

Economic Value of the Christina Basin

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The Christina Basin Clean Water Partnership

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Executive Summary

The water, natural resources, and ecosystems in the Christina River Basin contribute an economic value of \$900 million to \$4.9 billion annually to the Delaware and Pennsylvania economies (Table 1). This report examines that economic value in three different ways:

- 1. Economic value directly related to Christina Basin water resources and habitat.** The Christina Basin contributes \$1.6 billion in annual economic activity from water quality, water supply, fish/wildlife, recreation, agriculture, forests, and parks benefits. When accounting for navigation benefits at the Port of Wilmington, the Basin contributes \$4.5 billion annually.
- 2. Value of goods and services provided by Christina Basin ecosystems.** Using natural capital as a measure of value, habitat in the Christina Basin provides \$900 million annually in ecosystem goods and services in 2010 dollars, with a net present value (NPV) of \$29 billion calculated over a 100-year period.
- 3. Employment related to Christina Basin resources and habitats.** Using employment as a measure of value, natural resources within the Christina Basin directly and indirectly supports 125,000 jobs with \$4.9 billion in annual wages.

The purpose of these estimates is to demonstrate that the Christina Basin provides real and significant economic benefits to Delaware and Pennsylvania, benefits that are worthy of investment to keep these natural resources healthy and productive. Estimates were made by taking values from existing literature and studies and applying them to the Christina Basin using ecological economics and benefits-transfer techniques described in this report. Values are converted to 2010 dollars based on the change in the Northeast Region Consumer Price Index except where noted.

Note that the values in the three categories are not summed because there is some overlap between certain values within each category that could result in double counting. For example, the jobs of fishermen that contribute to employment and wages are also a factor in the economic activity generated from fishing, and the ecosystem values of forests for water-quality benefits may be at least partially captured in the economic value of water supply. Accurately determining (and eliminating) this overlap is difficult within the scope of this analysis.

Table 1. Annual economic value of the Christina Basin

Watershed/Basin	Economic Activity (\$ million)	Ecosystems Services (\$ million)	Jobs and Wages (\$ mil)	
Brandywine Creek.	890	560	50,000	2,000
Red Clay Creek	145	84	10,000	425
White Clay Creek	420	165	25,000	1,000
Christina River ¹	190	99	40,000	1,500
Christina Basin¹	1,645	908	125,000	4,925

1. Excludes navigation benefits from Port of Wilmington.

1. The Basin

The Christina River Basin is part of the larger 13,000 mi² Delaware River Basin. The Basin is a distinctive natural resource in Delaware and Pennsylvania and occupies 565 sq. mi. Its headwaters and 2/3 of its land area are in Pennsylvania, and its lower third is located within Delaware and a small slice of Maryland. The Basin includes four major watersheds including the Brandywine, Red Clay, and White Clay Creeks, and the Christina River (Figure 1).

The Christina River Basin requires significant inter-governmental coordination because it spans:

- Three states: Delaware, Pennsylvania, and Maryland,
- Five counties: Chester, Lancaster, and Delaware counties in Pennsylvania, New Castle County in Delaware, and Cecil County in Maryland,
- Over 60 townships, boroughs, and cities such as Elsmere, Newark, Newport, and Wilmington in Delaware and Avondale, Coatesville, Downingtown, Kennett Square, West Chester, and West Grove in Pennsylvania.

The Basin is home to more than 0.5 million people in three states (U.S. Census, 2010) and land use is generally divided among three sectors – urban/suburban (1/3), agriculture (1/3), and open space/forests (1/3).

The Christina Basin provides many ecological and natural functions such as:

- *Parks*: Brandywine Creek State Park, White Clay Creek State Park, and White Clay Creek Preserve and Marsh Creek State Park are located in the Christina Basin.
- *Conservation Areas*: Large, privately owned conservation areas in the basin include Woodlawn Trustees land along the Brandywine Creek, Delaware Nature Society land along the Red Clay Creek in Delaware, and Brandywine Conservancy, Red Clay Valley Association, and Brandywine Valley Association holdings in Pennsylvania.
- *Habitat*: Contiguous forests and wetlands provide habitat for several federal or state-listed endangered or threatened species:
 - Bog Turtle (*Glyptemys muhlenbergii*)
 - Cerulean Warbler (*Dendroica cerulea*)
 - Long-tailed Salamander (*Eurycea longicauda*)
 - Bald Eagle (*Haliaeetus leucocephalus*)
- *Exceptional Value Waters*: The Brandywine Creek above Wilmington and the White Clay Creek above Newark have more protective water quality standards through their designation by the Delaware DNREC as waters of Exceptional Recreational and Ecological Significance (ERES waters).
- *Wild and Scenic Status*: President Clinton and the U.S. Congress designated the White Clay Creek and its tributaries as federal Wild and Scenic River. The White Clay Creek is the only wild and scenic river in Delaware, and it is the first river nationally to be protected on a watershed basis.
- *Recreation*: The streams and parks throughout the Basin provide a variety of primary and secondary recreational opportunities such as canoeing, hiking/biking, boating, trout fishing, and warm water fishing.



Figure 1. The Watersheds of the Christina Basin

2. Economic Value

The economic value of the Christina Basin from water quality, water supply, fish/wildlife, recreation, agriculture, forests and public parks benefits exceeds \$1.6 billion (Table 2 and 3 and Figure 2). Including navigation benefits from the Port of Wilmington, the economic value of the Basin exceeds \$4.5 billion

Table 2. Annual economic activity in the Christina Basin

Sector	Annual Value (\$ mil)
Fish/Wildlife	61
Public Parks	160
Forests	211
Recreation	231
Water Supply	276
Water Quality	343
Agriculture	378
Total	>\$1.6 billion
Ports	3,266
Total	>\$4.5 billion

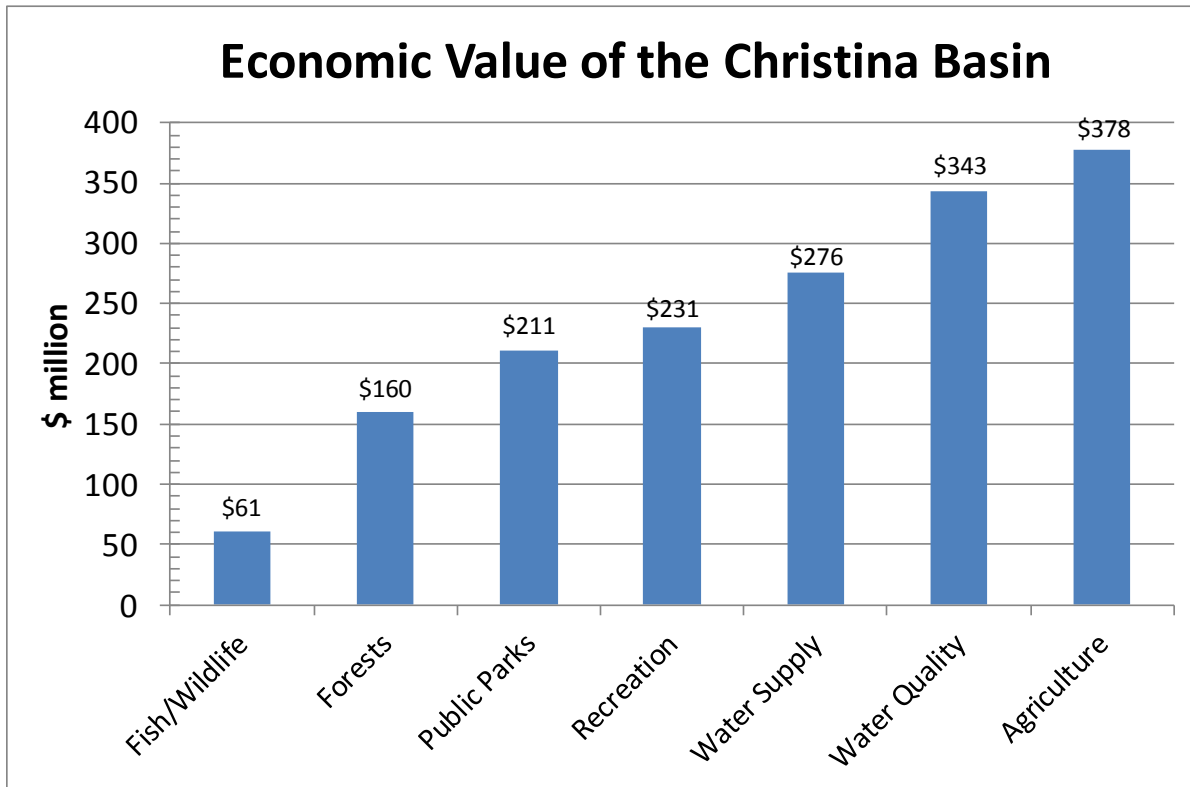


Figure 2. Economic value of the Christina Basin by sector

Table 3. Annual economic value of the Christina Basin

Sector	Activity	Brandywine	Red Clay	White Clay	Christina	Basin
		(\$ mil)	(\$ mil)	(\$ mil)	(\$ mil)	(\$ mil)
Water Quality	Boatable (WTP=\$13.20) ¹	3	0.6	2	2	7.6
	Fishable (WTP=\$13.22) ¹	3	0.6	2	2	7.6
	Swimmable (WTP=\$112.75) ¹	28	5.4	14	21	68.4
	Increased Property Value (+8%, 20 yrs) ^{2,3}	94	44.8	47.7	44	230.5
	Water Treatment by Forest (\$76/mgd) ⁴	2	0.0	0.8	0.1	2.9
	Wastewater Treatment ^{5,6}	23	1.9	0.8	0.7	26.4
Water Supply	Drinking Water (\$7.85/1,000 gal) ^{6,7}	137	1.3	93	38	269.3
	Reservoir Storage	2.6	0.0	0.1	0	2.7
	Irrigation (\$300/ac-ft) ^{8,9}	1.3	0.2	0.5	0.1	2.1
	Industrial (\$200/ac-ft) ^{8,10}	1.6	0.0	0	0	1.6
Fish/Wildlife	Fishing ¹¹	10	1.9	4	4	19.9
	Hunting ¹¹	11	1.6	3	2	17.6
	Wildlife/Bird-watching ¹¹	11	2.4	5	5	23.4
Recreation	Outdoor Recreation (241,020 visitors) ¹²	110	21.4	56	18	205.4
	State Parks (\$53/visit, 8,374 acres) ¹³	22.5	0.0	3	0	25.5
Agriculture	Crop, poultry, livestock(\$3,482/ac) ¹⁴	260	39.0	62	17	378.0
Ports	Port Activity	0	0.0	0.0	3,200	3200.0
Forests	Carbon Storage (\$827/acre) ¹⁵	71	11.1	19.0	10	111.1
	Carbon Sequestration (\$29/acre) ¹⁵	3	0.4	0.6	0.3	4.3
	Air Pollution Removal (\$266/acre) ¹⁵	23	3.6	6.0	3	35.6
	Building Energy Savings (\$56/acre) ¹⁵	5	0.8	1.0	0.7	7.5
	Avoided Carbon Emissions (\$3/acre) ¹⁵	0.3	0.0	0.7	0.03	1.1
Public Parks	Health Benefits (\$9,734/acre) ¹⁶	52	7.9	76.0	20	155.9
	Community Cohesion (\$2,383/acre) ¹⁶	13	1.9	19.0	5	38.9
	Stormwater Benefit (\$921/acre) ¹⁶	5	0.8	7.0	2	14.8
	Air Pollution Control (\$88/acre) ¹⁶	0.5	0.1	0.7	0.2	1.5
Total		>\$890M	>\$145M	>\$420M	>\$190M	>\$1.6M

1. University of Delaware (2003). 2. EPA (1973). 3. Brookings Institute (2010).
4. Trust for Public Land, AWWA (2004). 5. DNREC (2010). 6. WRA.
7. Chester County Conservation District and Chester Water Resources Authority (1998).
8. Resources for the Future (1996). 9. USDA (2007). 10. USGS (2005).
11. U.S. Fish and Wildlife Service (2008). 12. Outdoor Industry Foundation (2006).
13. PA DEP and Penn State. 14. USDA Census of Agriculture 2007 (2009).
15. U.S. Forest Service, Del Ctr. Hort. (2008). 16. Trust for Public Land.

3. Ecosystem Services

The estimated value of goods and services provided in the watersheds of the Christina Basin (563 mi² or 360,264 acres) is \$908 million (in 2010 dollars) with a net present value (NPV) of \$29 billion (Table 4). Ecosystem-services areas within the Christina Basin watersheds comprise forests (37.1%), farmland (31.4%), freshwater wetlands (2.5%), open water (0.04%), marine (0.2%), and saltwater wetlands (.2%). Roughly thirty percent of the land in the Christina Basin is urban (Figure 3).

Farmland, forests, and freshwater wetlands provide the highest ecosystems goods and services values (Figures 4 and 5). The Brandywine Creek Watershed, at \$561 million, provides the highest value of annual ecosystem services, ahead of the White Clay Creek at \$165 million, and the Christina River at \$99 million (Figure 6). The watershed with the highest value of annual ecosystem services per acre is the Brandywine (\$2,702/acre), followed by the Red Clay (\$2,437/acre) and the White Clay (\$2,412/acre) watersheds.

Table 1. Value of ecosystem goods and services in the Christina River Basin

Ecosystem	Area (acres)	\$/acre/yr	PV \$	NPV \$
Freshwater wetlands	8,934	13,621	\$121,681,960	3,954,663,700
Marine	749	10,006	\$7,495,600	243,607,015
Farmland	113,282	4,142	\$469,270,074	15,251,277,406
Forest land	133,770	1,978	\$264,614,109	8,599,958,539
Saltwater wetland	853	7,235	\$6,171,545	200,575,225
Barren land	666	0	\$0	
Urban	100,478	342	\$34,324,520	1,115,546,915
Beach/dune	45	48,644	\$2,172,606	70,609,702
Open water	1,488	1,946	\$2,895,110	94,091,076
Total	360,264	2,702	\$908,625,525	29,530,329,578

Ecosystem goods and services in the Christina Basin watersheds using NJDEP data and USDA farm-good values are worth \$908 million (2010 dollars) or \$29 billion (NPV), which are conservatively in the lower end of the range. If lower per-acre estimates of ecosystem services from other studies were used instead of the NJDEP values, ecosystem services in the Christina Basin watersheds would be worth \$343 million or NPV of \$11 billion. If higher per-acre estimates from other studies were used, the value of ecosystems in the Christina Basin watersheds would be \$3 billion or NPV of \$104 billion.

<u>Estimate</u>	<u>PV (\$B)</u>	<u>NPV (\$B)</u>
Low	\$343 million	\$11 billion
NJDEP	\$908 million	\$29 billion
High	\$3 billion	\$104 billion

Ecosystems Area (acres) in the Christina Basin

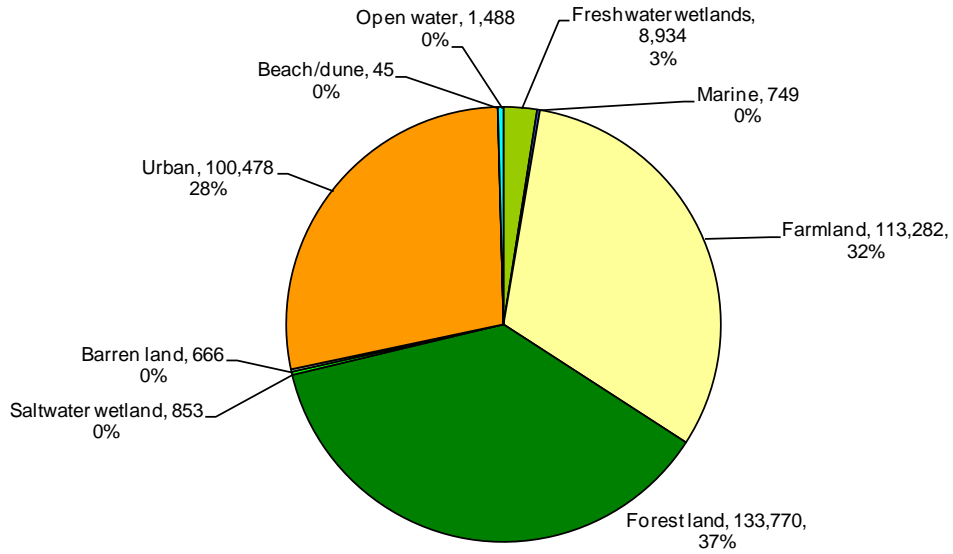


Figure 3. Ecosystems service areas in the Christina Basin

Ecosystem Services Value Watersheds in the Christina Basin

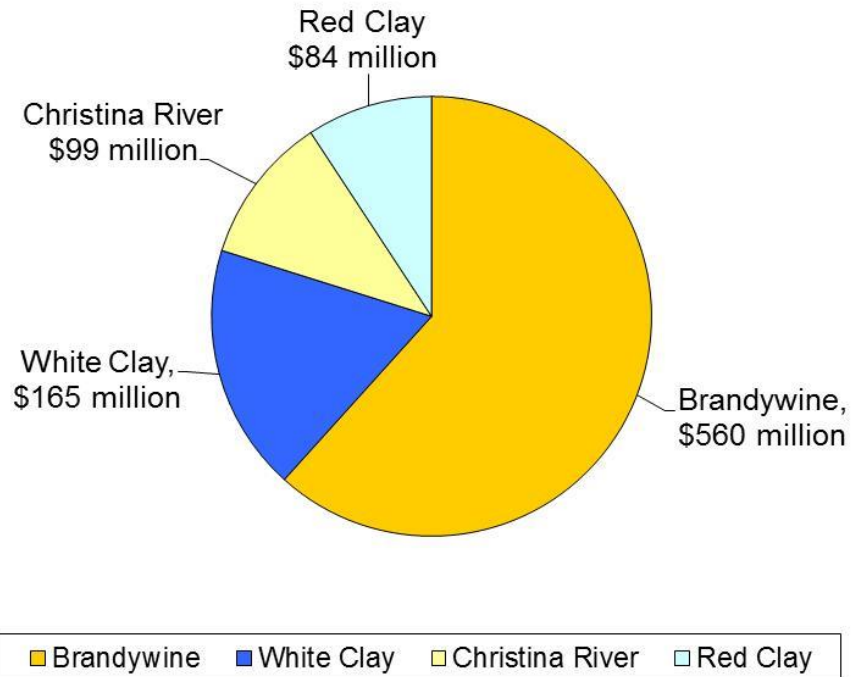


Figure 4. Value of natural goods and services by watershed in the Christina Basin

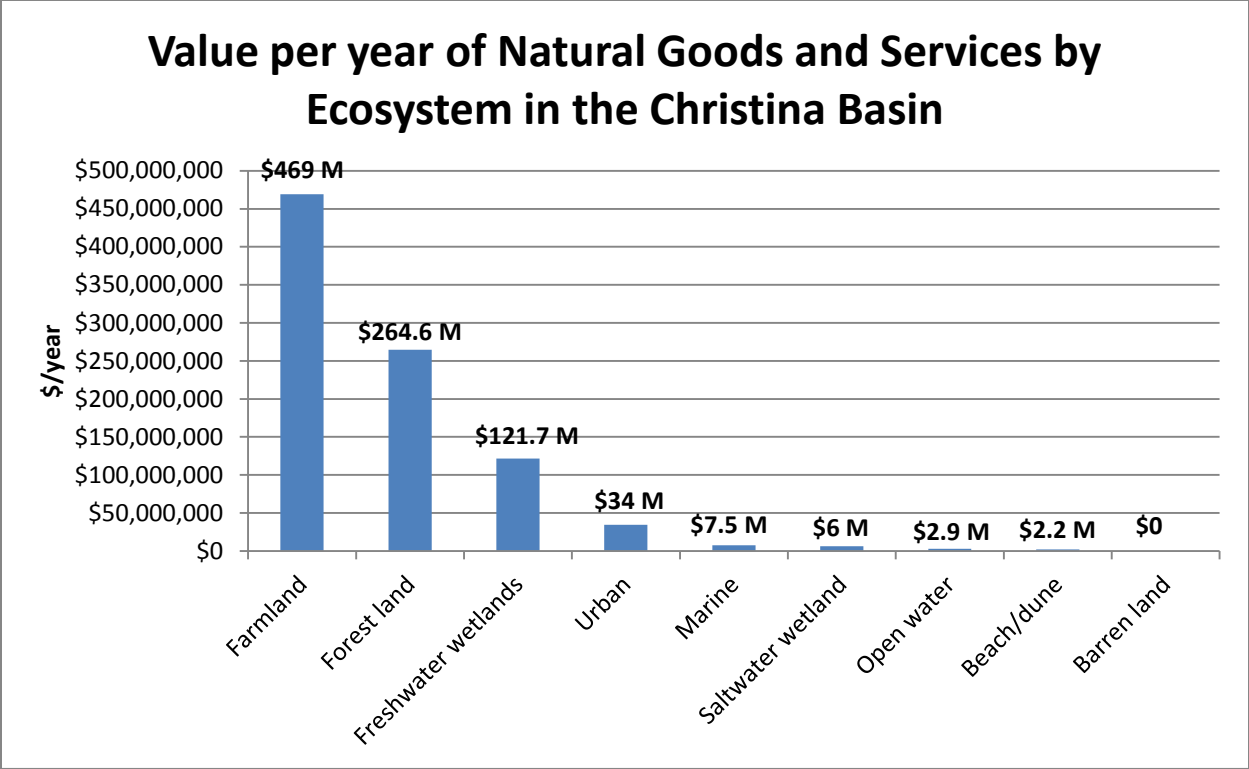


Figure 5. Natural goods and services value (2010 dollars) in the Christina Basin

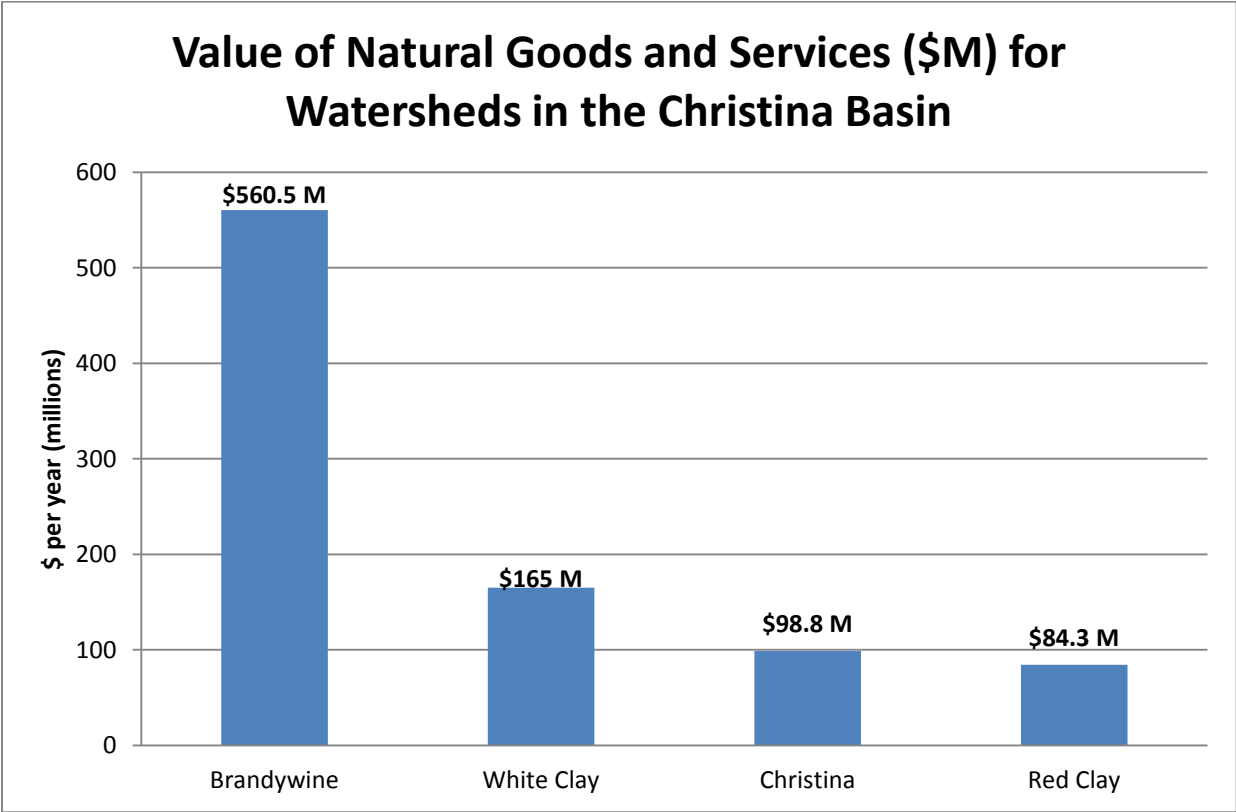


Figure 6. Value of natural goods and services by watershed in the Christina Basin

5. Jobs and Wages

The Christina Basin's water resources and habitats support over 125,000 direct and indirect jobs and with \$4.9 billion in annual wages in the coastal, farm, ecotourism, recreation, watershed organization, port, and water supply/wastewater industries (Tables 5 and 6).

Table 5. Jobs and wages directly and indirectly related to the Christina Basin

Sector	Brandywine		Red Clay		White Clay		Christina River		Basin	
	Jobs	Wages (\$ mil)	Jobs	Wages (\$ mil)	Jobs	Wages (\$ mil)	Jobs	Wages (\$ mil)	Jobs	Wages (\$ mil)
Direct Watershed ¹	23,208	1,205	4,361	217	11,399	549	15,728	733	54,696	2,704
Indirect Watershed ¹	27,850	964	5,233	173	13,679	439	18,873	586	65,635	2,162
Coastal ^{2,6}	781	16	436	9	1,639	33	2,974	59	5,830	117
Farm ³	3,453	136	411	16	846	33	69	3	4,779	188
Fish/Hunt/Bird ⁴	1,121	37	204	7	427	14	373	12	2,125	70
Outdoor Recreation	1,299	43	252	8	661	56	988	32	3,200	139
Watershed Orgs. ⁵	124	6	116	6	117	6	4,600	307	4,957	325
Ports	0	0	0	0	0	0	129	6	129	6
Water Supply ⁷	175	10	0	0	99	5	18	1	292	16
Wastewater ⁵	58	2	5	0.2	4	0.2	2	0.1	69	3
Total	> 50,000	> \$2 bil	>10,000	>\$425 mil	> 25,000	> \$1 bil	>40,000	>\$1.5 bil	>120,000	> \$4.9 bil

1. U.S. Census Bureau (2010). 2. National Coastal Econ. Program (2009). 3. U.S. Dept. of Agriculture., (2007)

4. U.S. Fish and Wildlife Service (2008). 5. WRA and DRBC (2010). 6. Martins Associates (2007)).

7. Delaware Tourism Office (2008).

Table 6. Direct and indirect watershed-related jobs in the Christina Basin

Sector	2007 North American Industry Classification System (NAICS) code	Direct Jobs ¹	Direct Wages ¹ (x\$1000)	Indirect Jobs ²	Indirect Wages ² (x\$1000)
Construction	23711	214	12,553	257	10,042
Living/Resources	115, 31213, 42446, 44422, 44522, 44523	572	19,152	687	15,322
Minerals	21, 2211	49	3,568	59	2,854
Tourism/Recreation	42391, 45111, 532292, 532411, 44121, 44121, 441222, 712, 7131, 71312, 7139, 71391, 71393, 71394, 71399, 721, 72111, 7221, 722211, 722213, 72231, 722320	28,482	480,023	34,179	384,019
Transportation	483, 4832, 487, 4872, 4883, 488320	599	24,182	719	19,346
Environmental	541, 813211, 8134	23,626	2,089,870	28,351	1,671,896
Water/Wastewater	2213, 562	1,153	62,129	1,384	49,703
Total		54,696	2,703,250	65,636	2,162,600