CHAPTER 4.3 INDIVIDUAL RIVER BASIN DESCRIPTION AND ASSESSMENTS

Potomac and Shenandoah River Basin

The Potomac-Shenandoah River basin, as its name implies, is made up of the Shenandoah River sub-basin and the Potomac River sub-basin. It occupies the northern portion of Virginia and covers 5,681 square miles or 13% of the Commonwealth's total area.

In Virginia, the Potomac-Shenandoah basin is defined by both hydrologic and political boundaries. The James River and Rappahannock River basins bound the basin to the south. The West Virginia and Maryland State lines and the District of Columbia bound the northern and western perimeter of the basin.

The headwaters of the Shenandoah River sub-basin begin in Augusta County and flow in a northeasterly direction for approximately 100 miles to the West Virginia state line. The basin averages 30 miles in width and covers 3,384 square miles.

The topography of the Shenandoah River sub-basin is characterized by rolling hills and valleys bordered by the Appalachian Mountains to the west and the Blue Ridge Mountains to the east. The Massanutten Mountain Range divides the Shenandoah River into the North and South Forks. Tributaries of the Shenandoah River exhibit steep profiles as they drain the surrounding mountain ridge. The mainstem of the Shenandoah exhibits a moderately sloping profile with occasional riffles and pools. Approximately 45% of the land is forested due to the large amount of federally-owned land and the steep topography. Farmland and pasture account for 39% of the land area, while 16% is urban.

The Potomac River sub-basin headwaters begin in Highland County. The drainage area is 323 square miles for the headwaters. The river then flows in a northeasterly direction through West Virginia and Maryland before joining the Shenandoah at Harper's Ferry, West Virginia. The Potomac River continues as the border between Maryland and Virginia. These waters flow approximately 200 miles in a southeasterly direction along Loudoun and Fairfax counties to its confluence with the Chesapeake Bay in Northumberland County. Approximately 2,298 of the 14,700 square miles of the Potomac River sub-basin drainage area lie in Virginia. The rest covers four states and the District of Columbia.

Gently sloping hills and valleys from Harpers Ferry to approximately 45 miles downriver characterize the topography of the upper Piedmont region of the Potomac River sub-basin. In the central Piedmont area, the profile is rather flat until it nears the fall line at Great Falls, where the stream elevation rapidly descends from over 200 feet to sea level. Tributaries in the central Piedmont exhibit moderate and near constant profiles. Their flat slope largely characterizes streams in the Coastal Plain area. Approximately 40% of the Potomac River basin is forested, 33% is farmland and pasture and an estimated 27% is urban.

The 2010 population for the Potomac-Shenandoah River basin was approximately 3,141,200. The majority of the population resides in urban Virginia surrounding Washington, D.C. All or part of the following jurisdictions lie within the basin: Counties – Arlington, Augusta, Clarke, Fairfax, Fauquier, Frederick, Highland, King George, Loudoun, Northumberland, Page, Prince William, Rockingham, Shenandoah, Stafford, Warren, and Westmoreland; Cities – Alexandria, Fairfax, Falls Church, Harrisonburg, Manassas, Manassas Park, Staunton, Waynesboro, and Winchester.

The Potomac-Shenandoah River basin is divided into eight USGS hydrologic units as follows: HUC 02070001- South Branch Potomac; HUC 02070004 - Conococheague-Opequon; HUC 02070005 - South Fork Shenandoah; HUC 02070006 - North Fork Shenandoah; HUC 02070007 - Shenandoah; HUC 02070008 - Middle Potomac-Catoctin; HUC 02070010 - Middle Potomac-Anacostia-Occoquan; HUC 02070011 - Lower Potomac. The eight hydrologic units are further divided into 92 waterbodies or watersheds and 181 6th order sub-watersheds.

Public Concerns over Excessive Algae in the Shenandoah River

During the public comment periods for the 2012 and 2014 Integrated Reports, DEQ received comments from citizens regarding the presence of algae in the Shenandoah River and concern that the algae in the river impaired the recreation designated use. In response to citizen comments, additional photographic evidence, and recent information provided by citizen groups, DEQ determined that there was uncertainty about the attainment status of the recreation designated use for 7 assessment units (5 stream segments) in the Shenandoah River basin. These waters (listed in Table 4.3-a) comprise a total of 25 stream miles and were classified in the 2014 Assessment Database as Category 3C for the recreation use, which indicates an observed effect, but insufficient data to determine whether or not the recreation use is supported. These segments have been prioritized for follow-up monitoring in 2016 and 2017 by DEQ to develop and test field methods for estimating the percent coverage of river bottom by filamentous algae that are scientifically based, defensible and reproducible. DEQ made additional commitments for future activities, including decisions on thresholds for percent coverage that constitute a "nuisance" condition and impairment under the general narrative water quality standard, and inclusion of such thresholds in DEQ's guidance for the 2018 Assessment Report.

In May 2016, DEQ began developing a scientifically valid field method for evaluating algae cover that can be applied consistently throughout the state, with an initial study area focused on the Shenandoah River. The 2016 field season extended through early November. To meet the demanding field schedule, DEQ hired two employees who were solely dedicated to algae monitoring. DEQ's monitoring staff visited each of the five sites weekly, as conditions permitted. During 2016, DEQ tested three lateral transect methods to estimate percent cover by filamentous algae at evenly spaced increments along the wetted channel width. Of the three methods tested, staff found that the Quadrat method results showed greatest agreement among field staff. DEQ found that the lateral transects provided good estimates of algal percent cover, but given the potential for bias and error, staff began reviewing analytical methods to more objectively and consistently determine numeric algae densities. Based on methods in place in Montana[1], DEQ staff began collecting chlorophyll-a (the green pigment in algae that coverts light to energy) and Ash Free Dry Mass (a weight measurement) data to estimate algal densities on the substrate of the rivers. 15 data points were collected in the 2016 field season.

What is the Quadrat Method?

For the Quadrat method, monitoring staff use a view scope to compare percent coverage of algae within a square frame to a visual percent cover chart. Several measurements are taken along the width of the channel. The individual values are averaged to generate a single estimate of percent cover by filamentous algae for the site.

The results of the 2016 monitoring season were made available on the agency's Shenandoah River Algae website[2], and presented to the public during a public information webinar in December 2016 and at the Environment Virginia Conference in April 2017. In general, the results from the 2016 monitoring season indicate that more data is needed before decisions on recreation use impacts can be made. Many of the South Fork Shenandoah segments showed little to no algae throughout the 2016 growing season. The North Fork segments did have filamentous algae present during periods of prolonged low flow, but the algae was ephemeral and dependent on multiple variables including precipitation, river flows, and sunlight. Consequently, the 7 Assessment Units remain in Category 3C in the 2016 IR.

[1] http://deq.mt.gov/Portals/112/Water/WQPB/QAProgram/Documents/PDF/SOPs/WQPBWQM-011v6_FNL.pdf

[2] http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityAssessments/ShenandoahAlgae.aspx

During the 2017 growing season, DEQ staff conducted algal monitoring weekly from June through October. Monitoring focused on the collection of transect data and analytical data, as conditions allowed. Additional goals include:

- further developing the Monitoring Plan to define sample intervals;
- proposing impairment thresholds and assessment methods based on 2016 and 2017 data results;
- holding a public webinar to present updated findings and recommendations to the public;
- incorporating decisions on impairment thresholds and assessment method as well as information on monitoring results in 2018 Integrated Report;
- working with local citizen monitoring groups to determine meaningful and discrete ways in which they can assist with this effort.

DEQ will continue to consider recommendations from the Interstate Commission on the Potomac River Basin, the Academic Advisory Committee, and the Mid-Atlantic jurisdictions that comprise EPA Region III (PA, WV, MD, VA, DE and DC).

Table 4.3-a. Assessment units in the Shenandoah River that have been classified as having an indeterminate recreation use status, with algae identified as a potential cause of impairment.

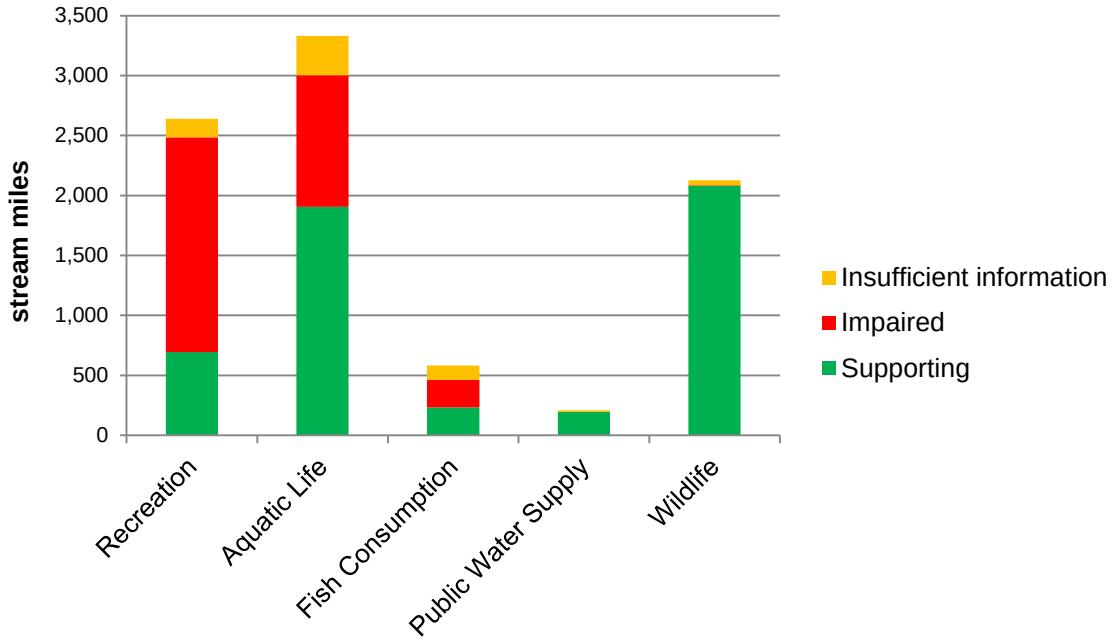
Assessment Unit ID	Stream Name	Location Description	Length (mi)
VAV-B40R_SSF01B14	South Fork Shenandoah River	South Fork Shenandoah River from the Bentonville Landing Bridge downstream to the Andy Guest State Park STP outfall.	2.2
VAV-B40R_SSF03A14	South Fork Shenandoah River	South Fork Shenandoah River from the Foster's Landing Rapids downstream to Seekford's Ford.	5.4
VAV-B37R_SSF02B14	South Fork Shenandoah River	South Fork Shenandoah River from Naked Creek downstream to the Shenandoah STP outfall.	2.0
VAV-B35R_SSF01A00	South Fork Shenandoah River	South Fork Shenandoah River from its confluence with Dry Run downstream to its confluence with Naked Creek.	3.6
VAV-B51R_NFS05A00	North Fork Shenandoah River	North Fork Shenandoah River from the Strasburg Public Water Intake downstream to the 5 mile upper limit of the PWS designation for the Winchester Public Water Intake.	1.6
VAV-B51R_NFS06A00	North Fork Shenandoah River	North Fork Shenandoah River from the 5 mile upper limit of the PWS designation for the Strasburg Public Water Intake downstream to the Strasburg Public Water Intake.	5.9
VAV-B45R_NFS02A00	North Fork Shenandoah River	North Fork Shenandoah River from its confluence with Fort Run downstream to its confluence with Plains Mill Spring Run.	4.5

Basin assessment information is included in the following figures and tables.

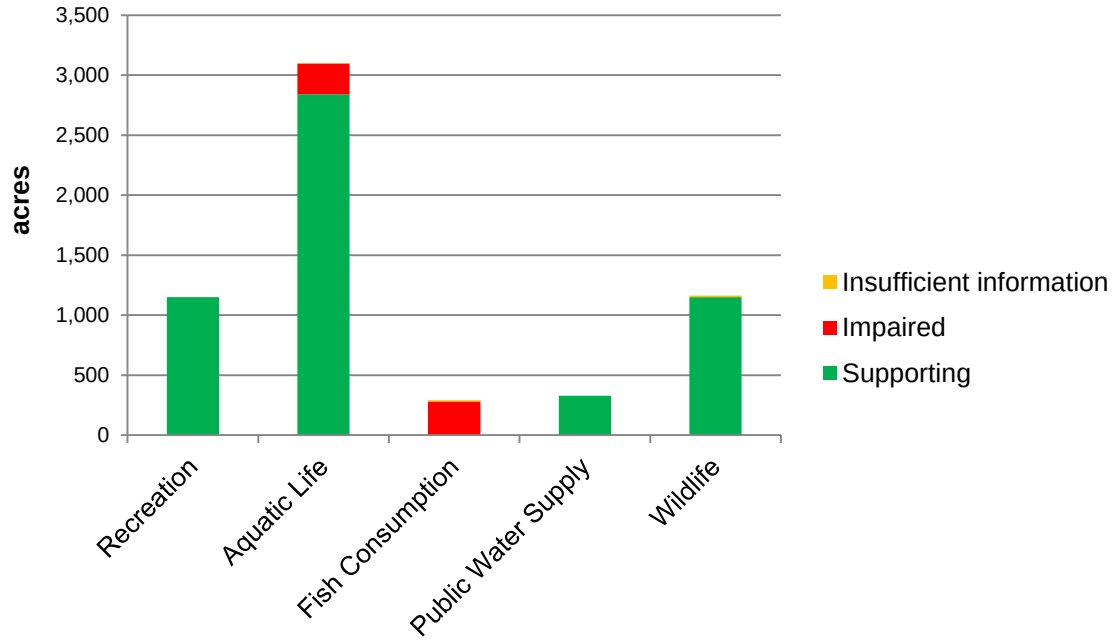
Figure 4.3-1 Designated Use support summary for Potomac-Shenandoah River basin. (Note: Waters that have some data, but not enough to determine use support, are classified as having "Insufficient information".)

Basin Size: *All Sizes Rounded to Nearest Whole Number*
Rivers - 13,232 miles
Lakes - 4,241 acres
Estuaries - 59 sq. miles

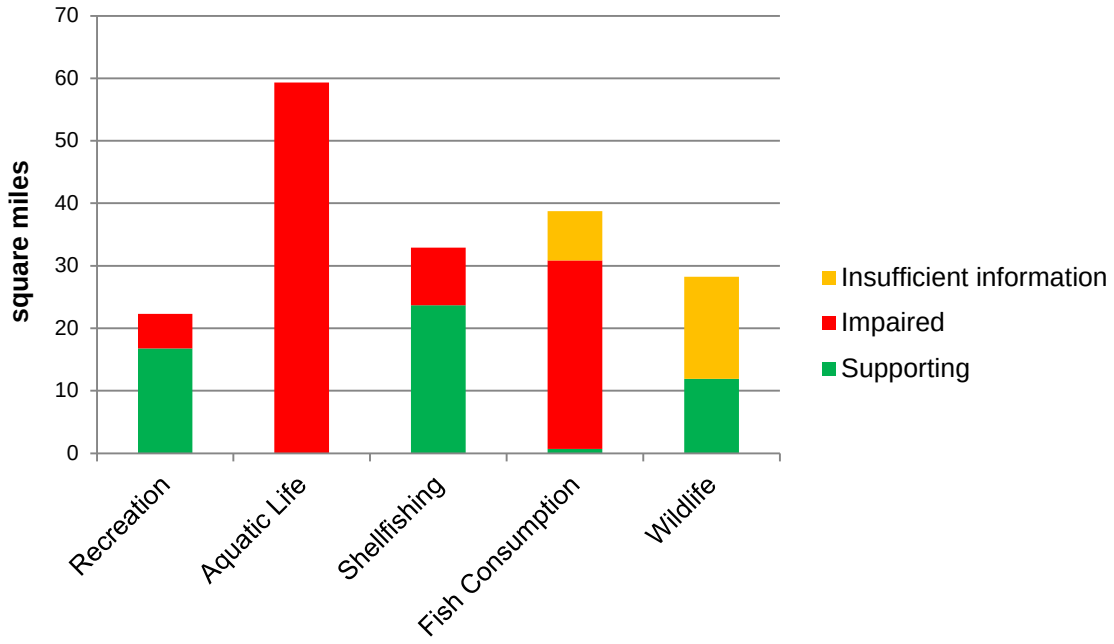
a) Rivers Assessment (10,175 miles were not assessed)



b) Lakes Assessment (926 acres were not assessed)



c) Estuaries assessment



d) Assessment of Chesapeake Bay-specific designated uses (Migratory fish spawning and nursery use was not assessed.)

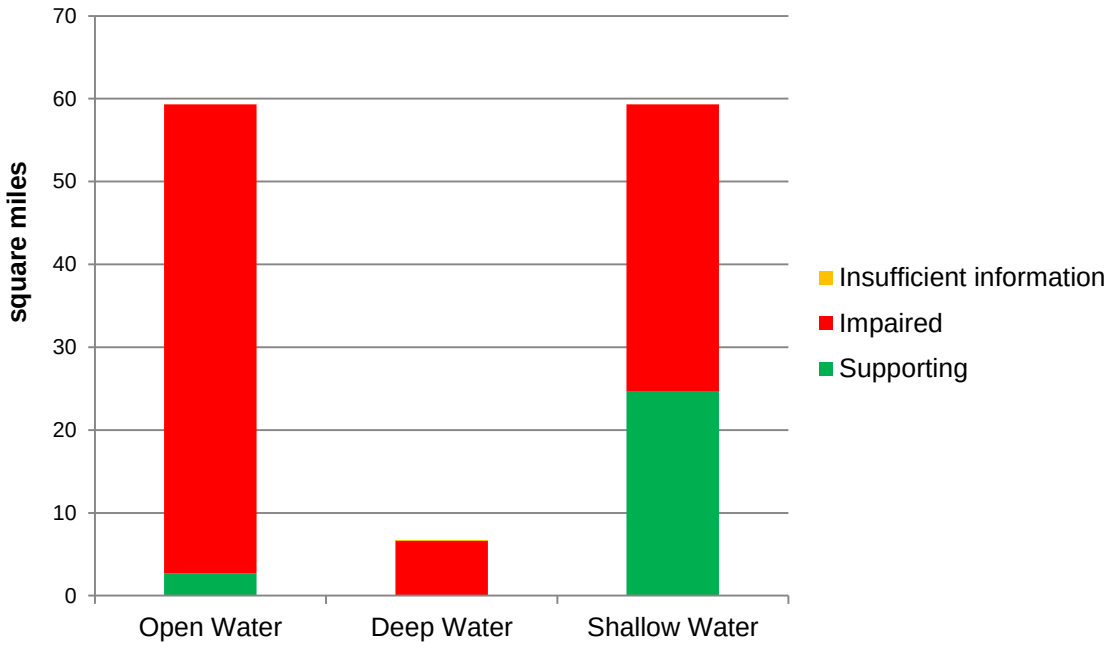


Table 4.3-1 Significant causes of designated use impairment in the Potomac-Shenandoah River basin, by waterbody type, ranked by percentage of impaired water size. (Note: Waters can have multiple pollutants.)

Rivers		*Lakes*		*Estuaries*	
Bacteria	79%	**PCBs in Fish Tissue**	52%	**Dissolved Oxygen**	98%
Impaired Benthics	32%	**Mercury in Fish Tissue**	33%	**Impaired Aquatic Plants**	58%
pH	13%	**Temperature**	29%	**PCBs in Fish Tissue**	51%
Dissolved Oxygen	7%	**Dissolved Oxygen**	17%	**Bacteria**	19%
Mercury in Fish Tissue	7%	**pH**	2%	**pH**	3%
PCBs in Fish Tissue	6%	**--**	--	**Impaired Benthics**	2%

Table 4.3-2 Suspected sources of designated use impairment in the Potomac-Shenandoah River basin, by water body type, ranked by percentage of impaired water size. (Note: Waters can have multiple sources of pollution.)

Rivers		*Lakes*		*Estuaries*	
Wildlife other than Waterfowl	60%	**Source Unknown**	81%	**Sources Outside State Borders**	100%
Non-Point Sources	51%	**Atmospheric Deposition (Toxics)**	19%	**Agriculture**	100%
Agriculture	34%	**Combined Sewer Overflows**	19%	**Atmospheric Deposition (Nitrogen)**	100%
Source Unknown	24%	**Contaminated Sediments**	19%	**Industrial or Municipal Point Source Discharges**	100%
Grazing in Riparian or Shoreline Zones	18%	**Upstream Source**	19%	**Internal Nutrient Recycling**	100%
Livestock Grazing or Feeding Operations	16%	**Natural Conditions**	17%	**Loss of Riparian Habitat**	100%

James River Basin

The James River Basin occupies the central portion of Virginia and covers 10,265 square miles or approximately 24% of the Commonwealth's total land area. It is Virginia's largest river basin and is made up of the Upper, Middle, and Lower James River sub-basins as well as the Appomattox River sub-basin.

The James River basin is defined by both hydrologic and political boundaries. The Potomac-Shenandoah River basin, the Rappahannock River basin and the York River basins bound the basin to the north. The southern boundary is made up of the New River basin, the Roanoke River basin and the Chowan River basin. Its headwaters originate along the Virginia/West Virginia state line.

The James River basin begins in the Alleghany Mountains and flows in a southeasterly direction to Hampton Roads where it enters the Chesapeake Bay. The James is formed by the confluence of the Jackson and Cowpasture Rivers and flows 242 miles to the Fall Line at Richmond and another 106 miles to the Chesapeake Bay.

The topography of the James River basin varies throughout the four physiographic provinces that it spans. The Valley and Ridge Province extends from the Appalachian Plateau in West Virginia to the Blue Ridge Province. The Blue Ridge Province, a remnant of a former highland, differs from the Valley and Ridge Province. It is a province of rugged terrain with steep slopes and narrow ridges in the north and broad moderate slopes in the south. The Piedmont Province extends to the Fall Line and has scattered hills and small mountains, gradually turning into gently rolling slopes and lower elevation in the eastern portion of the province. The Fall Zone separates the Coastal Plain Province from the Piedmont. The Fall Zone is a three-mile stretch of river running through Richmond where the river descends 84 feet as it flows from the resistant rocks of the Piedmont to the softer sediments of the Coastal Plain.

Over 65% of the James River basin is forested, with 19% in cropland and pasture. Approximately 12% is considered urban. The 2010 population for the James River basin was approximately 2,892,000. This population is concentrated in two metropolitan areas: Tidewater, with over one million people, and the Greater Richmond – Petersburg area with over 650,000. Two smaller population centers are the Lynchburg and Charlottesville areas, each with over 100,000 people. All or portions of the following 38 counties and 17 cities lie within the basin: counties - Albemarle, Alleghany, Amelia, Amherst, Appomattox, Augusta, Bath, Bedford, Botetourt, Buckingham, Campbell, Charles City, Chesterfield, Craig, Cumberland, Dinwiddie, Fluvanna, Giles, Goochland, Greene, Hanover, Henrico, Highland, Isle of Wight, James City, Louisa, Montgomery, Nelson, New Kent, Nottoway, Orange, Powhatan, Prince Edward, Prince George, Roanoke, Rockbridge, Surry, and York; cities - Buena Vista, Charlottesville, Chesapeake, Colonial Heights, Covington, Hampton, Hopewell, Lexington, Lynchburg, Newport News, Norfolk, Petersburg, Portsmouth, Richmond, Suffolk, Williamsburg, and Virginia Beach.

Average annual precipitation is 42.5 inches. Average annual snowfall amount ranges from over 30 inches in the mountains to less than 10 inches along the coast.

Major tributaries to the James River are Jackson River, Cowpasture River, Craig Creek, Maury River, Tye River, Rockfish River, Slate River, Rivanna River, Willis River, Appomattox River, Chickahominy River, Pagan River, Nansemond River, and the Elizabeth River.

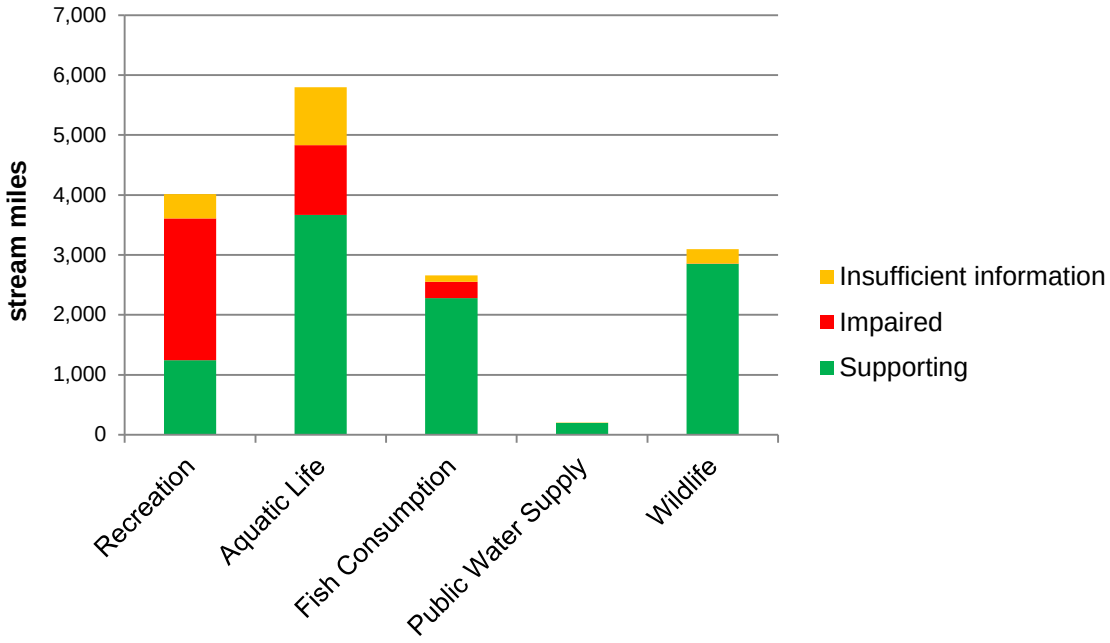
The James River Basin is divided into eight USGS hydrologic units as follows: HUC 02080201 –Upper James, HUC 02080202 – Maury, HUC 02080203 – Upper Middle James, HUC 02080204 – Rivanna, HUC 02080205 – Lower Middle James, HUC 02080206 – Lower James, HUC 02080207 – Appomattox, and HUC 02080208 – the Elizabeth. The eight hydrologic units are further divided into 109 waterbodies or watersheds and 298 6th order sub-watersheds.

Basin assessment information is presented in the following tables and figures.

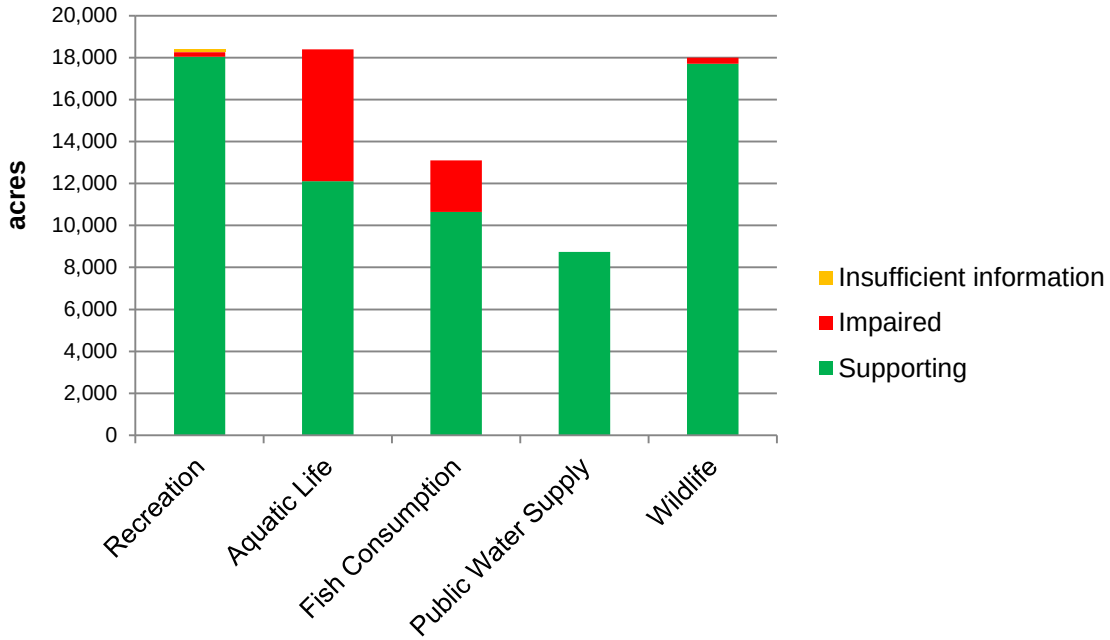
Figure 4.3-2 Designated Use support summary for the James River basin.

Basin Size: *All Sizes Rounded to Nearest Whole Number*
Rivers - 26,054 miles
Lakes - 18,542 acres
Estuaries - 265 sq. miles

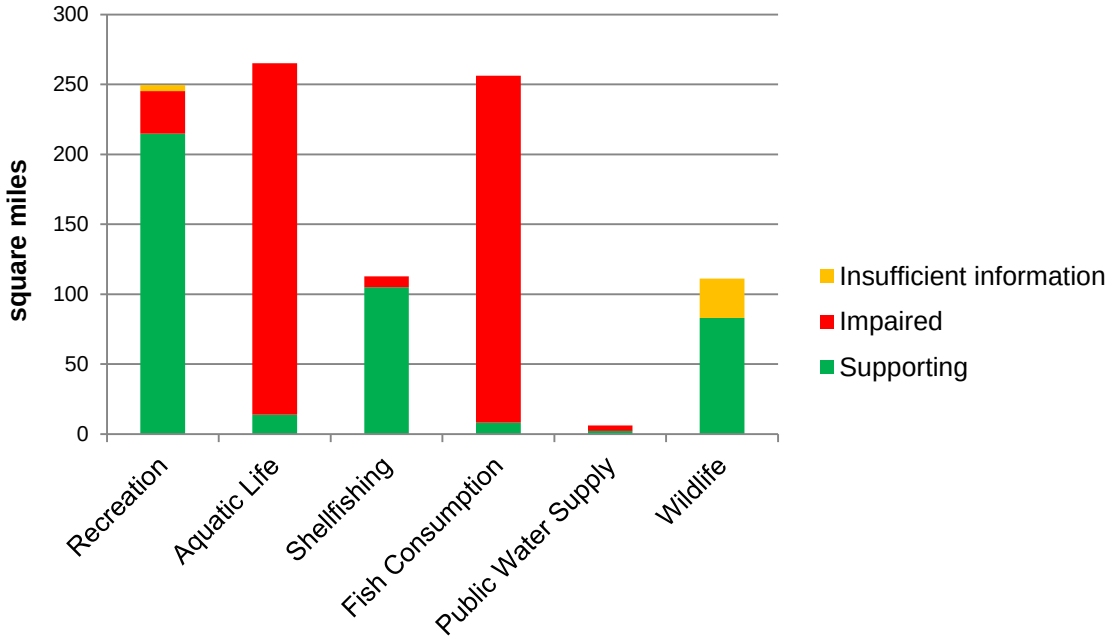
a) Rivers Assessment (19,501 miles were not assessed)



b) Lakes Assessment (53 acres were not assessed)



c) Estuaries assessment



d) Assessment of Chesapeake Bay-specific designated uses (Migratory fish spawning and nursery use was not assessed).

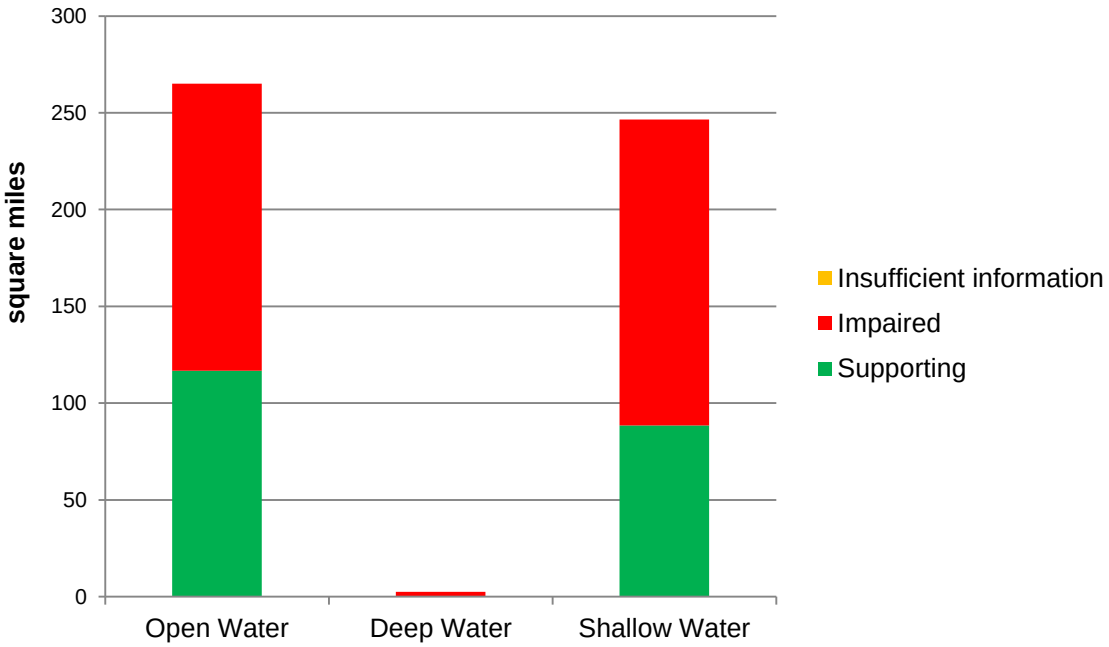


Table 4.3-3 Significant causes of designated use impairment in the James River basin, by waterbody type, ranked by percentage of impaired water size. (Note: Waters can have multiple pollutants.)

Rivers		***Lakes***		***Estuaries***	
Bacteria	76%	**Dissolved Oxygen**	81%	**PCBs in Fish Tissue**	94%
Impaired Benthics	22%	**Mercury in Fish Tissue**	33%	**Impaired Aquatic Plants**	60%
Dissolved Oxygen	10%	**Total Phosphorous**	26%	**Chlorophyll a**	59%
PCBs in Fish Tissue	8%	**pH**	15%	**Impaired Benthics**	36%
pH	8%	**Copper**	4%	**Bacteria**	13%
Temperature	3%	**PCB in Fish Tissue**	4%	**Dissolved Oxygen**	7%

Table 4.3-4 Suspected sources of designated use impairment in the James River Basin, by water body type, ranked by percentage of impaired water size. (Note: Waters can have multiple sources of pollution.)

Rivers		***Lakes***		***Estuaries***	
Non-Point Sources	**56%**	**Source Unknown**	94%	**Source Unknown**	98%
Wildlife other than Waterfowl	**41%**	**Natural Conditions**	19%	**Industrial or Municipal Point Source Discharges**	69%
Source Unknown	**24%**	**Atmospheric Deposition (Toxics)**	15%	**Non-Point Sources**	60%
Unspecified Domestic Waste	**23%**	**Dam or Impoundments**	8%	**Agriculture**	22%
Livestock Grazing or Feeding Operations	**23%**	**Non-Point Sources**	4%	**Atmospheric Deposition (Nitrogen)**	22%
Wastes from Pets	**22%**	**Urbanized High Density Areas**	4%	**Loss of Riparian Habitat**	22%

Rappahannock River Basin

The Rappahannock River basin is located in the northeastern portion of Virginia and covers 2,712 square miles or approximately 6% of the Commonwealth's total area.

The Rappahannock River basin is bordered by the Potomac-Shenandoah basin to the north and the York River basin and Chesapeake/Atlantic Coastal basin to the south and east. The headwaters lie in Fauquier and Rappahannock counties and flow in a southeasterly direction to its confluence with the Chesapeake Bay between Lancaster and Middlesex counties. The Rappahannock River basin is 184 miles in length and varies in width from 20 to 50 miles. The Rappahannock River basin's major tributaries are the Hazel River, Thornton River, Mountain Run, Rapidan River, Robinson River, Cat Point Creek, and the Corrotoman River.

The topography of the Rappahannock River basin changes from steep slopes to flat land as it flows from the Blue Ridge Mountains to the Chesapeake Bay. About 51% of the basin land is forested, while pasture and cropland make up another 36%. Only about 6% of the land area is considered urban.

Most of the Rappahannock River basin lies in the eastern Piedmont and Coastal Plain areas of the Commonwealth while its headwaters, located on the eastern slopes of the Blue Ridge, are considered to be in the northwestern Piedmont section.

The 2010 population of the Rappahannock River basin was approximately 483,770. The basin is mostly rural in character with no large population centers. However, the basin has seen increasing urban pressure from the influence of metropolitan Washington in the Fredericksburg and Fauquier areas of the basin. All or portions of the following 17 counties and one city lie within the basin: Albemarle, Caroline, Culpeper, Essex, Fauquier, Greene, King George, Lancaster, Madison, Middlesex, Northumberland, Orange, Rappahannock, Richmond, Spotsylvania, Stafford, and Westmoreland; City - Fredericksburg.

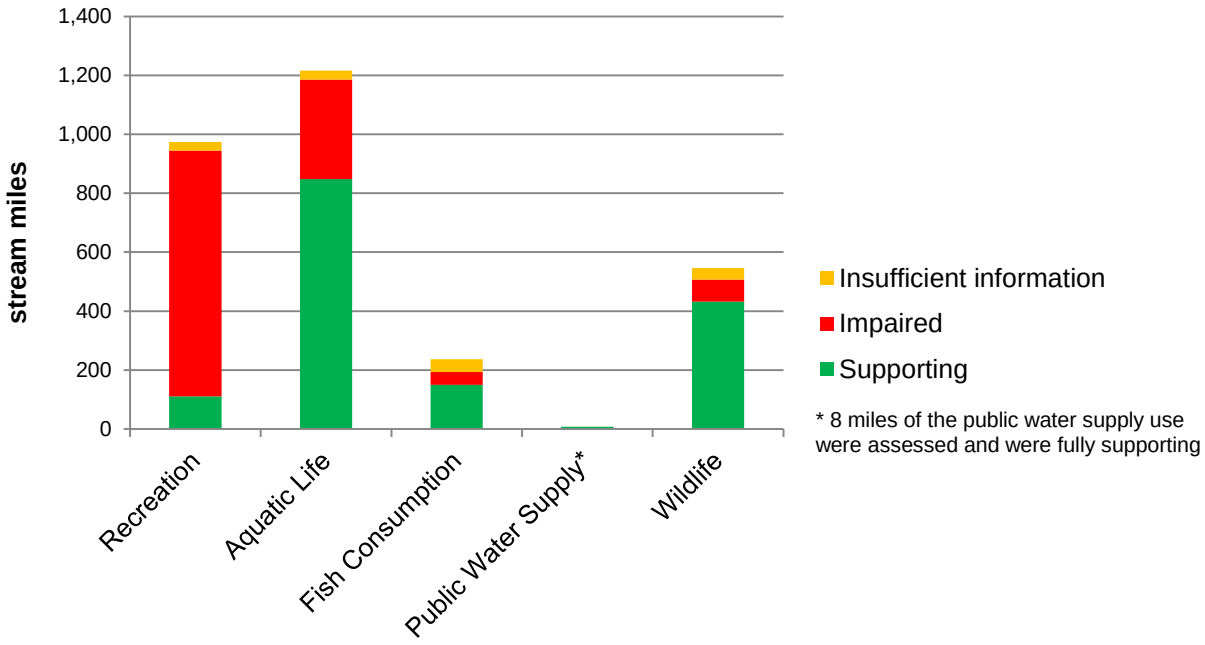
The Rappahannock River Basin is divided into two USGS hydrologic units as follows: HUC 02080103 – Rapidan – Upper Rappahannock; and HUC 02080104 – Lower Rappahannock. The two hydrologic units are further divided into 26 waterbodies or watersheds and 74 6th order sub-watersheds.

Basin assessment information is presented in the following figures and tables.

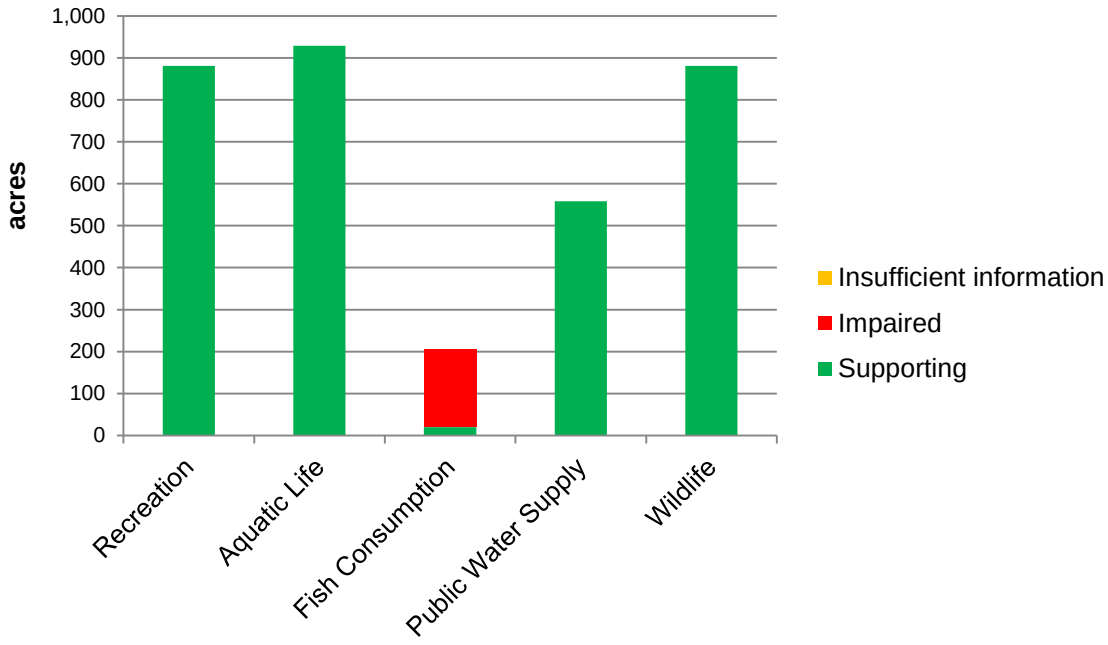
Figure 4.3-3 Designated use support summary for the Rappahannock River basin. (Note: Waters that have some data, but not enough to determine use support, are classified as having "Insufficient information".)

Basin Size: *All Sizes Rounded to Nearest Whole Number*
Rivers - 6,488 miles
Lakes - 948 acres
Estuaries - 155 sq. miles

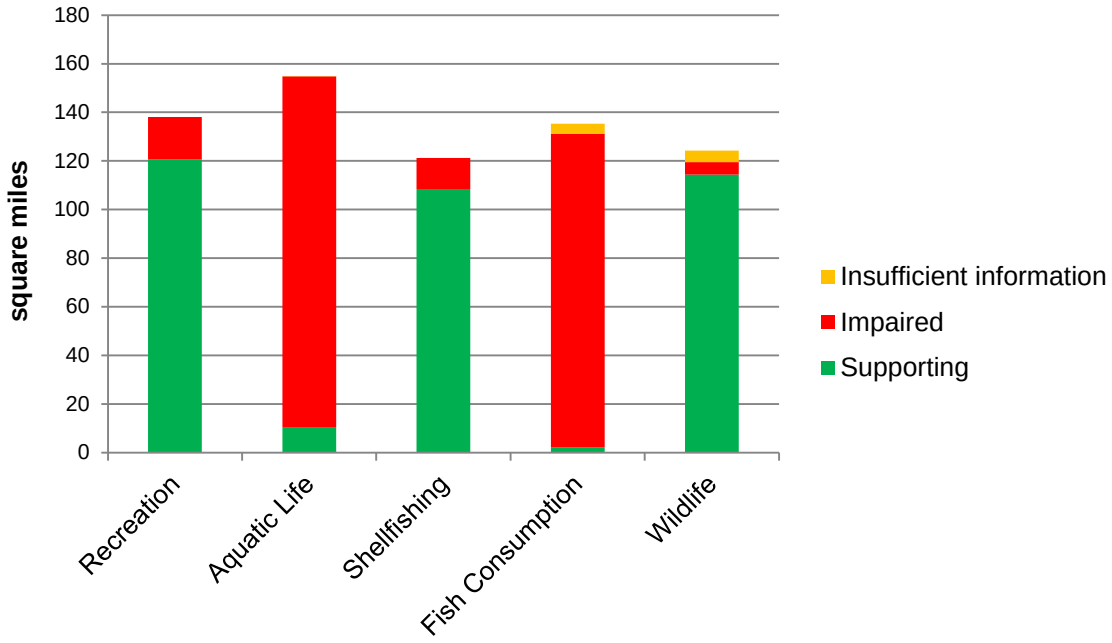
a) Rivers Assessment (5,290 miles were not assessed)



b) Lakes Assessment



c) Estuaries assessment



d) Assessment of Chesapeake Bay-specific designated uses (Migratory fish spawning and nursery use was not assessed).

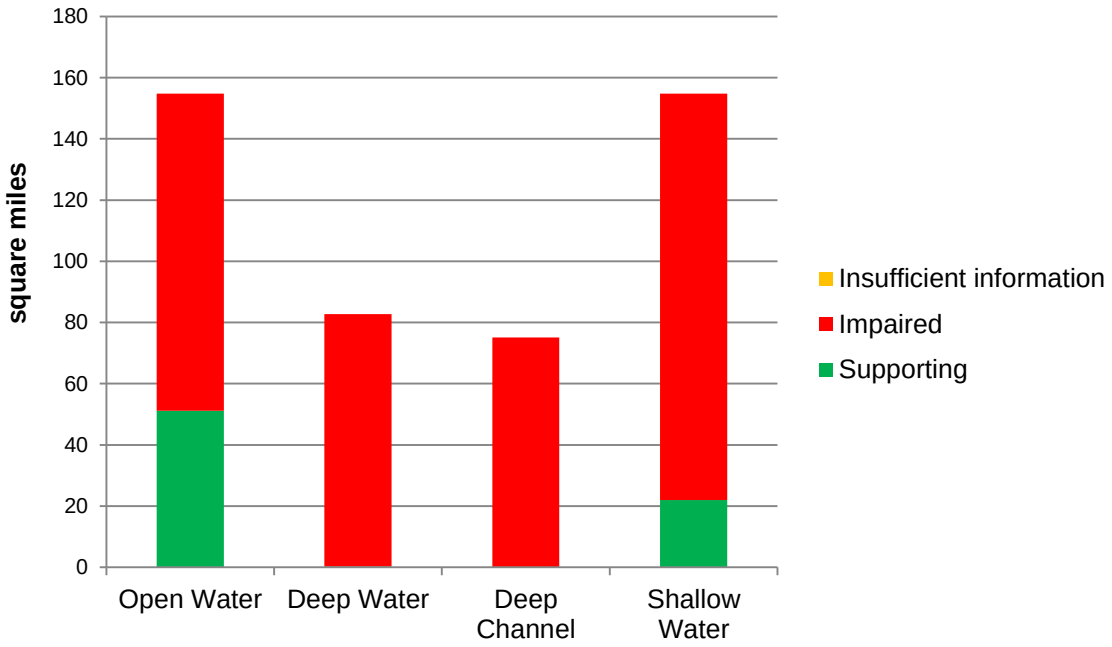


Table 4.3-5 Significant causes of designated use impairment in the Rappahannock River basin, by waterbody type, ranked by percentage of impaired water size. (Note: Waters can have multiple pollutants.)

Rivers		*Lakes*		*Estuaries*	
Bacteria	83%	**Mercury in Fish Tissue**	100%	**Impaired Aquatic Plants**	87%
pH	13%	**--**	--	**PCB in Fish Tissue**	84%
Impaired Benthics	10%	**--**	--	**Impaired Benthics**	81%
Dissolved Oxygen	10%	**--**	--	**Dissolved Oxygen**	68%
Mirex	7%	**--**	--	**Bacteria**	18%
PCBs in Fish Tissue	3%	**--**	--	**Chloride**	3%

Table 4.3-6 Suspected sources of designated use impairment in the Rappahannock River basin, by water body type, ranked by percentage of impaired water size. (Note: Waters can have multiple sources of pollution.)

Rivers		*Lakes*		*Estuaries*	
Livestock Grazing or Feeding Operations	47%	**Source Unknown**	100%	**Source Unknown**	90%
Waterfowl	47%	**Atmospheric Deposition (Toxics)**	26%	**Municipal or Industrial Point Source Discharges**	88%
Wildlife other than Waterfowl	47%	**--**	--	**Agriculture**	87%
Waste from Pets	44%	**--**	--	**Internal Nutrient Recycling**	87%
Non-Point Sources	30%	**--**	--	**Loss of Riparian Habitat**	87%
On-site Septic Treatment Systems	30%	**--**	--	**Clean Sediments**	87%

Roanoke River Basin

The Roanoke River basin covers 6,393 square miles or approximately 15% of the Commonwealth's total area. In addition to the Roanoke itself, the basin also contains the Yadkin River sub-basin.

The Virginia portion of the Roanoke River basin is defined by both hydrologic and political boundaries. The basin is bound by the James River basin on the north, to the east by the Chowan River basin, and to the west by the New River basin. The southern boundary of the basin is the Virginia/North Carolina state line.

The topography of the Roanoke River basin ranges from steep slopes and valleys in the Valley and Ridge Province to gently sloping terrain east of the mountains in the Piedmont Province.

The Roanoke River basin headwaters begin in the mountainous terrain of eastern Montgomery County and flow in a southeasterly direction to the Virginia/North Carolina state line. The Roanoke basin passes through three physiographic provinces- the Valley and Ridge Province to the northwest, and the Blue Ridge and Piedmont Provinces to the southeast.

The Roanoke watershed is large enough to accommodate two major reservoirs, Smith Mountain and Leesville Lakes to the north and Kerr Reservoir and Lake Gaston located at the junction of the Roanoke River and the North Carolina state line. These reservoirs range in size from the 33,300 acre Kerr Reservoir to the 2,600-acre Leesville Lake. These impoundments are used for both recreation and hydroelectricity. Major tributaries in the northern section of the basin are the Little Otter and Big Otter Rivers along with the Blackwater and Pigg Rivers. Major tributaries in the southern portion include the Dan River, Smith River, and Banister River. Over 62% of the Roanoke River Basin is forested, while nearly 25% is in cropland and pasture. Approximately 10% is considered urban.

The 2010 population for the Roanoke River Basin was approximately 943,200. All or portions of the following 17 counties and 4 cities lie within the basin: counties – Appomattox, Bedford, Botetourt, Brunswick, Campbell, Carroll, Charlotte, Floyd, Franklin, Grayson, Halifax, Henry, Mecklenburg, Montgomery, Patrick, Pittsylvania, and Roanoke; cities – Danville, Martinsville, Roanoke, and Salem.

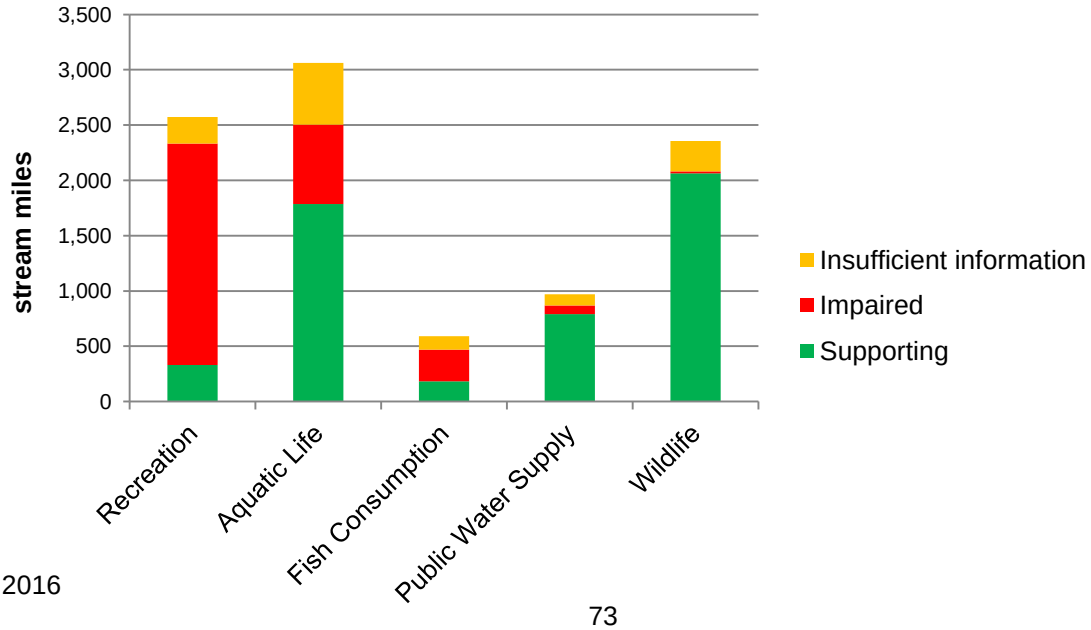
The Roanoke River basin is divided into seven USGS hydrologic units as follows: HUC 03010101 – Upper Roanoke; HUC 03010102 – Middle Roanoke; HUC 03010103 – Upper Dan; HUC 03010104 – Lower Dan; HUC 03010105 – Banister; HUC 03010106 – Roanoke Rapids and HUC 03040101 – Upper Yadkin. The seven hydrologic units are further divided into 87 waterbodies or watersheds and 202 6th order sub-watersheds.

Basin assessment information is presented in the following figures and tables.

Figure 4.3-4 Designated use support summary for the Roanoke River basin. (Note: Waters that have some data, but not enough to determine use support, are classified as having "Insufficient information".)

Basin Size: *All Sizes Rounded to Nearest Whole Number*
Rivers - 17,274 miles
Lakes - 66,784 acres
Estuaries - 0 sq. miles

a) Rivers Assessment (14,622 miles were not assessed)



b) Lakes Assessment (1,353 acres were not assessed)

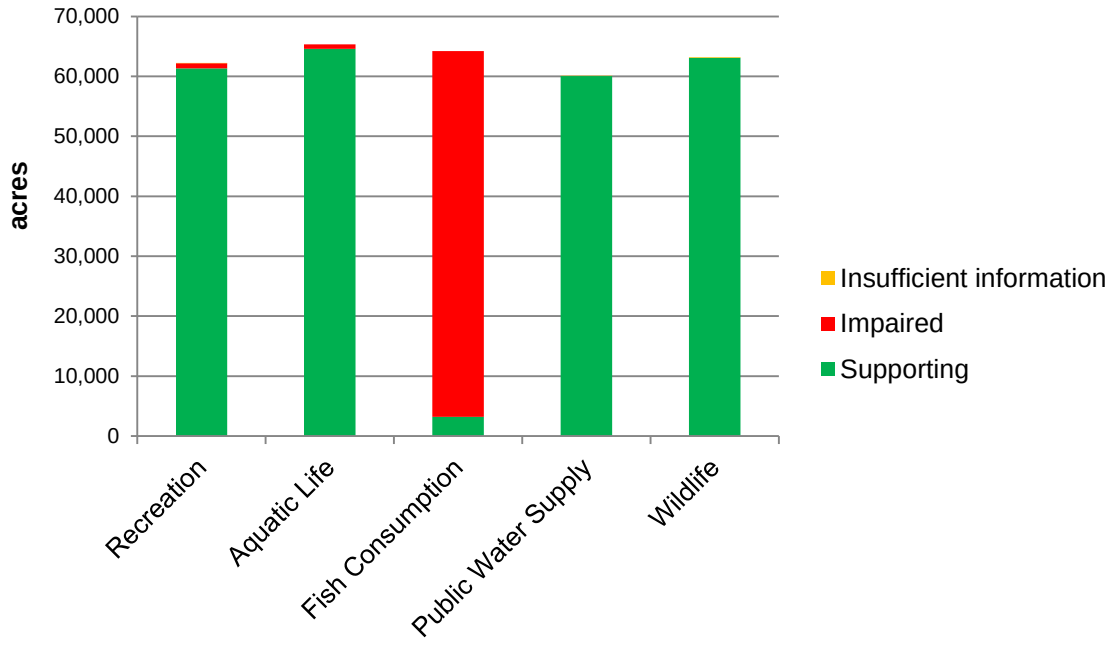


Table 4.3-7 Significant causes of designated use impairment in the Roanoke River basin, by waterbody type, ranked by percentage of impaired water size. (Note: Waters can have multiple pollutants.)

Rivers		***Lakes***	
Bacteria	90%	**PCBs in Fish Tissue**	93%
Impaired Benthics	25%	**Mercury in Fish Tissue**	71%
Mercury in Fish Tissue	11%	**Bacteria**	1%
PCBs in Fish Tissue	11%	**Dissolved Oxygen**	1%
Temperature	6%	**Chlorophyll a**	<1%
Dissolved Oxygen	3%	**pH**	<1%

Table 4.3-8 Suspected sources of designated use impairment in the Roanoke River basin, by water body type, ranked by percentage of impaired water size. (Note: Waters can have multiple sources of pollution.)

Rivers		***Lakes***	
Wildlife other than Waterfowl	86%	**Source Unknown**	99%
Livestock Grazing or Feeding Operations	82%	**Wildlife other than Waterfowl**	1%
Unspecified Domestic Waste	82%	**Unspecified Domestic Waste**	1%
Waste from Pets	49%	**Livestock Grazing or Feeding Operations**	1%
On-Site Septic Treatment Systems	34%	**On-site Septic Treatment Systems**	1%
Source Unknown	30%	**Natural Conditions**	<1%

Chowan River-Dismal Swamp Basin

The Chowan River and Dismal Swamp basin is located in the southeastern portion of Virginia and covers 4,220 square miles or approximately 10% of the Commonwealth's total area.

The basin extends eastward from Charlotte County to the Chesapeake Bay. The Chowan River-Dismal Swamp basin in Virginia is defined by both hydrologic and political boundaries - the James River basin to the north, the Chesapeake/Atlantic and Small Coastal River basins to the east, the Roanoke River basin to the west and the Virginia/North Carolina State line to the south. The basin is approximately 145 miles in length and varies from 10 to 50 miles in width. The Chowan River-Dismal Swamp basin flows through the Piedmont and Coastal Plain Physiological Provinces. The Chowan portion flows 130 miles from west to east, crossing both the Piedmont and Coastal Plain, while the Dismal Swamp lies entirely within the Coastal Plain. The Piedmont portion is characterized by rolling hills, steeper slopes and somewhat more pronounced stream valleys. The Coastal Plain, in contrast, is nearly flat with a descending series of terraces.

The Chowan River-Dismal Swamp basin is mostly rural with approximately 64% of its land covered by forest. Cropland and pasture make up another 28%, while only about 6% is classified as urban.

The 2010 population for the Chowan River-Dismal Swamp basin was approximately 597,900. All or portions of the following 13 counties and 6 cities lie within the basin: counties – Brunswick, Charlotte, Dinwiddie, Greensville, Isle of Wight, Lunenburg, Mecklenburg, Nottoway, Prince Edward, Prince George, Southampton, Surry, and Sussex; Cities – Chesapeake, Emporia, Franklin, Petersburg, Suffolk, and Virginia Beach.

Major tributaries of the Chowan River are the Meherrin, the Nottoway and the Blackwater. The Nottoway and the Blackwater join at the Virginia/North Carolina state line to form the Chowan River. The Dismal Swamp portion is mostly flat with many swamp and marshland areas.

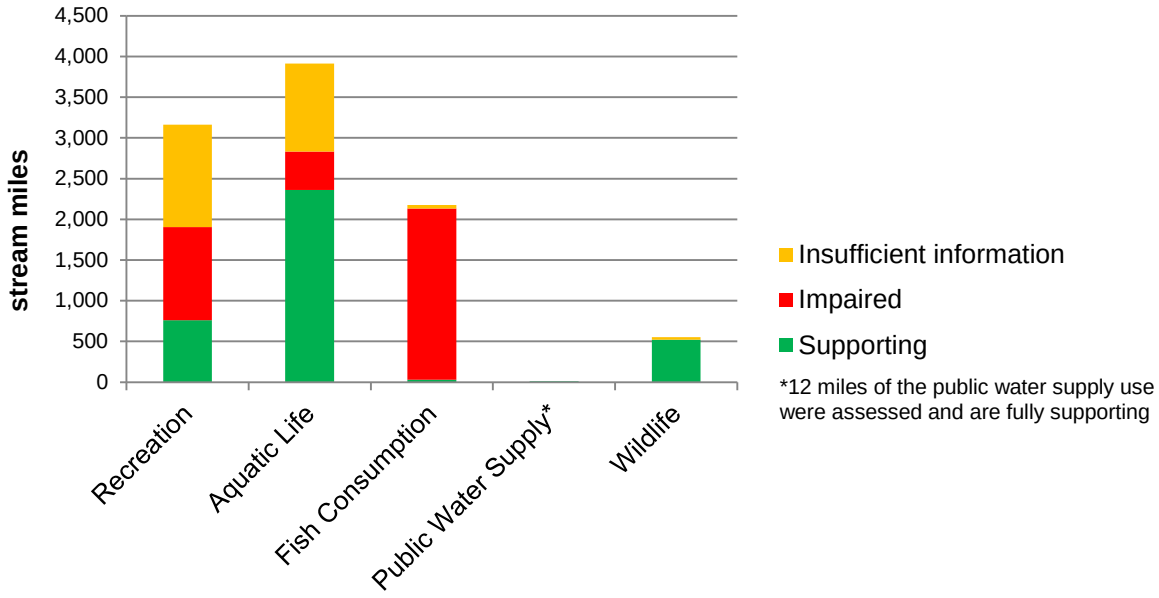
The Chowan River-Dismal Swamp basin is divided into five USGS hydrologic units as follows: HUC 03010201 – Nottoway; HUC 03010202 – Blackwater; HUC 03010203 – Chowan; HUC 03010204 – Meherrin; and HUC 03010205 – Albemarle Sound. The five hydrologic units are further divided into 42 waterbodies or watersheds and 127 6th order sub-watersheds.

Basin assessment information is presented in the following figures and tables.

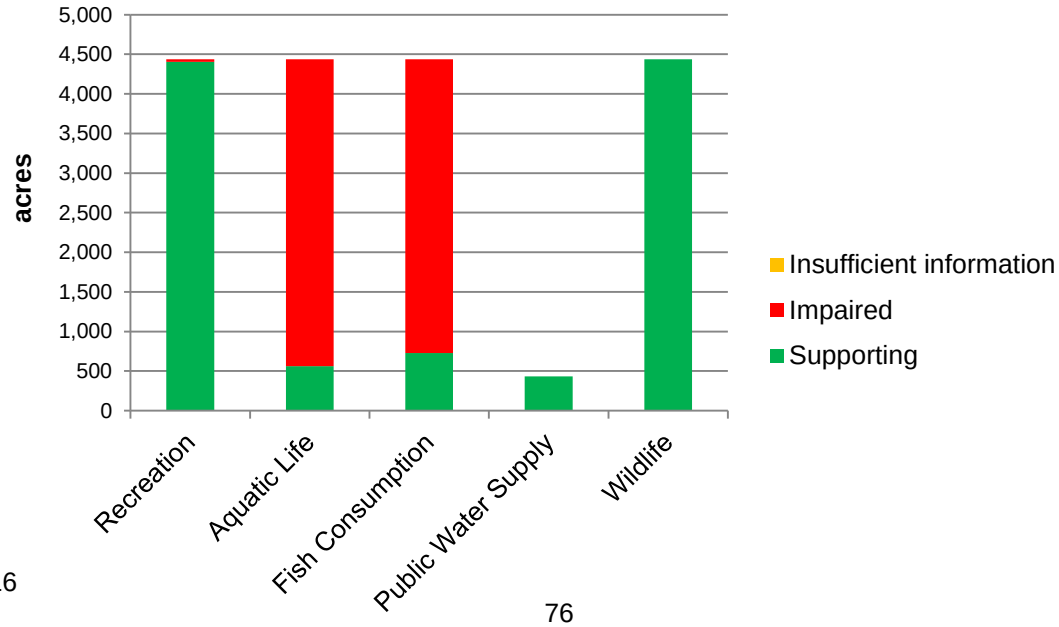
Figure 4.3-5 Designated use support summary for the Chowan River-Dismal Swamp basin. (Note: Waters that have some data, but not enough to determine use support, are classified as having "Insufficient information".)

Basin Size: *All Sizes Rounded to Nearest Whole Number*
Rivers - 10,932 miles
Lakes - 4,699 acres
Estuaries - 39 sq. miles

a) Rivers Assessment (6,702 miles were not assessed)



b) Lakes Assessment (263 acres were not assessed)



c) Estuaries assessment

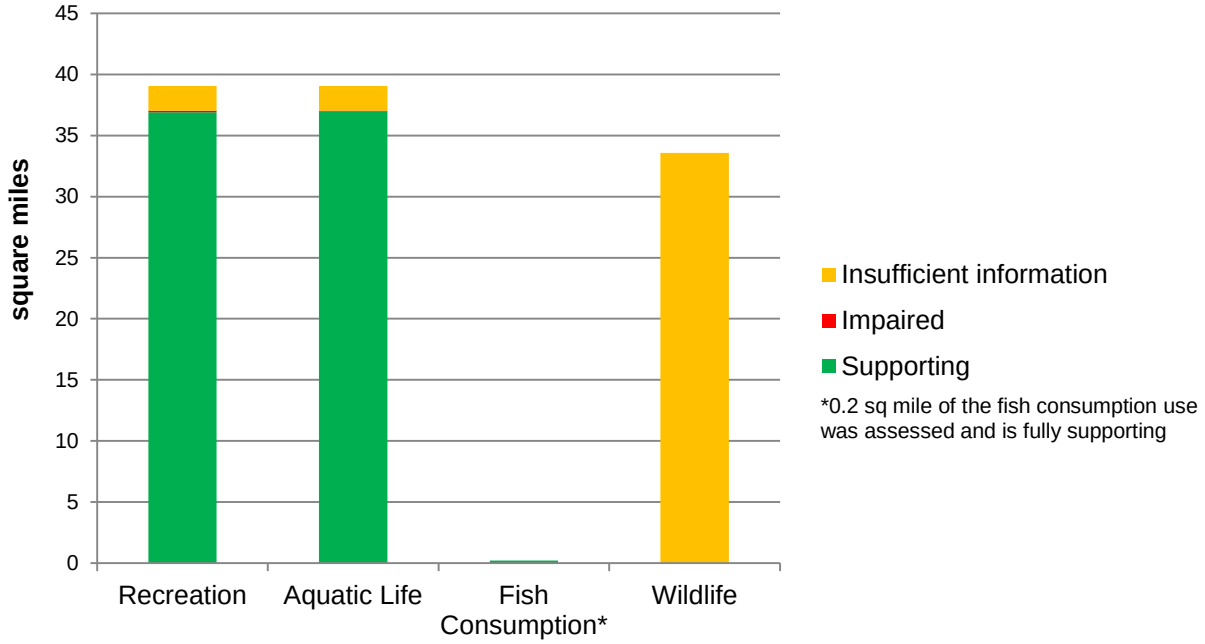


Table 4.3-9 Significant causes of designated use impairment in the Chowan River-Dismal Swamp basin, by waterbody type, ranked by percentage of impaired water size. (Note: Waters can have multiple pollutants.)

Rivers		***Lakes***		***Estuaries***	
Mercury in Fish Tissue	69%	**Mercury in Fish Tissue**	89%	**Bacteria**	100%
Bacteria	38%	**pH**	80%	**Dissolved Oxygen**	62%
Dissolved Oxygen	9%	**Total Phosphorus**	8%	**pH**	11%
Impaired Benthics	7%	**Dissolved Oxygen**	7%	**--**	--
pH	3%	**Chlorophyll a**	4%	**--**	--
PCBs in Fish Tissue	1%	**Bacteria**	1%	**--**	--

Table 4.3-10 Suspected sources of designated use impairment in the Chowan River-Dismal Swamp basin, by water body type, ranked by percentage of impaired water size. (Note: Waters can have multiple sources of pollution.)

Rivers		***Lakes***		***Estuaries***	
Source Unknown	87%	**Source Unknown**	100%	**Source Unknown**	78%
Atmospheric Deposition (Toxics)	30%	**Agriculture**	4%	**Natural Conditions**	33%

Rivers		*Lakes*		*Estuaries*	
Non-Point Sources	19%	**Natural Conditions**	3%	**Crop Production**	22%
Wildlife other than Waterfowl	11%	**--**	--	**Livestock Grazing or Feeding Operations**	22%
Municipal Point Source Discharges	9%	**--**	--	**On-site Septic Treatment Systems**	22%
Agriculture	6%	**--**	--	**Waterfowl or Wildlife**	22%

Tennessee-Big Sandy River Basin

The segment of the Tennessee and Big Sandy River basin which lies in Virginia is made up of the Holston, Clinch-Powell, and Big Sandy River sub-basins. These sub-basins are located in the extreme southwest portion of Virginia and cover 4,132 square miles or approximately 10% of the Commonwealth's total land area.

The Virginia portion of the Tennessee-Big Sandy River basin is defined by both hydrologic and political boundaries. The West Virginia state line lies to the north, Kentucky to the west, and Tennessee to the south. The New River basin makes up the eastern boundary.

While numerous southwestern Virginia streams feed the Tennessee and Big Sandy Rivers, neither river forms within the Commonwealth itself. The Big Sandy sub-basin contains the Levisa and Tug Forks that flows northward into Kentucky forming the Big Sandy River. The southwestward flowing Holston, Clinch, and Powell tributaries form the Tennessee River in Tennessee. Both of the major river sub-basins eventually empty into the Gulf of Mexico via the Ohio and Mississippi Rivers.

The Tennessee-Big Sandy River basin spans three physiographic provinces: Appalachian Plateau, Valley and Ridge, and the Blue Ridge. The Big Sandy portion of the basin lies within the Appalachian Plateau. This province is characterized as rugged, with mountainous terrain and steep valleys. Parallel valleys and ridges running in a northeast to southwest direction characterize the Tennessee portion, lying in the Valley and Ridge Province. A small portion of the basin, located in the Blue Ridge Province, is more like a plateau with no single, prominent ridge that characterizes the province to the southeast.

Within Virginia, approximately 48% of the Tennessee River basin is forested, while cropland and pasture make up another 39.7%. The Big Sandy portion of the basin is approximately 86% forest, with only about 5% in cropland and pasture. Urban areas make up only a small percentage of the total land area.

The 2010 population for the Tennessee-Big Sandy River Basin was approximately 458,700. All or parts of the following jurisdictions lie within the basin: counties – Bland, Buchanan, Dickenson, Grayson, Lee, Russell, Scott, Smyth, Tazewell, Washington, Wise, and Wythe; Cities – Bristol and Norton.

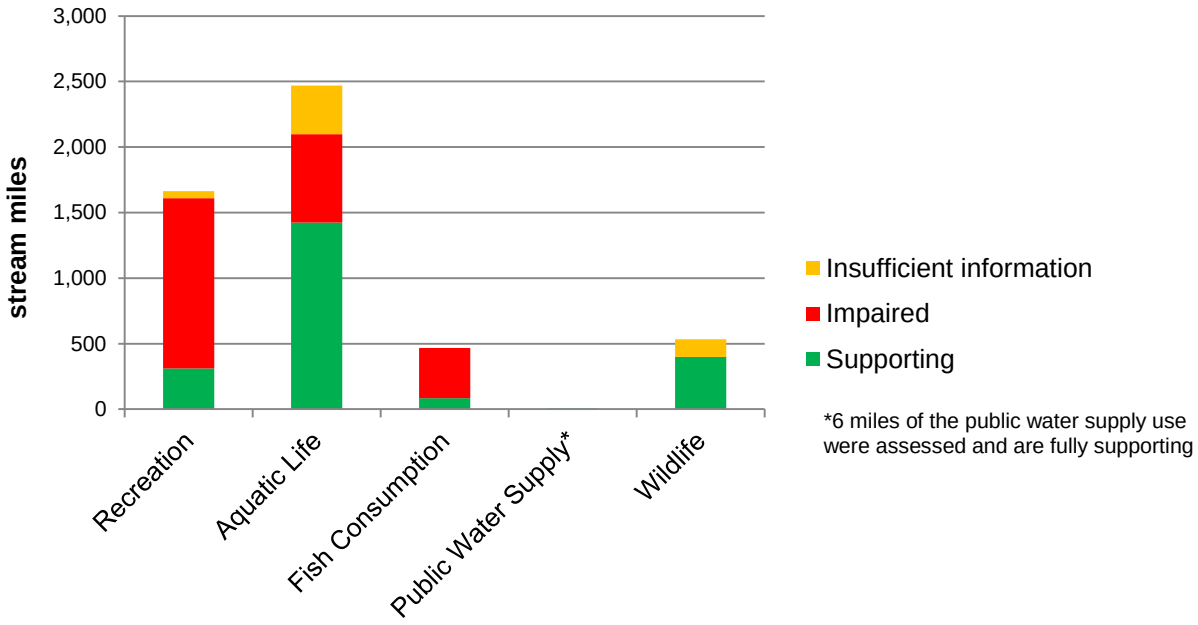
The Tennessee-Big Sandy River basin is divided into six USGS hydrologic units as follows: HUC 05070201 – Tug Fork; HUC 05070202 – Upper Levisa; HUC 06010101 – North Fork Holston; HUC 06010102 - South and Middle Fork Holston; HUC 06010205 – Upper Clinch; and HUC 06010206 – Powell River. The six hydrologic units are further divided into 56 waterbodies or watersheds and 135 6th order sub-watersheds.

Basin assessment information is presented in the following figures and tables.

Figure 4.3-6 Designated use support summary for the Tennessee-Big Sandy River basin. (Note: Waters that have some data, but not enough to determine use support, are classified as having "Insufficient information".)

Basin Size: *All Sizes Rounded to Nearest Whole Number*
Rivers - 10,664 miles
Lakes - 3,857 acres
Estuaries - 0 sq. miles

a) Rivers Assessment (8,301 miles were not assessed)



b) Lakes Assessment

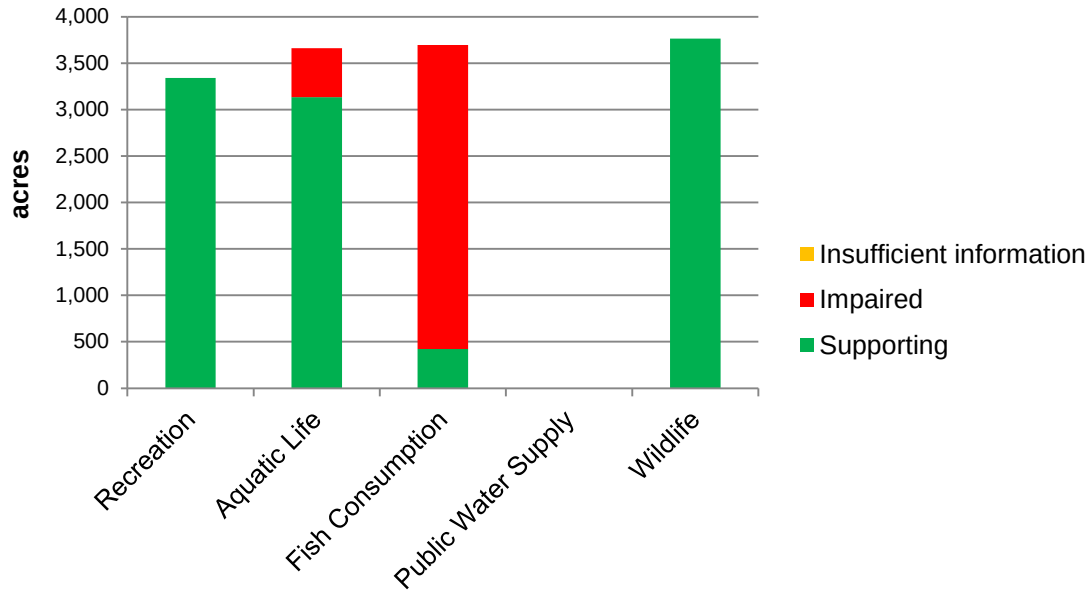


Table 4.3-11 Significant causes of designated use impairment in the Tennessee-Big Sandy River basin, by waterbody type, ranked by percentage of impaired water size. (Note: Waters can have multiple pollutants.)

Rivers		***Lakes***	
Bacteria	71%	**Mercury in Fish Tissue**	89%
Impaired Benthics	34%	**PCBs in Fish Tissue**	46%
PCBs in Fish Tissue	17%	**pH**	13%
Sedimentation/ Siltation	7%	**Temperature**	11%
Mercury in Fish Tissue	5%	**--**	--
Temperature	4%	**--**	--

Table 4.3-12 Suspected sources of designated use impairment in the Tennessee-Big Sandy River basin, by water body type, ranked by percentage of impaired water size. (Note: Waters can have multiple sources of pollution.)

Rivers		***Lakes***	
Unrestricted Cattle Access	43%	**Source Unknown**	49%
Rural Residential Areas	43%	**Atmospheric Deposition (Toxics)**	42%
Source Unknown	22%	**Natural Conditions**	14%
Coal Mining	16%	**--**	--
Sewage Discharges in Unsewered Areas	15%	**--**	--
Surface Mining	10%	**--**	--

Chesapeake Bay/Atlantic Ocean and Small Coastal Basins

The Chesapeake Bay/Atlantic Ocean and small coastal basins are located in the eastern part of Virginia and covers 3,592 square miles or approximately 8% of the Commonwealth's total land area. The combined basins encompass the small bays, river inlets, islands and shoreline immediately surrounding the Chesapeake Bay and the southern portion of the Delmarva Peninsula. These basins also include the Chesapeake Bay itself.

The Chesapeake Bay/Atlantic Ocean and small coastal basins are defined by both hydrologic and political boundaries. The Potomac River, the Rappahannock River, the York River, the James River, and the Chowan River-Dismal Swamp basins border the small coastal basins to its west. The Eastern Shore portion is bordered on the west by the Chesapeake Bay, on the north by Maryland, and on the east by the Atlantic Ocean.

The topography of the Chesapeake Bay/Atlantic Ocean and small coastal basins vary little. The basins lie within the Coastal Plain Physiographic Province where elevations average no more than a few feet above sea level. More significant elevation occurs along the central spine of the Eastern Shore portion, which forms a plateau about 45 feet above sea level. Much of these basins consist of marshland. About 30% of the Chesapeake Bay/Atlantic Ocean and small coastal basins are forested, while nearly 22% is in cropland and pasture. Approximately 24% is considered urban.

The 2010 population for the Chesapeake Bay/Atlantic Ocean and small coastal basins was approximately 741,800. All or portions of the following jurisdictions lie within these basins: Counties – Accomack, Essex, Gloucester, King and Queen, Lancaster, Matthews, Middlesex, Northampton, Northumberland, and York; Cities – Hampton, Newport News, Norfolk, Poquoson, and Virginia Beach.

Tributaries in the Chesapeake Bay/coastal basins drain into the Chesapeake Bay or the Atlantic Ocean. Major tributaries flowing into the Chesapeake Bay from the western shore are the Great Wicomico River, Piankatank River, Fleets Bay, Mobjack Bay including the East, North, Ware, and Severn Rivers, Poquoson River, Back River and Lynnhaven River. Tributaries in the Eastern Shore portion that drain into the Bay are Pocomoke River, Onancock, Pungoteague, Occohannock, and Nassawadox Creeks. Machipongo River, Assawoman Creek, Parker Creek, Folly Creek, and Finney Creek drain east directly into the Atlantic Ocean.

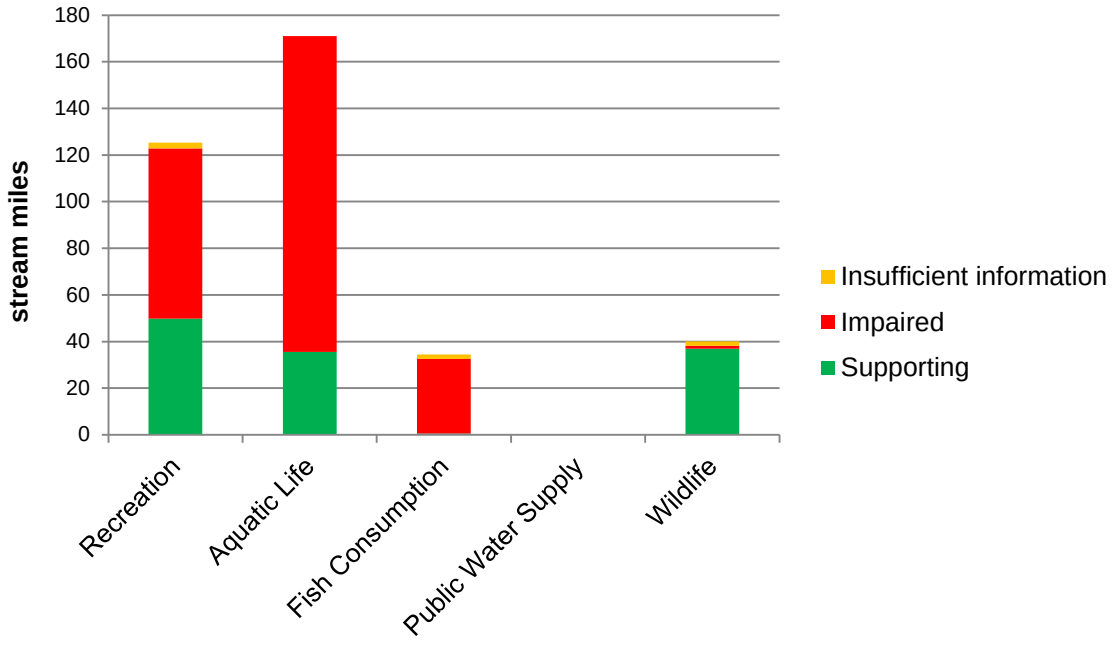
The Chesapeake Bay/Atlantic Ocean and small coastal basins are divided into seven USGS hydrologic units as follows: HUC 02060009 – Pocomoke; HUC 02060010 – Chincoteague; HUC 02080101 – Lower Chesapeake Bay; HUC 02080102 – Great Wicomico-Piankatank; HUC 02080108 – Lower Lynnhaven-Poquoson; HUC 02080109 – Western Lower Delmarva; and HUC 02080110 – Tangier. The seven hydrologic units are further divided into 24 waterbodies or watersheds and 73 6th order sub-watersheds.

Basin assessment information is presented in the following figures and tables.

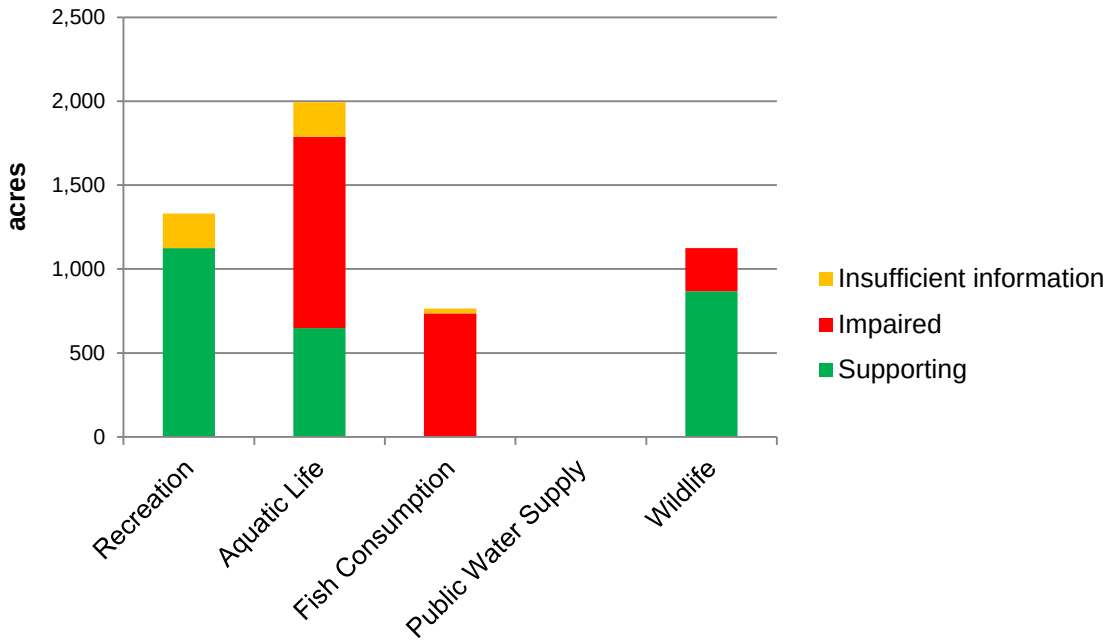
Figure 4.3-7 Designated use support summary for the Chesapeake Bay/Atlantic Ocean and small coastal basins. (Note: Waters that have some data, but not enough to determine use support, are classified as having "Insufficient information".)

Basin Size: *All Sizes Rounded to Nearest Whole Number*
Rivers - 1,880 miles
Lakes - 2,150 acres
Estuaries - 2,247 sq. miles

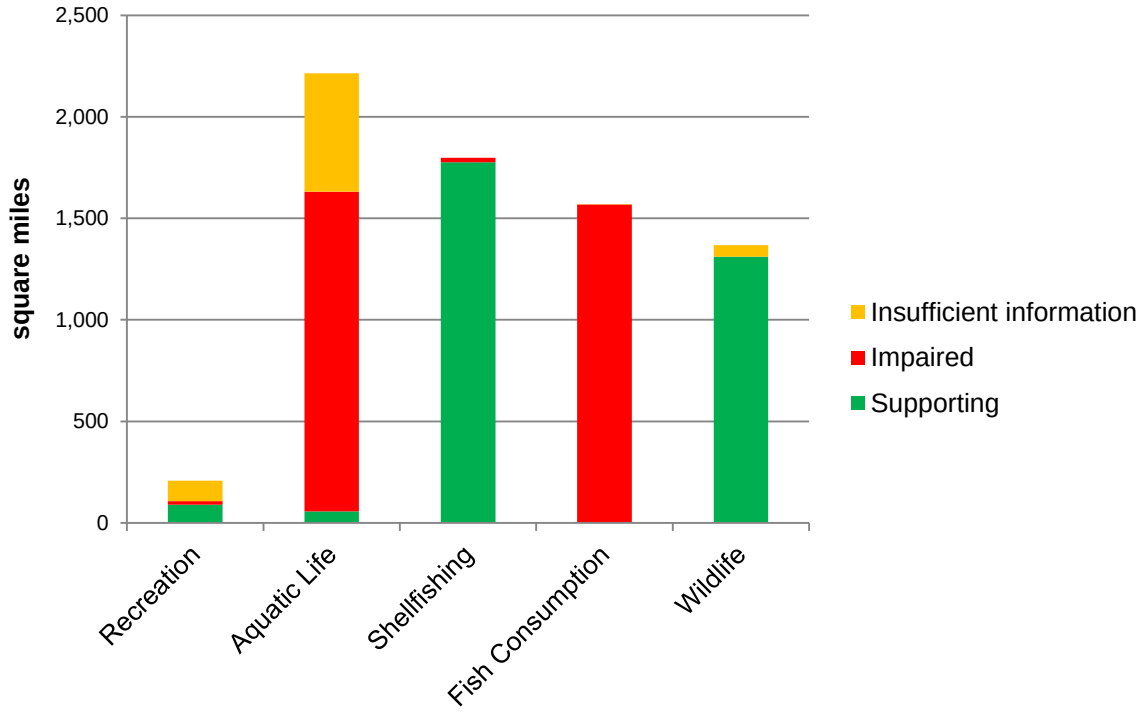
a) Rivers Assessment (1,709 miles were not assessed)



b) Lakes Assessment (308 acres were not assessed)



c) Estuaries assessment (398 square miles were not assessed)



d) Assessment of Chesapeake Bay-specific designated uses (Migratory fish spawning and nursery use was not assessed).

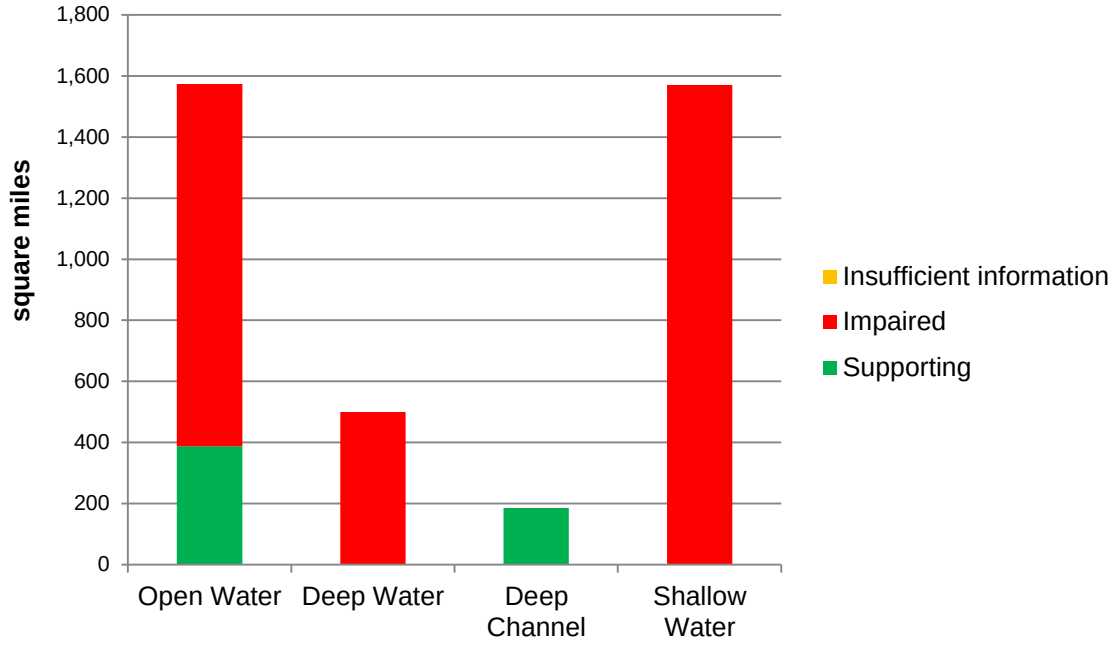


Table 4.3-13 Significant causes of designated use impairment in the Chesapeake Bay/Atlantic Ocean and small coastal basins, by waterbody type, ranked by percentage of impaired water size. (Note: Waters can have multiple pollutants.)

Rivers		*Lakes*		*Estuaries*	
Dissolved Oxygen	66%	**Dissolved Oxygen**	79%	**Impaired Aquatic Plants**	100%
Bacteria	50%	**Chlorophyll a**	73%	**PCBs in Fish Tissue**	99%
pH	38%	**Total Phosphorus**	73%	**Dissolved Oxygen**	76%
Impaired Benthics	25%	**PCBs in Fish Tissue**	62%	**Impaired Benthics**	2%
Mercury in Fish Tissue	22%	**Mercury in Fish Tissue**	45%	**Bacteria**	2%
Copper	1%	**Copper**	22%	**Mercury in Fish Tissue**	<1%

Table 4.3-14 Suspected sources of designated use impairment in the Chesapeake Bay/Atlantic Ocean and small coastal basins, by water body type, ranked by percentage of impaired water size. (Note: Waters can have multiple sources of pollution.)

Rivers		*Lakes*		*Estuaries*	
Source Unknown	65%	**Source Unknown**	100%	**Source Unknown**	100%
Natural Conditions	58%	**Residential Districts**	40%	**Loss of Riparian Habitat**	100%
Non-Point Sources	27%	**Urbanized High Density Areas**	22%	**Atmospheric Deposition (Nitrogen)**	100%
Atmospheric Deposition (Toxics)	22%	**--**	--	**Internal Nutrient Recycling**	100%
Urbanized High Density Areas	1%	**--**	--	**Industrial Point Source Discharges**	100%
Seafood Processing Operations	1%	**--**	--	**Sources Outside State Borders**	100%

York River Basin

The York River basin lies in the central and eastern section of Virginia and covers 2,674 square miles or 6% of the Commonwealth's total area. It is defined by hydrologic boundaries. The basin is bound by the Rappahannock River basin to the north, the James River basin to the south and west and the Chesapeake Bay/Atlantic Ocean and small coastal basins to the east.

The headwaters of the York River begin in Orange County and flow in a southeasterly direction for approximately 220 miles to its mouth at the Chesapeake Bay. The basin's width varies from five miles at the mouth to 40 miles at its headwaters.

The basin is comprised of the York River and its two major tributaries, the Pamunkey and the Mattaponi Rivers. The York River itself is only about 30 miles in length. The Pamunkey River's major tributaries are the North and South Anna Rivers and the Little River, while the major Mattaponi tributaries are the Matta, Po, and Ni Rivers.

Lying in the Piedmont and Coastal Plain physiographic provinces, the basin's topography is characterized by slightly rolling hills at the headwaters or extreme western portion, to gently sloping hills and flat farmland near its mouth. Tributaries in the central Piedmont exhibit moderate and near constant profiles. Their flat slope largely characterizes streams in the Coastal Plain. Approximately 65% of the land area is forest. Farmland and pasture account for approximately 20% of the land area. Approximately 10% of the river basin land area is urban.

The 2010 population for the York River basin was approximately 435,400. The majority of the population is rural and is evenly distributed throughout the basin. The only major city that falls within this basin is a portion of Williamsburg. All or portions of the following thirteen counties lie within the basin: Albemarle, Caroline, Fluvanna, Gloucester, Goochland, Hanover, James City, King and Queen, King William, Louisa, New Kent, Orange, Spotsylvania, and York.

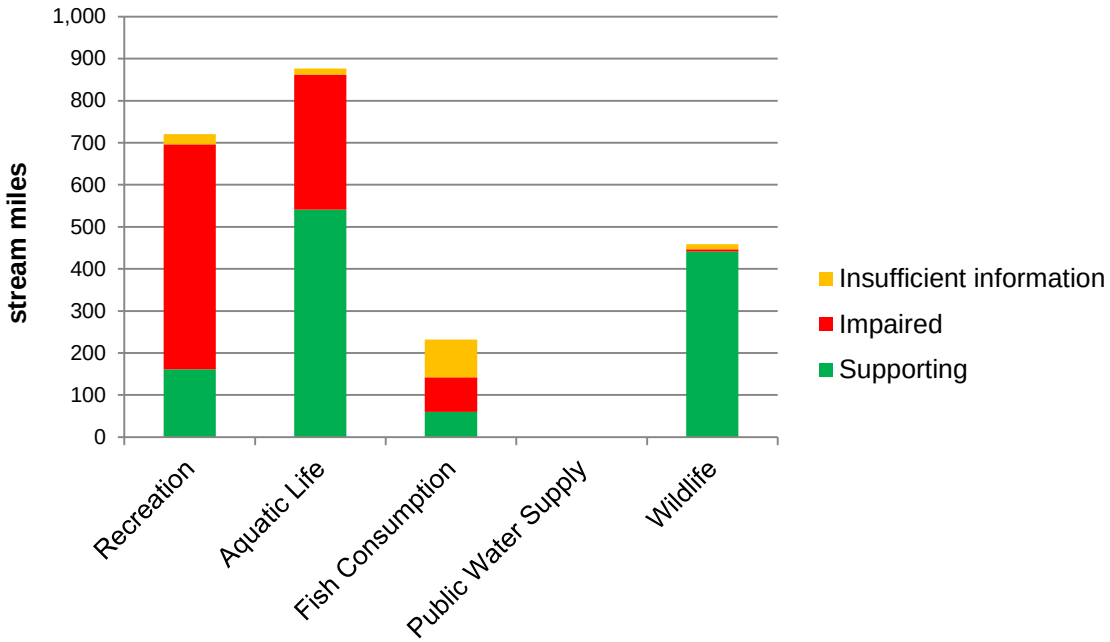
The York River basin is divided into three USGS hydrologic units as follows: HUC 02080105 – Mattaponi; HUC 02080106 - Pamunkey and HUC 02080107 - York. The three hydrologic units are further divided into 27 waterbodies or watersheds and 69 6th order sub-watersheds.

Basin assessment information is presented in the following figures and tables.

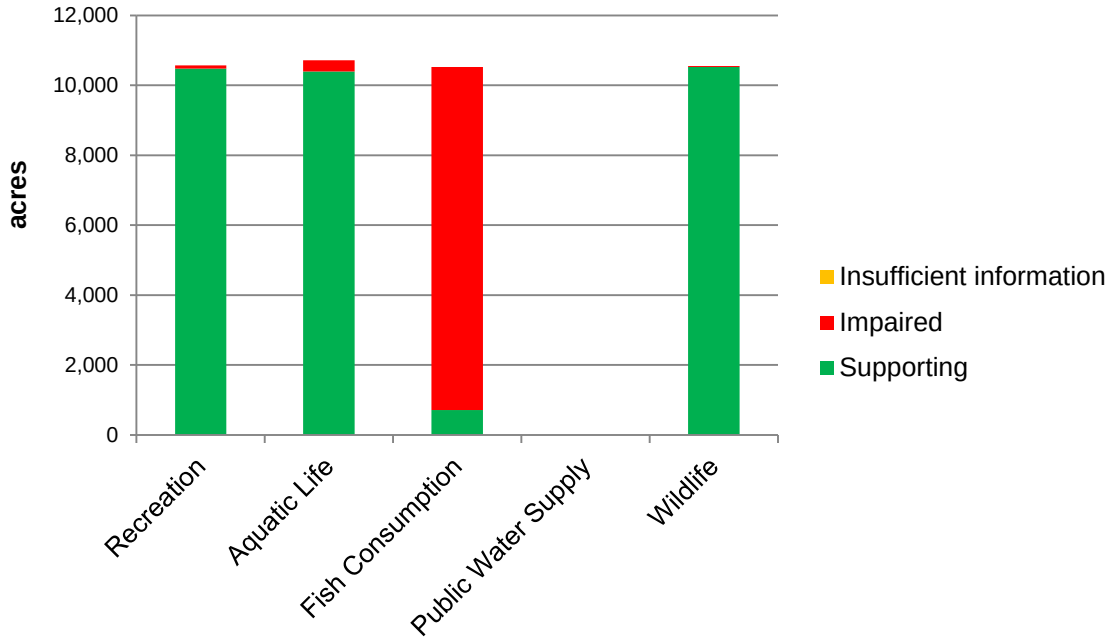
Figure 4.3-8 Designated use support summary for the York River basin. (Note: Waters that have some data, but not enough to determine use support, are classified as having "Insufficient information".)

Basin Size: *All Sizes Rounded to Nearest Whole Number*
Rivers - 6,703 miles
Lakes - 11,330 acres
Estuaries – 82 sq. miles

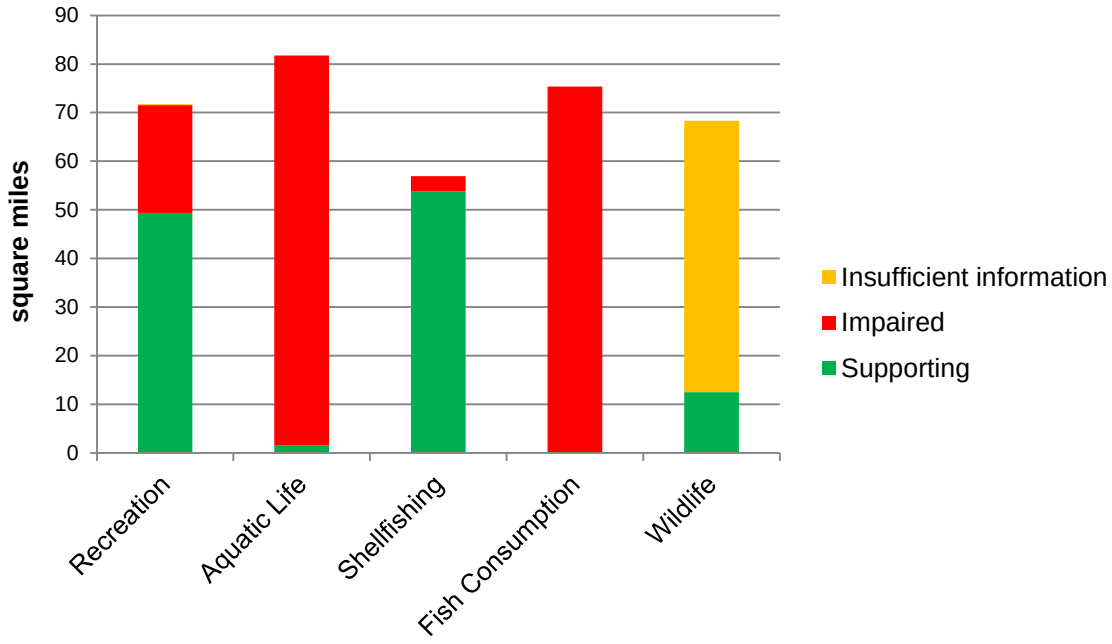
a) Rivers Assessment (5,828 miles were not assessed)



b) Lakes Assessment (436 acres were not assessed)



c) Estuaries assessment



d) Assessment of Chesapeake Bay-specific designated uses (Migratory fish spawning and nursery use was not assessed).

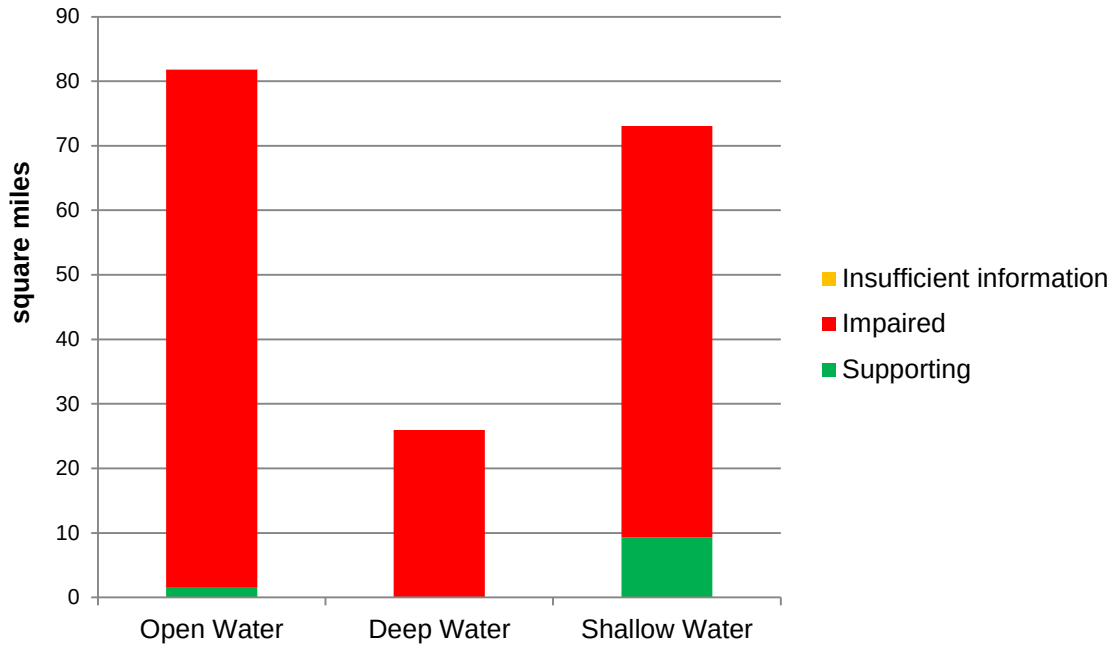


Table 4.3-15 Significant causes of designated use impairment in the York River basin, by waterbody type, ranked by percentage of impaired water size. (Note: Waters can have multiple pollutants.)

Rivers		***Lakes***		***Estuaries***	
Bacteria	80%	**PCBs in Fish Tissue**	95%	**Dissolved Oxygen**	100%
pH	21%	**Mercury in Fish Tissue**	22%	**PCBs in Fish Tissue**	94%
Dissolved Oxygen	21%	**PCBs in Water Column**	12%	**Impaired Aquatic Plants**	79%
Impaired Benthics	12%	**Dissolved Oxygen**	3%	**Bacteria**	30%
PCBs in Fish Tissue	9%	**PAHs (Benzo(a)pyrene, Benzo[b,k]fluoranthene)**	1%	**Mercury in Fish Tissue**	22%
Mercury in Fish Tissue	7%	**Bacteria**	1%	**Impaired Benthics**	7%

Table 4.3-16 Suspected sources of designated use impairment in the York River basin, by water body type, ranked by percentage of impaired water size. (Note: Waters can have multiple sources of pollution.)

Rivers		***Lakes***		***Estuaries***	
Grazing in Riparian or Shoreline Zones	38%	**Source Unknown**	100%	**Industrial or Municipal Point Source Discharges**	100%

Rivers		*Lakes*		*Estuaries*	
Sewage Discharges in Unsewered Areas	38%	**Changes in Ordinary Stratification and Bottom Water Hypoxia/Anoxia**	3%	**Sources Outside State Borders**	100%
Waterfowl	38%	**Inactive Abandoned Mine Lands**	<1%	**Agriculture**	100%
Wildlife Other than Waterfowl	38%	**--**	--	**Atmospheric Deposition (Nitrogen)**	100%
Livestock Grazing or Feeding Operations	38%	**--**	--	**Internal Nutrient Recycling**	100%
Runoff from Forest/Grassland/ Parkland	38%	**--**	--	**Loss of Riparian Habitat**	100%

New River Basin

The New River basin is located in southwest Virginia and covers 3,068 square miles or approximately 7% of the Commonwealth's total land area. The New River flows from its headwaters in Watauga County, North Carolina in a northeasterly direction to Radford, Virginia, and then in a northwesterly direction to Glen Lyn, where it exits into West Virginia. There it flows to the confluence of the Gauley River forming the Kanawha River, a tributary to the Ohio River.

The New River basin in Virginia is defined by both hydrologic and political boundaries. It is bordered by the James River basin and Roanoke River basin to the east, and the Tennessee and Big Sandy River basin to the west. The southern boundary of the Virginia portion is the North Carolina state line and its northwest boundary is the West Virginia state line.

The New River basin runs 115 miles in length from Blowing Rock, North Carolina to Bluestone Dam near Hinton, West Virginia with a maximum basin width of 70 miles near Rural Retreat, Virginia. The Virginia portion of the New River basin is 87 miles in length.

The topography of the New River basin is generally rugged; the upper reaches of its tributaries are extremely steep. High mountains, narrow valleys and steep ravines characterize the basin. There are ten tributaries in the Upper New River basin each having more than 100 square miles in drainage area and many others with forty or more square miles.

The New River basin is the least densely populated of the Commonwealth's major river basins. The higher elevations of the basin have steep slopes and are thickly forested, while the mount bases are mostly used for agriculture. Approximately 59% of its land is forested. Cropland and pasture make up another 35%, with approximately 3% considered urban.

The 2010 population for the New River basin was approximately 412,900. All or portions of the following jurisdictions lie within the basin: Counties - Bland, Carroll, Craig, Floyd, Giles, Grayson, Montgomery, Pulaski, Smyth, Tazewell, Wythe; Cities - Galax and Radford.

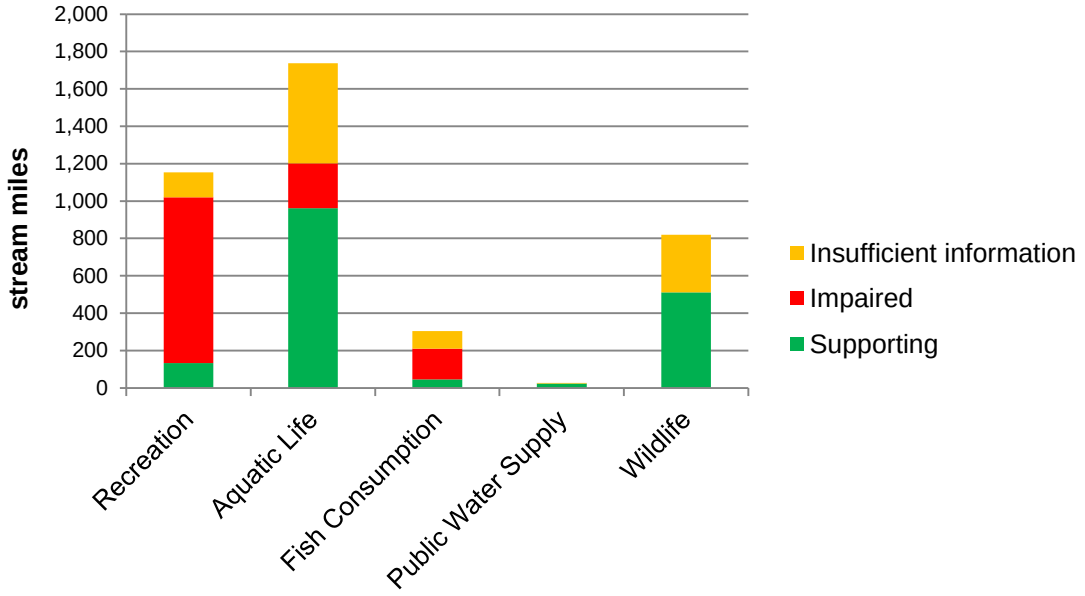
The New River basin is divided into two USGS hydrologic units as follows: HUC 05050001 – Upper New; and HUC 05050002 – Middle New. The two hydrologic units are further divided into 38 waterbodies or watersheds and 88 6th order watersheds.

Basin assessment information is presented in the following figures and tables.

Figure 4.3-9 Designated use support summary for the New River basin. (Note: Waters that have some data, but not enough to determine use support, are classified as having "Insufficient information")

Basin Size: *All Sizes Rounded to Nearest Whole Number*
Rivers - 7,747 miles
Lakes - 4,661 acres
Estuaries - 0 sq. miles

a) Rivers Assessment (6,449 miles were not assessed)



b) Lakes Assessment (34 acres were not assessed)

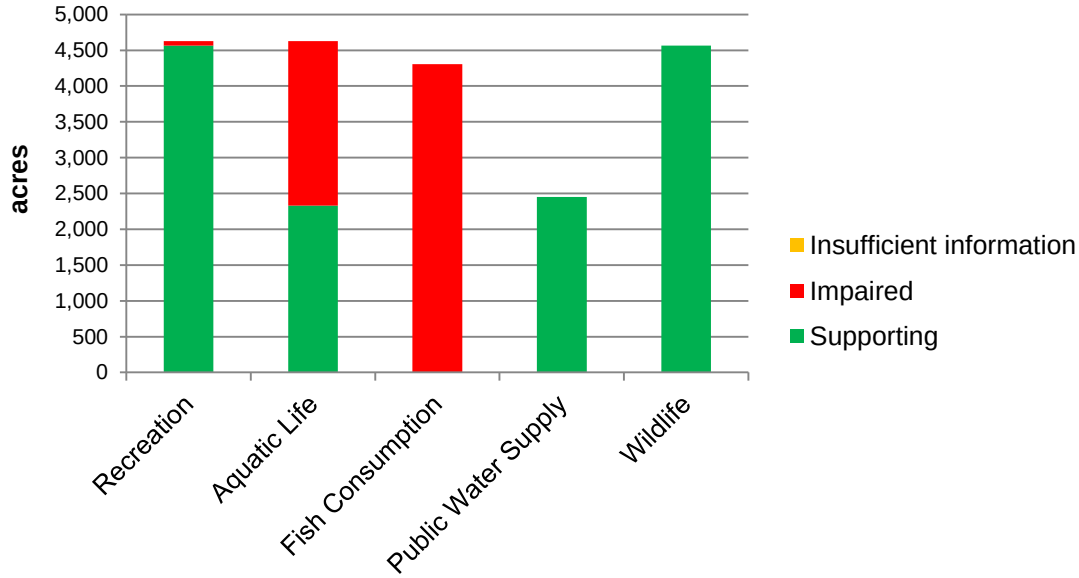


Table 4.3-17 Significant causes of designated use impairment in the New River basin, by waterbody type, ranked by percentage of impaired water size. (Note: Waters can have multiple pollutants.)

Rivers		***Lakes***	
Bacteria	88%	**PCBs in Fish Tissue**	99%
Impaired Benthics	13%	**Dissolved Oxygen**	53%
PCBs in Fish Tissue	12%	**Bacteria**	1%
Temperature	11%	**--**	**--**
Mercury in Fish Tissue	3%	**--**	--
Sedimentation/Siltation	2%	**--**	--

Table 4.3-18 Suspected sources of designated use impairment in the New River basin, by water body type, ranked by percentage of impaired water size. (Note: Waters can have multiple sources of pollution.)

Rivers		***Lakes***	
Livestock Grazing or Feeding Operations	54%	**Source Unknown**	99%
Source Unknown	36%	**Natural Conditions**	53%
Unspecified Domestic Waste	32%	**Livestock Grazing or Feeding Operations**	1%
Unrestricted Cattle Access	31%	**On-site Septic Treatment Systems**	1%
On-site Septic Treatment Systems	30%	**Unspecified Domestic Waste**	1%
Wildlife other than Waterfowl	29%	**Wildlife other than Waterfowl**	1%