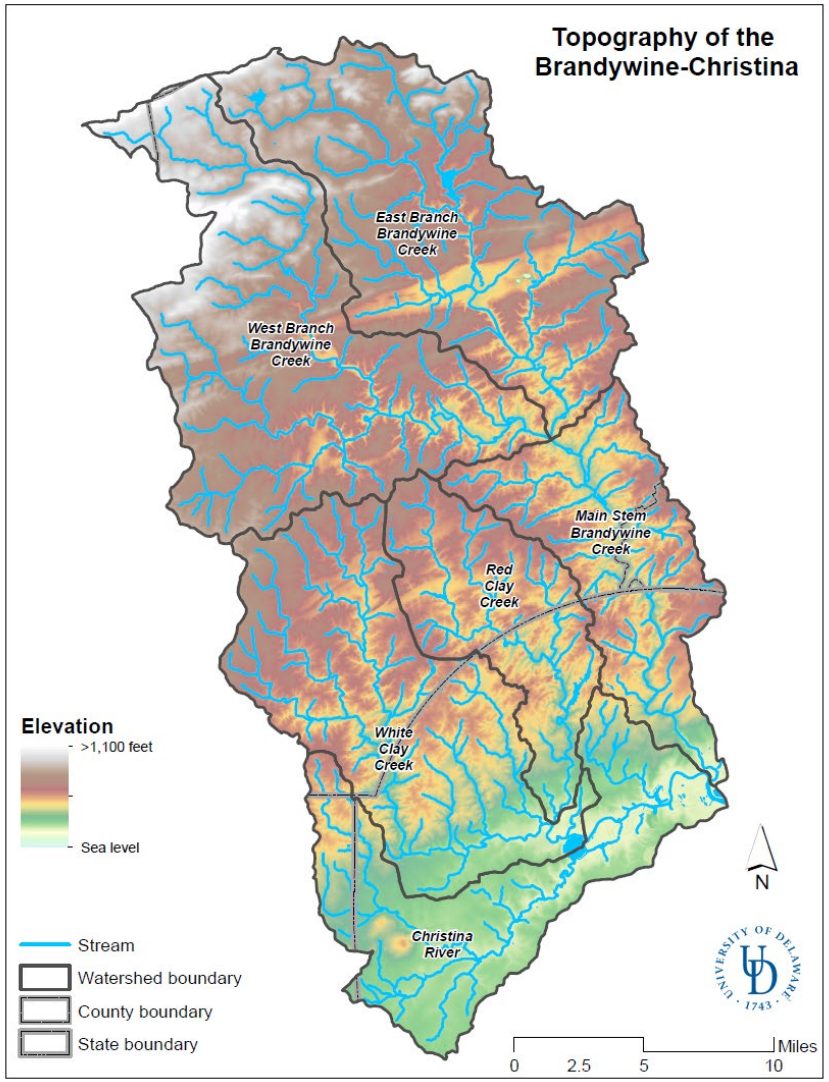
2. Habitats in the Brandywine Creek watershed provide **$560 million** annually in ecosystem goods and services, with a net present value (NPV) of **$18.3 billion** calculated over a 100-year period.

3. Natural resources within the Brandywine Creek watershed directly and indirectly support **50,000 jobs** with over **$2 billion** in annual wages.

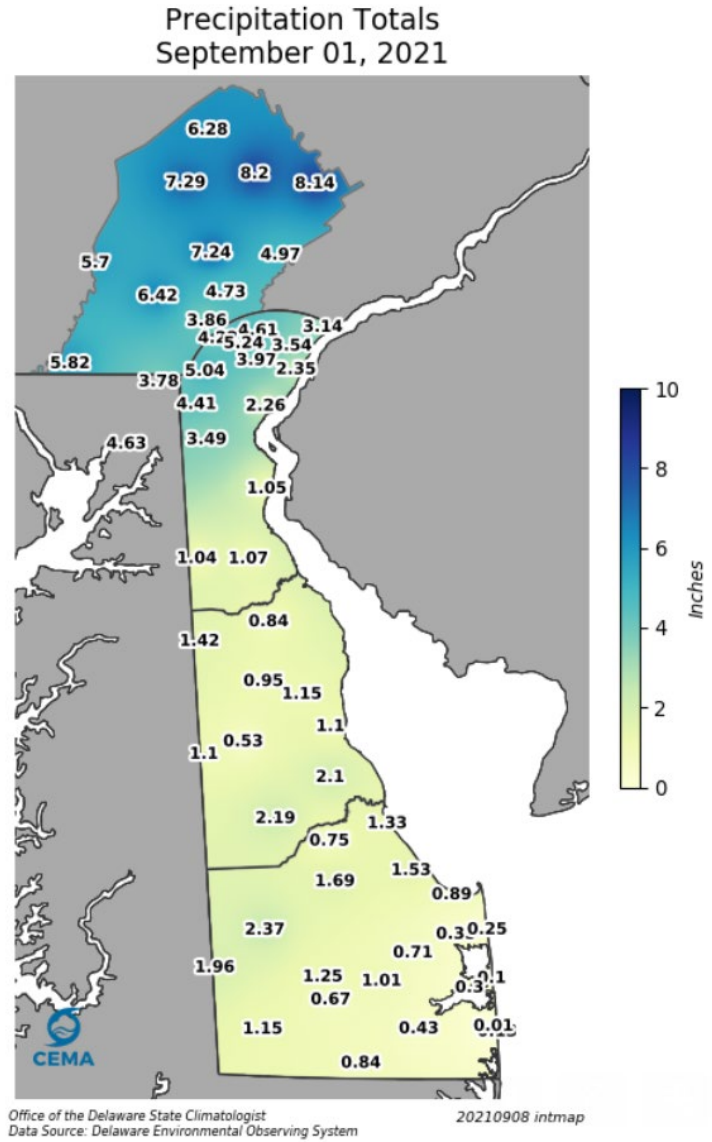


2020 AD

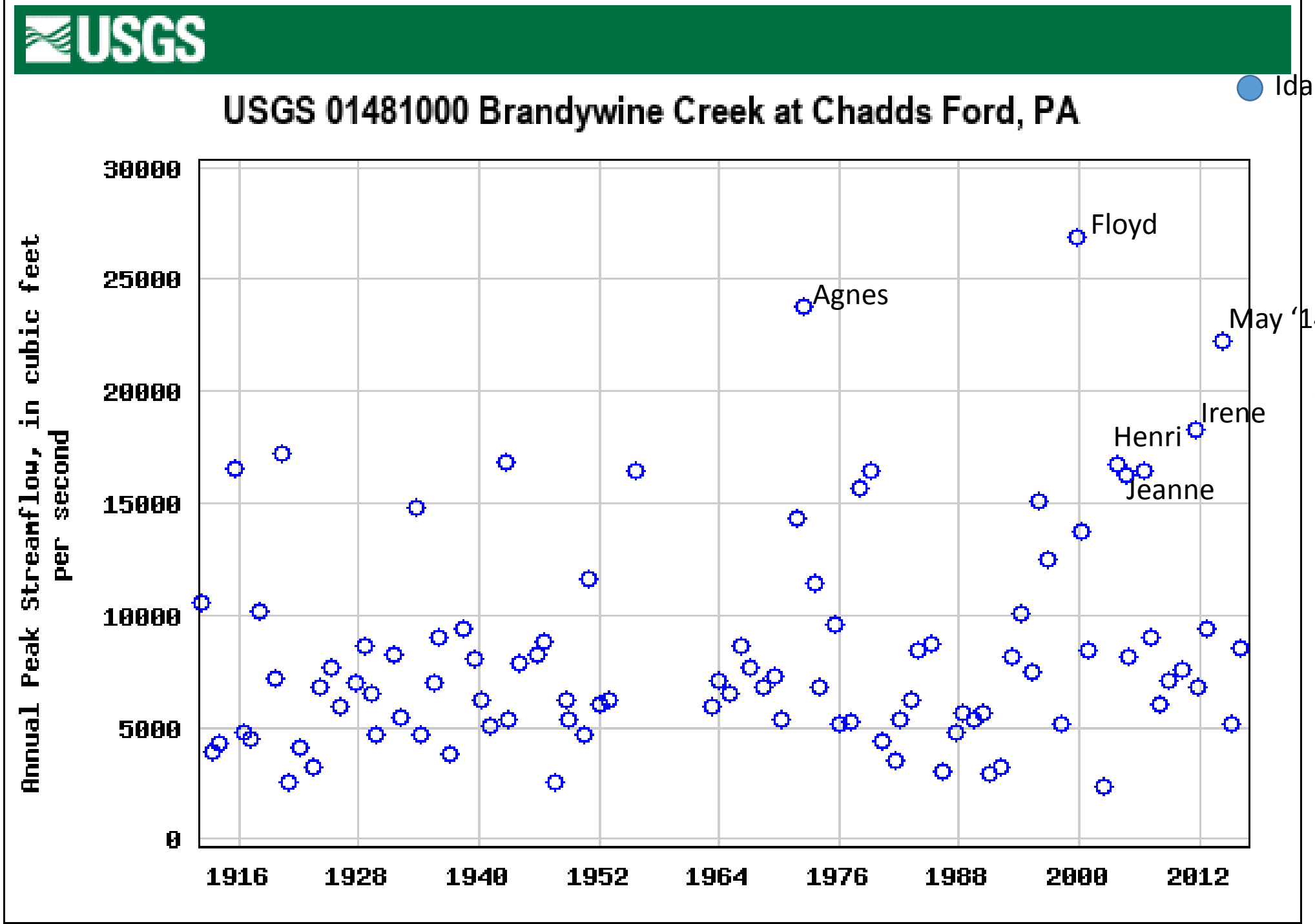
Brandywine River National Wild and Scenic River?



Ida's flood wave was accentuated by steep Piedmont topography in the funnel shaped Brandywine River watershed as it siphoned down to Chadds Ford, Pa then to Del. at William Penn's 1682 arc boundary.

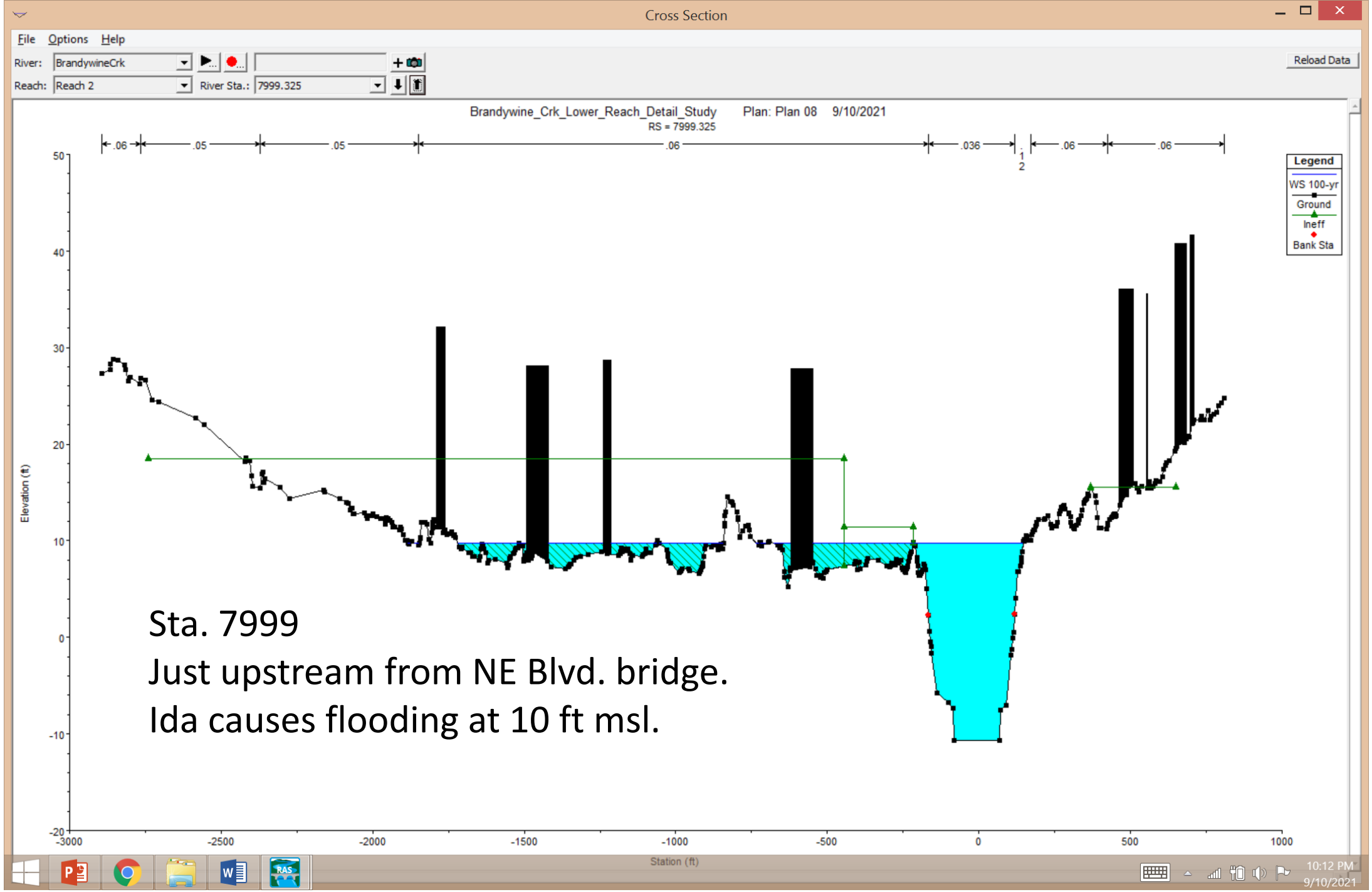


The remnants of Tropical Storm Ida left 7.29 inches of rain in the headwaters of the Brandywine watershed at Glenmoore and 8.2 inches at Chester Springs in Chester County, PA.



Since 1911, Brandywine Cr. at Chadds Ford, Pa never exceeded 25,000 cfs until Floyd in 1999 (27,000 cfs) then Ida in 2021 (33,000 cfs).

GIS topo map illustrates in blue the ground at El. 10 msl and less and depicts the overflow point upstream from the Northeast Blvd. Bridge this is the area where a low berm or dike would prevent overflow of the river.


Cross Section
File Options Help
River: BrandywineCrk
Reach: Reach 2
River Sta.: 7999.325
Reload Data
Brandywine_Crk_Lower_Reach_Detail_Study Plan: Plan 08 9/10/2021
RS = 7999.325
.06 .05 .05 .06 .036 .06 .06
1
2
Legend
WS 100-yr
Ground
Ineff
Bank Sta
Elevation (ft)
50
40
30
20
10
0
-10
-20
-3000 -2500 -2000 -1500 -1000 -500 0 500 1000
Station (ft)
Sta. 7999
Just upstream from NE Blvd. bridge.
Ida causes flooding at 10 ft msl.
10:12 PM
9/10/2021


NE Blvd bridge
9/2/21 AM COW DPW


NE Blvd bridge
9/2/21 AM COW DPW

Overall Site Reuse Vision Plan

S/G/A LANDSCAPE ARCHITECTURE PLANNING
STROMBERG/GARRIGAN & ASSOCIATES

DRAFT
FOR DISCUSSION PURPOSES ONLY

Northeast Brandywine Riverfront U.S. EPA Brownfields Area-Wide Plan
X

A low flood control dike can be created by simply raising the proposed pedestrian trail to 15 ft msl TOB from the E. 16th St bridge downstream to the NE Blvd. bridge.


KAWAI