## The Patuxent River

## Maryland

The Patuxent River is one of three major tributaries in Maryland feeding the Chesapeake Bay, the largest estuary in North America. It is the longest (110 miles) and deepest (175 feet) river which is entirely within Maryland. The 937 square mile Patuxent River Basin encompasses about 10% of Maryland's surface area. Its watershed lies in both the Coastal Plain and the Piedmont physiographic provinces, and includes portions of seven counties: Anne Arundel, Calvert, Charles, Howard, Montgomery, Prince George's, and St. Mary's. The major urban centers include Columbia (99,615), Bowie (54,727) and Laurel (25,115). In 2010, the population in the Patuxent watershed equaled 714,000.

In the latest census, land use within the Patuxent River watershed was characterized as approximately 40% urban, 40% forest, and 20% agricultural. Urban land use rose 11% between 2000 and 2010, coincident with an increase in impervious surface to an average of 9%, with a high of 19% in the Little Patuxent sub-watershed. In the last 40 years the population has more than doubled, and the acreage in development has more than tripled.

In 1984, water quality in the Patuxent River was already declining due to rapid population growth, despite 85% of its watershed being classified as agriculture and forest. At that time, wastewater treatment plants (WWTP) were the major source of poor water quality. The Clean Water Act Section 208 Water Quality Plan for the Patuxent River Basin, approved by Maryland and the Environmental Protection Agency (EPA) in 1983, was specifically aimed at decreasing point source pollution from wastewater treatment plants. However, 50% of nitrogen and 100% of sediment were from non-point sources. Compared to 1985, wastewater treatment plants in 1994 showed a 50% decrease in nitrogen, and a 75% decrease in phosphorus, despite a 25% increase in flows. Nonetheless, development in the watershed continued to increase, and the percentage of land in agriculture or forest decreased. In 2008, as measured by the habitat quality indicators of summer dissolved oxygen, water clarity, and submerged aquatic vegetation, the Patuxent River overall was found to be markedly impaired. In 2012, a similar evaluation incorporating the health of benthic organisms was repeated with the same result.

The health of the Patuxent River is directly related to the health of its watershed, wetlands, and streams. Land management techniques affect issues such as erosion, runoff, and nutrient pollution from urban, suburban, and agricultural lands. Wetlands provide a buffer between the land and water by acting as a source of nitrate uptake and denitrification. Understanding these factors is key to understanding and affecting the state of the river.

## Freshwater Stream Conditions in the Patuxent River Basin

The Patuxent River watershed encompasses 1,032 of the 9,203 first through fourth order stream miles found in Maryland. Freshwater stream conditions in the Patuxent River basin are monitored by the Maryland Biological Stream Survey (MBSS) division of the Maryland Department of Natural Resources (MD-DNR). The information gathered by MBSS is made available to local governments, and to the public by means of the Stream Health website *(*http://streamhealth.maryland.gov/). MBSS investigation is also used as a means of listing streams as impaired under section 303(d) of the federal Clean Water Act, requiring a TMDL (Total Maximum Daily Load) as part of their rehabilitation.

### Maryland Biological Stream Survey

MBSS rates stream health by evaluating a number of factors including the biological condition, physical habitat, and water chemistry. Data collected over time is encouraging in some areas, but of great concern in others. Overall, the Benthic Index of Biotic Integrity (BIBI), Physical Habitat Index (PHI), and water chemistry (specifically, nitrate and phosphorus) of the Patuxent River watershed lean toward the good to fair ranges. However, the upper river watershed is of most concern, registering a resounding "poor" BIBI.

### 1. **Benthic Index of Biotic Integrity (BIBI)**

Biologic determinants of stream health include the number and distribution of fish, herpetofauna, and benthic species, including the presence of Rare, Threatened, and Endangered species (RTE). The Benthic Index of Biotic Integrity (BIBI) is a quantitative method of calculating and comparing the biological condition of streams. It is determined by comparison to a reference site, the abundance of predators and long-lived benthic species, and benthic taxa diversity, especially those orders which are sensitive to pollution.

MBSS sampling found the BIBI to be roughly 60% good to fair and 40% poor to very poor throughout the Patuxent watershed. The BIBI of the upper watershed was shown to be poor. Not surprising, there was a negative correlation between BIBI and the percent of impervious surface. Consistent with the poor BIBI and elevated percent impervious surface, the upper river watershed is the seat of the Patuxent River's three major urban centers: Columbia, Bowie, and Laurel.

### 2. **The Physical Habitat Index (PHI)**

The Physical Habitat Index (PHI) reflects the suitability of the stream environment. Physical habitat is always examined as a possible cause of biologic degradation. If physical habitat requirements are not met, biological capacity is limited. PHI is determined by flow condition, substrate, erosion, and woody debris, amongst other factors. Two factors included in the evaluation of PHI are instream habitat and riffle embeddedness.

Instream habitat reflects the variety and complexity of fish habitat, whereas riffle embeddedness represents the degree of sedimentation, a component of water quality that is detrimental to macroinvertebrates. MBSS found the total of marginal to poor instream habitat and riffle embeddedness in the Patuxent River Basin to be 32% and 42%, respectively. Overall, the PHI showed that 46% of stream miles in the Patuxent River watershed were degraded or severely degraded.

### 3. **Water Chemistry**

Nutrients such as nitrate and phosphorus are measured as a reflection of water quality. These two nutrients are found in excess in streams due to urban influences (nonpoint source pollution), point sources, and agriculture, amongst other causes. In the Patuxent River watershed, nitrate was moderate in 52% of MBSS sites and low in approximately 48% of sites. Phosphorus levels were high in approximately 15%, moderate in 36%, and low in 48% of stream miles.

The condition of the Patuxent River mainstem is determined by the interplay of the health of the watershed, water quality modification by tidal marsh complexes, and influx of nutrients and sediment from the Chesapeake Bay. Understanding these processes is vital component of understanding the qualities of the Patuxent River.

## Water and Habitat Quality in the Patuxent River Mainstem

The health of the Patuxent River mainstem has declined with the transformation of its watershed from agricultural and forested lands, to more densely populated areas and more intensive agriculture. Water quality has deteriorated as elevated levels of sediment and nutrients impact water clarity, dissolved oxygen, and concentration of algae. These factors, along with changes in salinity and water temperature, have reduced

habitat quality and, in turn, decreased the abundance of aquatic life such as submerged aquatic vegetation (SAV) and benthic organisms.

Point sources such as wastewater treatment plants (WWTP) have been shown to be the major sources of excess nitrogen and phosphorus, particularly in the upper river. Agriculture remains the primary source of sediment, again, especially in the upper river. Current and historical status of water and habitat quality parameters of the Patuxent River main stem, as measured by 12 tidal and 3 nontidal monitoring stations, are made available to the public by means of the Eyes on the Bay website (http://eyesonthebay.net/), as well as to the Maryland Department of the Environment (MDE) and policymakers.

## Water Quality

The Chesapeake Bay Total Maximum Daily Load (TMDL) was established by the U.S. Environmental Protection Agency in 2010 and is designed to protect the Bay from excess nitrogen, phosphorus, and sediment. The Patuxent River is required to achieve interim and final target loads as part of the Chesapeake Bay TMDL by 2017 (60%) and 2025 (100%), respectively. Maryland has developed a Watershed Implementation Plan (WIP) to achieve these reductions. The final target loads for the Patuxent River for these water quality parameters are 3.1 million lbs per year of nitrogen, 0.24 million lbs per year of phosphorus, and 123 million lbs per year of sediment.

The origin of nutrients and sediment in the Patuxent River are as follows:

| | Nitrogen | | Phosphorus | | Sediment | |
|---|---|---|---|---|---|---|
| | % overall | million lbs per year | % overall | million lbs per year | % overall | million lbs per year |
| **Upper River** | 59 | 1.75 | 56 | 0.15 | 59 | 67 |
| **Western Branch** | 8 | 0.24 | 11 | 0.03 | 20 | 23 |
| **Middle River** | 12 | 0.36 | 11 | 0.03 | 10 | 11 |
| **Lower River** | 21 | 0.62 | 22 | 0.06 | 11 | 12 |

Table 1. Contribution of Patuxent River segments to the total amount of nutrients and sediment in the river mainstem, both by percentage and by absolute amounts.

## Summary

### Nontidal

Nitrogen and phosphorus levels are much lower than they have been over the past thirty years in the lower watershed due to wastewater treatment plant upgrades, but they are still too high throughout the nontidal region. Nitrogen is degrading in the upper part of the watershed.

### Upper River

The counties making up the upper river basin are Anne Arundel, Howard, Montgomery, and Prince George's. This river segment includes the watershed that drains to the tidal fresh segment of the Patuxent River (0-0.5ppt salinity). The upper river contributes 59% of the nitrogen, 56% of the phosphorus, and 59% of the sediment load from the Patuxent River watershed. Both nitrogen and phosphorus are elevated but improving in the upper river. The greatest contributor to both nutrients is point sources which amount to 34% and 37% of the total load, respectively. Sediment is elevated but improving in the upper river. Agriculture is the primary source

of sediment, contributing 42% of the total. With respect to habitat quality, algal concentrations have been variable over the years, but are currently acceptable. Water clarity is too low, but summer bottom dissolved oxygen is good. SAV coverage has decreased following a high in 2005.

**Western Branch**

Western Branch is located in Prince George's county. The Western Branch contributes 8% of the nitrogen, 11% of the phosphorus, and 20% of the sediment load from the Patuxent River watershed. Urban runoff is the greatest contributor to nitrogen, phosphorus, and sediment in Western Branch, accounting for 41%, 72%, and 49% of the load, respectively.

**Middle River**

Calvert and Prince George's counties make up the middle river basin. This river segment includes the watershed that drains to the oligohaline segment of the Patuxent River (0.5-5ppt). The middle river contributes 12% of the nitrogen, 11% of the phosphorus, and 10% of the sediment from the Patuxent River watershed. Nitrogen is elevated but improving here. Agriculture, septic, and human-derived inputs to forest are approximately equal in their contribution (30-33%) of nitrogen to the middle river. Phosphorus is also elevated, with agriculture contributing 48% of the total load. Agriculture is also the primary source of sediment which is elevated in the middle river, contributing 80% of the total sediment load. With respect to habitat quality, algal abundance is too high, water clarity is too low, and both are degrading in some areas. Summer bottom dissolved oxygen is marginally acceptable, but often falls into the hypoxic range. Despite some variation, SAV coverage has decreased following a high in 2005. Limited sampling showed benthos to be degraded to severely degraded.

**Lower River**

The counties making up the lower river basin are Calvert, Charles, and St. Mary's. This river segment includes the watershed that drains to the mesohaline segment of the Patuxent River (5-18ppt). The lower river contributes 21% of the nitrogen from the Patuxent River watershed. Nitrogen is elevated in the lower river with the greatest source being septic which amounts to 38% of the load. Phosphorus and sediment are acceptable. With respect to habitat quality, algal levels are elevated and degrading. Water clarity is degrading. Summer bottom dissolved oxygen is too low, especially in the deepest channels near the mouth, and is also degrading in that region. SAV coverage is minimal, and benthos are degraded to severely degraded, especially in the deeper channels which are often hypoxic in the summer.

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In the face of challenges mentioned above, improvements in the urban sector such as wastewater treatment plant upgrades to ENR (Enhanced Nutrient Removal) specifications, stormwater runoff, and retrofits of septic systems have resulted in noticeable improvements. Seven major WWTP on the Patuxent River have been upgraded the Maryland Department of the Environment (MDE) Bay Restoration funds. However, there are twenty WWTP that are not currently targeted for MDE funds and therefore not required to upgrade due to their small size or their ownership (federal or private). Nonetheless, three of these twenty have elected to upgrade voluntarily. In all, these improvements have decreased inputs of nitrogen and phosphorus by 0.79 million lbs per year and 0.14 million lbs per year, respectively.

Agricultural improvements such as cover crops, exclusion of livestock from streams, maintenance of riparian buffers, and improved storage of animal waste have decreased the agricultural impacts to the Patuxent River System. Furthermore, programs and projects such as Program Open Space, Rural Legacy Program, Maryland Environmental Trust, and Maryland Agricultural Land Preservation Program have joined to protect land, decreasing the effects of ongoing development.

However, despite notable improvements in the health of some areas of the Patuxent River, the River as a whole remains compromised. The Patuxent River is purported to be the most studied river in Maryland, with many research, monitoring, restoration and conservation efforts in the river itself, as well as its watershed. Given the fragile circumstances of the Patuxent River, and the potential for a cooperative effort working to its benefit, the need was felt to collaborate and share findings amongst researchers, monitors, and others working in the Patuxent River and the Patuxent River basin. This was the impetus for the 2015 Patuxent River Conference.

**2015 Patuxent River Conference**

**June 18–19, 2015**

The 2015 Patuxent River Conference was held June 18–19, 2015 at the Jefferson Patterson Park and Museum located on the Patuxent River. Eighty participants from over 35 organizations came together to learn and share about research, monitoring, restoration, and management occurring within the Patuxent River and the Patuxent River watershed. The overall goal of the 2015 Patuxent River Conference, in concert with other institutions and efforts, was to continue to work toward a Patuxent River that is drinkable, swimmable, and fishable.

The objectives of the 2015 Patuxent River Conference were as follows:

1. Understand past and current research, monitoring, restoration, and conservation efforts in the Patuxent River and its watershed.
2. Agree to key issues that the partners will address over the next five years.
3. Begin the framework of a 5-year research and monitoring plan, and identify management options to implement those actions.
4. Identify a mechanism for the partners to collaborate and share the results of ongoing work.

The anticipated outcomes included:

1. Identification of the locations where work is being done.
2. Determination of more efficient and effective methods of working.
3. Exchange of research and monitoring findings.
4. Identification of gaps and determination of next steps.

The first day of the conference, June 18, 2015, was used to share past and current research, monitoring, restoration, and conservation efforts in the Patuxent River and its watershed. Fourteen talks and three posters highlighting water quality, watershed impacts, tidal habitat and species, and citizen science were presented. PowerPoints from these presentations can be found on the Patuxent River Conference website: http://www.friendsofjugbay.org/eventsMeetings/PaxRiverConf/ConferenceResults/Presentation.html

On the second day of the conference, June 19, 2015, participants were randomly divided into five small facilitated discussion groups. These groups brainstormed with the intent of generating and prioritizing gaps and questions of most concern that they believed would enhance the understanding of the Patuxent River ecosystem, if addressed. The following areas were the focus of these questions:

1. Watershed / Upland Habitat and Species
2. Tidal Habitat and Species
3. Conservation / Restoration / Management / Monitoring Strategy that would enhance water quality

The major themes raised during the discussion sessions included education and outreach, evaluation and effectiveness of restoration practices, consolidation and coordination of data, impacts of climate change, and wetlands as natural BMPs (Best Management Practices). Through this process, five questions were generated

within each of the three topic areas, one from each discussion group. The Discussion Group outcomes are detailed on the Patuxent River Conference website: http://www.friendsofjugbay.org/eventsMeetings/PaxRiverConf/ConferenceResults/Discussion.html

Following this exercise, participants reconvened to vote on the most fundamental questions from the fifteen questions generated overall. This process resulted in a total of five questions of most concern, that, if addressed, the group as a whole believed would most enhance the understanding of the Patuxent River ecosystem.

The five most fundamental questions are listed below:

| **Most Fundamental Questions** |
|---|
| How do we effectively communicate the connection between land management and the Patuxent River watershed? *(Watershed / Upland Species and Habitat)* |
| How do we monitor and evaluate restoration practices through the lens of water quality, habitat connectivity, and species conservation? *(Watershed / Upland Species and Habitat)* |
| What role do tidal creeks and wetlands play in processing land-based or Patuxent tidal fluxes of nutrients and sediments? *(Tidal Species and Habitat)* |
| How effective are different management strategies (i.e. Citizen Science, Living Shorelines, adaptive management, BMPs) in improving water quality / habitat quality, and how do we measure that effectiveness? *(Tidal Species and Habitat)* |
| How do we make integrated local demonstration projects to show stakeholders of the Patuxent River watershed that effective land management can improve the social and economic value of the land? *(Conservation, Restoration, Management, and Monitoring Strategy)* |

The final session of the 2015 Patuxent River Conference was a brainstorming session amongst the group at large meant to examine the outputs and priorities of the morning session. The goal of this discussion was to formulate ideas about how and who would move the ideas forward to continue the work begun at the conference. Preliminary "next steps" generated from the conference are described below as well as on the Patuxent River Conference website: http://www.friendsofjugbay.org/eventsMeetings/PaxRiverConf/ConferenceResults/Pax%20Next%20Steps%20Dox%20Final.pdf

## "Next Steps"

### Promote Conference Outcomes

- Post presentations from the Patuxent River Conference on the conference web pages hosted by the Friends of Jug Bay website.

- Develop a summary of “Next Steps” to share with participants and post on the website. Forward the Patuxent River Conference participant list to conference attendees.

- Summarize information originating from each of the five discussion groups and obtain feedback from group participants.

- Develop a white paper centered on the conference, including information originating from the small group discussions and the “Next Steps” generated by the participants.

- Explore the possibility of applying for a Chesapeake Conservation Corp intern to help move forward the “Next Steps” effort.

**Networking**

- Create a listserv for 2015 Patuxent River Conference participants and others interested in the Patuxent River watershed. Email: **paxcon.listserv@gmail.com** to request an invitation.

- Conduct informal “meetups” to exchange information and ideas about work in the Patuxent River watershed.

**Outreach**

- Initiate a conversation with the Patuxent River Commission to determine if the Commission has the structure in place to move forward ideas generated at the conference. Recommend the formation of a workgroup.

- Coordinate a work session for education, outreach, and science practitioners to develop data visualization and common messages about the Patuxent River that would be applicable to various audiences. Investigate partnering with the Sea Grant Extension Watershed Specialists on this project.

**Communicate the Science**

- Submit a proposal requesting the publication of a dedicated edition of a peer-reviewed scientific journal focusing on the Patuxent River (e.g. Estuaries and Coasts, Wetlands, or other appropriate journal).

- Explore the resurrection of the Patuxent River Summits which reviewed the state of the Patuxent River and occurred in years past in association with the Patuxent River Appreciation Days at the Calvert Marine Museum.

**Consolidate the Data**

- Assess the capacity within the Maryland Department of Natural Resources to conduct a data inventory of the restoration and monitoring work being done in the Patuxent River, and provide an overview of potential parameters and a timeline for completion.

- Investigate the integration of tidal and nontidal water quality data sets available at a local scale to inform decision-making processes at a local or county level.

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