# Indicator: Freshwater Flow

Things to consider:

- USGS flow gage data and availability
- Water supply vs. use
- Population and development patterns
- Wet and dry weather events
- Meaningful trends over time
- Comparing different watersheds

## Lower Columbia River Estuary Partnership Goals

The ecosystem and species are protected by increasing wetlands and habitat by 16,000 acres by 2010 and promoting improvements to stormwater management.

Toxic and conventional pollution is reduced by eliminating persistent bioaccumulative toxics, establishing maximum daily loads for streams that do not meet water quality standards, reducing hydrocarbon and heavy metal discharges, and reducing bacterial contamination.

Information about Columbia River ecosystems, economics, history, and culture is available to a range of audiences by compiling and evaluating data about the river, providing education programs for a range of audiences—focusing on children—and improving coordination among public and private partners.

• • •

The Lower Columbia River Estuary Partnership is one of 28 estuaries in the nation designated an "Estuary of National Significance". The National Estuary Program was authorized in the Clean Water Act in 1987 and is administered by the US Environmental Protection Agency. Our purpose is to protect nationally significant estuaries that have been degraded by human activity. We do this by bringing together diverse parties to identify problems, define a course of actions to address the problems, and implement the actions.

The Estuary Partnership is a 501(C)(3) non profit corporation; its Board of Directors includes public and private representatives from both Oregon and Washington and represents diverse interests and geography.

811 SW Naito Parkway, Suite 120 Portland, Oregon 97204 503-226-1565 www.lcrep.org

*Printed on recycled paper with environmentally friendly inks*

## Estuary Report Card 2005

| INDICATOR | GRADE | |
|---|---|---|
| Are endangered species in the lower Columbia River recovering? | C | Success in this area is mixed. The bald eagle is recovering; white-tailed deer is not; we can't yet quantify how threatened and endangered salmonids are doing. |
| Are pollutant levels in the lower Columbia River increasing or decreasing? | ? | The story is pretty hard to read. Until recently, no long term sustained monitoring has been in place to evaluate trends in the river. In addition, a lot of what has been done in terms of research and study is not readily accessible. |
| Are we gaining or losing habitat in the lower Columbia River? | C | The Estuary Partnership has funded 18 projects to date that are protecting and restoring 3,289 acres of habitat. In addition, many other partners also are supporting restoration and conservation projects. The more important question is: "What are we losing?" No one has yet done an adequate job tracking how much habitat we lose each year. |
| Do our land use decisions protect lower Columbia River water quality? | C | Since 1972, tree cover has declined significantly and impervious surfaces have increased. The trend can be reversed as we adjust land use decisions to retain tree cover and design more water quality sensitive development. |
| Has the Estuary Partnership provided children with more science-based programs about the lower Columbia River? | A | The Estuary Partnership education programs have reached over 46,545 students in five years in field, river and classroom programs, working with over 550 teachers in 32 school districts. We have provided an additional 79 service learning projects to over 3,100 students in the last two years. |
| Has the Estuary Partnership provided more hands-on opportunities to experience or protect the lower Columbia river? | A | More than 8,200 citizens have volunteered to help monitor or restore the lower Columbia river and its habitats, planting over 11,000 native shrubs and trees at 18 restoration sites since 2000. The Estuary Partnership also hosts a 146 mile water trail for paddlers. |

Maryland Coastal Bays Program
State of the Maryland Coastal Bays Report, 2004

Overall ranking for
Isle of Wight Bay: Fair

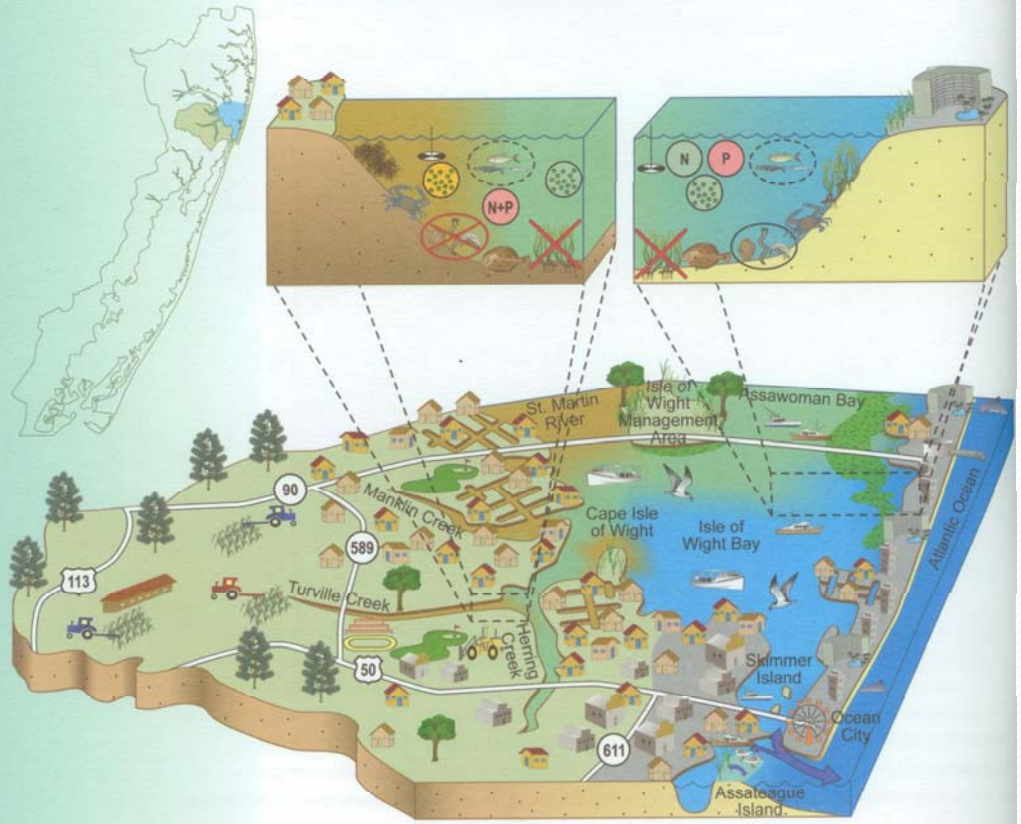
Had reasonable flushing from Ocean City Inlet, but extensive development in the watershed produced the poorest habitat indicators, reducing its overall ranking.

# Isle of Wight Bay

In **Isle of Wight Bay**, forage fish abundance has declined.

In **west Isle of Wight Bay**, water quality was poor to fair in the western tributaries and adjacent to the mouth of St. Martin River. Nitrogen and phosphorus concentrations were high (N+P), resulting in moderate chlorophyll (algal) concentrations in the upper tributaries, and low downstream. Water clarity was low (shallow Secchi depth) throughout. Benthic animal communities were degraded in upper Turville Creek, Manklin Creek and Herring Creek. The macroalga *Gracilaria* was unusually abundant in Turville Creek. Seagrass was absent from the western areas of Isle of Wight Bay and the tributaries.

In **east Isle of Wight Bay**, water quality was fair in the open bay, improving to good closer to the Ocean City Inlet in the south. Phosphorus concentrations remained high (P), while nitrogen concentrations improved to low (N), resulting in low chlorophyll levels and moderate water clarity. Benthic animal communities were intact in the open bay and in lower Turville Creek. Seagrass abundance was low in Isle of Wight Bay, with distribution occurring mainly in areas behind Ocean City, as well as south of the Isle of Wight Management Area.




Legend page 38

Buzzards Bay National Estuary Program


Home | BBNEP Info | Town Information | Pollution | Living Resources | Watershed Info | Enjoy Buzzards Bay | Technical Info | Special Topics

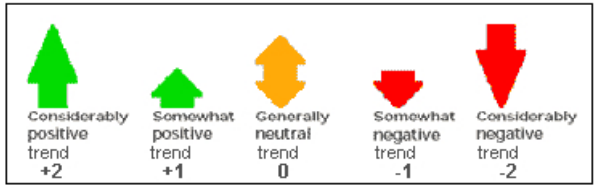
Home > Technical Data > Status & Trends

# Status & Trends

**Sub-Pages:** Coalition State of the Bay Reports | Citizens Monitoring Program | Population Trends |

**Related Pages:** Tracking Town Actions |

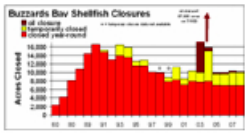
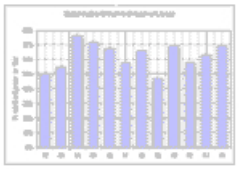
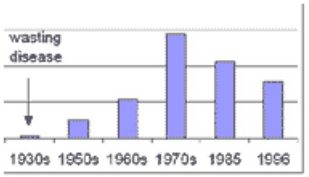
## General Bay-wide Trends (and October 2008 status)




Search our Site

**KEY PAGES**

- Site Index
- Contact us / About Us
- Bay & Watershed Info
- Old CCMP|New CCMP
- Links
- Funding
- Laws and Regulations
- NEP Information
- Reference
- Status & Trends
- Solutions
- Take Action
- Violations, Reporting
- Weather and Tides

| Category | Recent Trend | Historic Status* | Comments | Link for Graph | Link for Info |
|---|---|---|---|---|---|
| Shellfish Closures | ↑ | 60 | Oil closures dwindling, no net increase in permanent closures as of July 2008, but the big story was 1,110 acres opened in September 2008. |  | Shellfish Closure Status |
| Embayment Eutrophication | ↓ | 56 | Wet summers and more discharges from new growth pushing down scores. The one bright spot are improvements in the Wareham River as a result of their wastewater treatment plant upgrade in 2006. |  | CBB website |
| Eelgrass Beds | ↓ | 25 | New declines in north end of Buzzards Bay driving the trend, but there has been no update of eelgrass area since 2001. Look for a possible reversal in Wareham with the 2006 wastewater plant upgrade. |   | Eelgrass page |
| Herring Runs | ↑ | 4 | The dramatic decline of 2000-2006 seemed to have leveled off, and there was a slight increase in 2008. Is the moratorium helping, or is offshore seining the primary controlling factor? |  | Herring Runs page |

# WATERSHED INDICATORS

## Water Use Patterns

**INDICATOR DESCRIPTION:** Current and comprehensive water-use records enable the proper assessment, planning, and management of water resources.

**STATUS:** More than 15 million people rely on drinking water from the Delaware River Basin, including water that is diverted for people living outside the Basin, such as New York City. Per capita water use in the Basin is about 133 gallons per person per day.

Water is used within the Basin for diverse purposes. The dominant use sectors are power generation (thermoelectric), public water supply, and industrial use. Collectively, these account for roughly 90 percent of total withdrawals and consumptive use. Over 90 percent of all water used is obtained from surface waters.

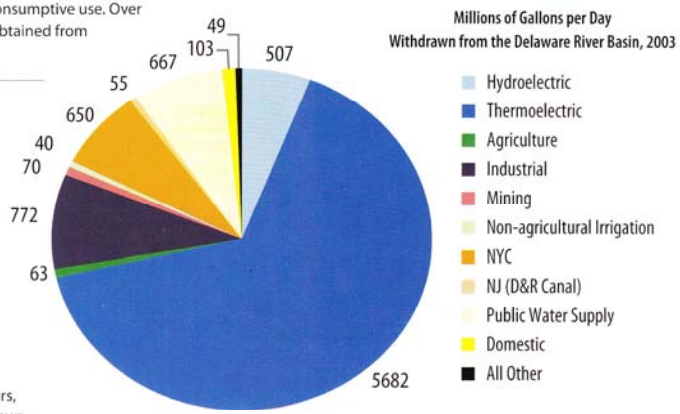
**TRENDS:** In the past decade, Basin-wide water use has remained fairly constant. Although there has been an overall increase in population, this has been offset by a decline in industrial water use and increased conservation.

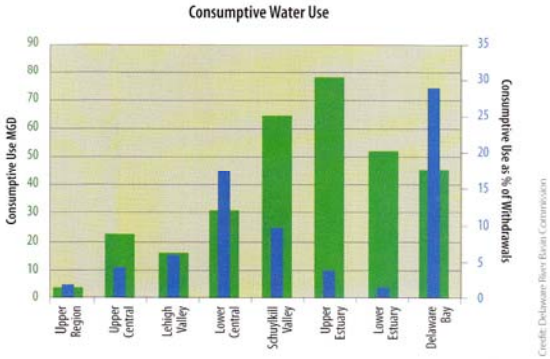
**ACTIONS AND NEEDS:** With further increases in population and requests for more water from various sectors, careful management of water supplies will continue to be of paramount importance. A better understanding of agricultural water demand is needed, and the potential growth in water demand for large, power-generating facilities should be carefully forecasted and managed. Ample freshwater is not only needed for human uses, but also so the streams and rivers of the tidal Estuary can meet their ecological needs.

***Fast Fact***

*The Delaware River Watershed provides clean drinking water to more than 15.2 million people.*

The Philadelphia Water Department's Somerton Tank Farm not only stores Delaware River drinking water, but it is also used to grow produce — in Northeast Philadelphia. Credit: Philadelphia Water Department



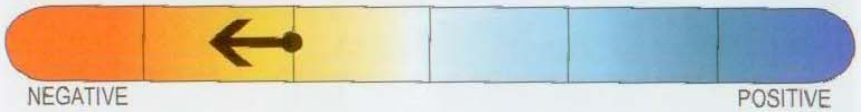

Credit: Delaware River Basin Commission



Partnership for the Delaware Estuary

www.delawareestuary.org

## INDICATOR: STREAM FLOW




Fresh water inflow to Puget Sound—the total flow of all of the major rivers—is an important element of the Sound's marine environment. The timing of regular yearly rainfall, and the timing and magnitude of winter and spring high-flow rain events influence water temperature, salinity, circulation patterns, habitat characteristics and marine life.

### STATUS

Across much of the western United States as well as in the Puget Sound region, scientists have observed hydrologic changes in the past 50 years that are consistent with the observed atmospheric warming, including reduced spring snow pack, earlier spring snow melt, increased winter flow and decreased summer flow.

These changes, most of which have been linked to rising temperatures, can lead to altered habitats for fish and other species. The observed changes also have implications for municipal and agricultural water needs that are dependent on surface water.

### TRENDS

From 1948 to 2003, fresh water inflow in Puget Sound changed in the following ways:

- Total annual inflow declined 13 percent because of changes in precipitation.
- Average snow melt is 12 days earlier, shifting 2.1 days per decade.
- The fraction of annual flow entering Puget Sound from June to September decreased by 18 percent.
- The likelihood of unusually high daily inflow increased, despite the decline in annual inflow.
- The likelihood of unusually low daily inflow increased.

FIGURE 9-28 **Average daily fresh water flow into Puget Sound 1948-2003**

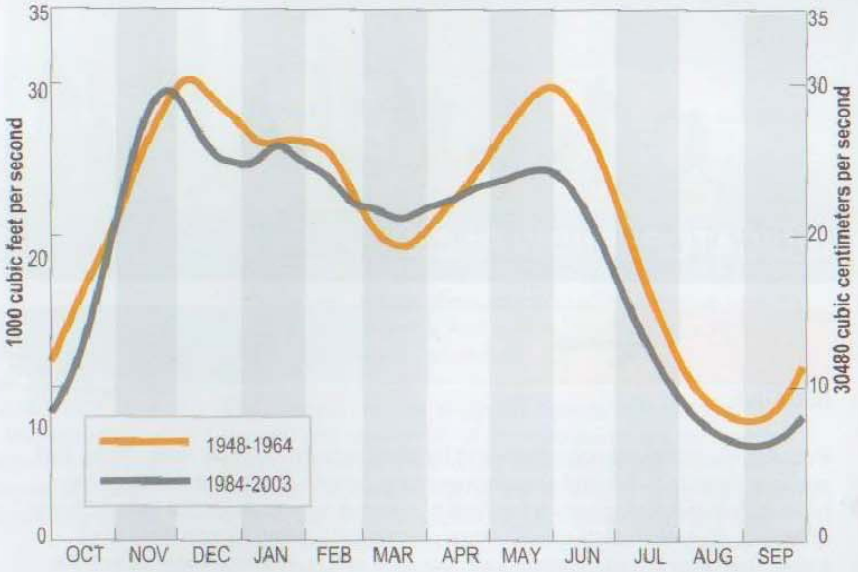



FIGURE 9-28: Average daily fresh water flow into Puget Sound (calculated by adding the flow of nine of the largest rivers) for 1948-1964 (orange) and 1984-2003 (blue). Note the decline in May-October flows and increase in March-April flows. *Source: Uncertain Future: Climate Change and Its Effects on Puget Sound. Action Team, 2005.*

PHOTO: (indicator) Northwest stream. | Shutterstock.com/Aaron Whitney

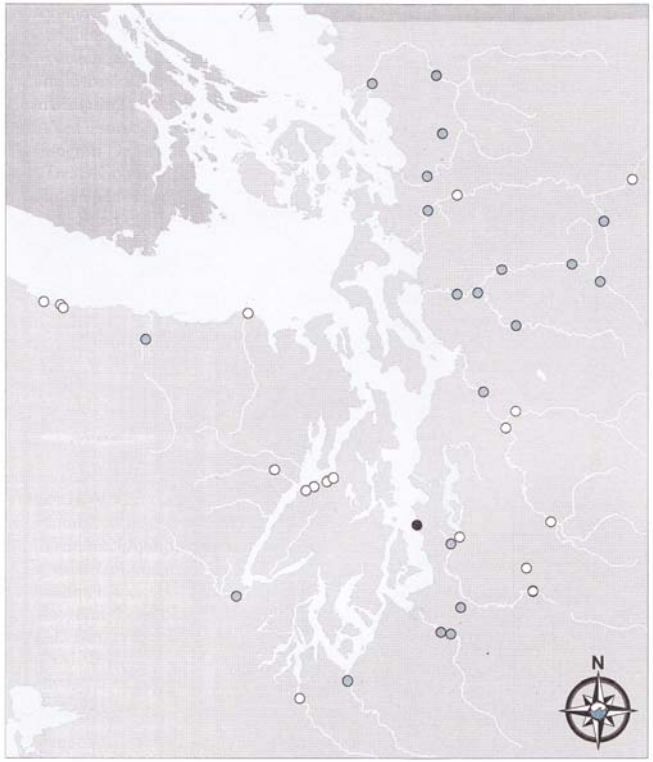



**Figure 3-6. Freshwater long-term and rotating monitoring stations and overall Water Quality Index (WQI) scores.** Fair to good water quality exists throughout the Sound, with one poor site at Fauntleroy Creek, near Seattle. (Source: Ecology)

- Poor
- Fair
- Good

presence. The ambient air temperature increases in and around cities and will affect streams that run through these areas. Any alterations in seasonal temperature patterns will also affect the smaller streams to an extent that cumulative effects appear in the larger lower mainstems of rivers emptying into Puget Sound or Hood Canal.

Trend analysis based on data collected from 1996 through 2005 showed improvements in overall WQI scores at seven of 24 long-term stations (Figure 3-8). This data do not include Ecology's six rotating stations. There were no significant declining trends in overall water quality for any of the 24 monitoring stations during this 10-year period (Hallock et al. 2006).

# 5. Stream Flow

## a. Historical Changes in Stream Flow

Stream flow is fed by rainfall runoff, stormwater, snowmelt, and groundwater intrusion (where groundwater flows to the surface). Climate patterns in the Pacific Northwest typically result in: higher stream flows from October through January, during peak rainfall; a drop in flows from January through March, as precipitation declines but moisture remains contained in the snowpack; a second peak in early spring, associated with accelerated snowmelt; and low flows through the summer as the snowpack shrinks.




## Ipswich River Restoration: EPA Targeted Watershed Grant

The Ipswich River winds 45 miles from Burlington, Massachusetts, to Plum Island Sound in Ipswich. Its 155-square-mile watershed encompasses all or part of 21 communities. The river has been an economic and ecological asset within northeastern Massachusetts since pre-colonial times, supporting productive fisheries and shellfish beds, and for over a hundred years has powered shipbuilders, tanneries, and textile mills. The river and its aquifers are also a critical source of drinking water for hundreds of thousands of people who live both within and outside of the watershed's boundaries.

But the Ipswich River is in trouble. American Rivers, a national rivers protection organization, named the Ipswich River the third most endangered river in the country in 2003. This designation reflects the severe and chronic reductions in flow the river has experienced, particularly since the mid-1990s. Since then, long sections of the river have dried up altogether, several times.

### An Integrated Solution

The Massachusetts Department of Conservation and Recreation (DCR) received a $1.04 million grant from the Environmental Protection Agency's **Targeted Watersheds Grant** program to demonstrate an integrated approach to addressing the problems facing the Ipswich River. This approach encompassed two strategies:

- Low-Impact Development (LID) – landscaping and design techniques that capture stormwater and recharge it to the groundwater
- Water Conservation – education strategies and technologies that reduce demand on water supplies, and associated groundwater pumping, especially during dry months

***On this web site, you can learn about:***

- The **Ipswich River watershed** and the challenges it faces
- The nine **demonstration projects** funded by the grant
- The **watershed computer modeling** effort to determine the approaches potentially most beneficial for the Ipswich River
- Education and **public outreach** efforts
- **News and publications**
- DCR's grant partners and other useful **links**
- **Definitions**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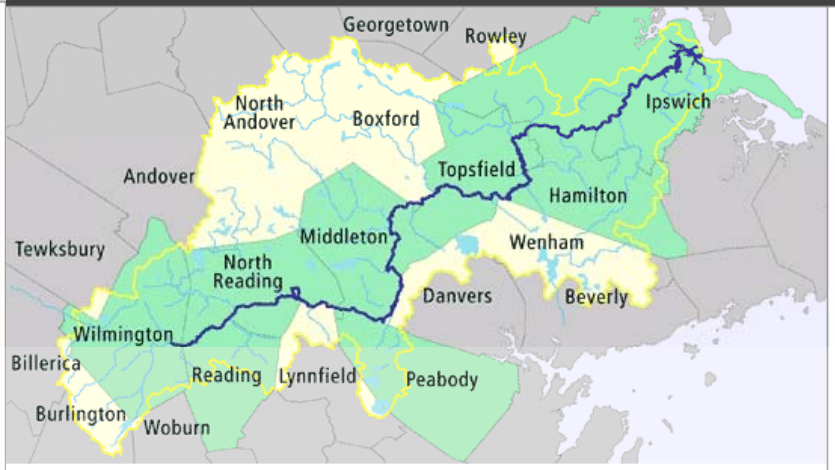
dcr Department of Conservation and Recreation




*Demonstration projects are located in eight communities, shown in green, within the watershed*

## Demonstration Projects

With funding from the EPA Targeted Watersheds Grant program, DCR implemented and monitored the performance of nine demonstration projects that highlighted **low-impact development** and water conservation techniques. The U.S. Geological Survey (USGS) used data collected from the demonstration projects in a watershed computer model that simulated the effect on river flows if these low-impact development and water conservation techniques were to be applied throughout the watershed. For information on this modeling effort, see the **Watershed Modeling** page.

### Low-Impact Development Demonstrations

Four projects demonstrated low-impact development approaches and their potential to decrease stormwater runoff and nonpoint source pollution and to enhance groundwater recharge:

1. **Low-impact development subdivision**
2. **Green roof**
3. **Permeable paving materials and bioretention in a parking lot**
4. **LID retrofits in a lake-side neighborhood**

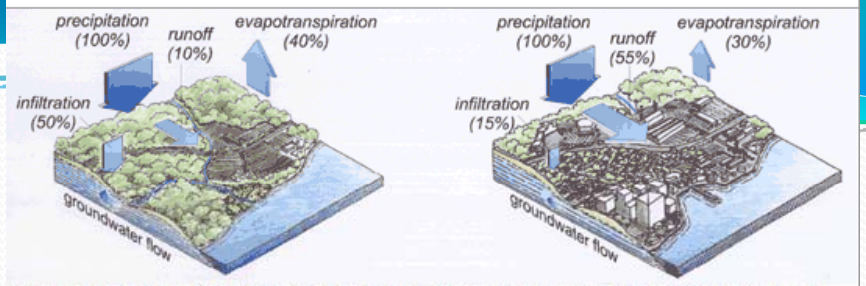
### Water Conservation Demonstrations

Five projects demonstrated innovative water conservation approaches and their potential to reduce water demand:

5. **Rainwater harvesting**
6. **Soil and turf amendments at municipal athletic fields**
7. **Water conservation retrofits and appliance rebates**
8. **Weather-based irrigation controllers**
9. **Water meter replacements and monthly water billing**

Tthese demonstration projects were located in eight communities within the Ipswich River watershed.

Massachusetts Department of Water Conservation
www.mass.gov/dcr/watersupply/ipswichriver

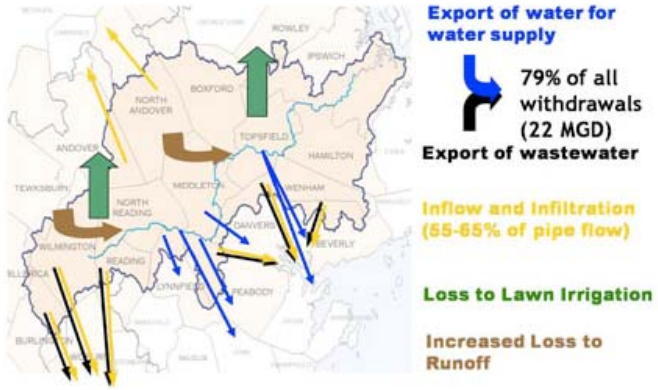



*Change in recharge and runoff before and after intensive development: Massachusetts Smart Growth Toolkit*

**Where is the water in the Ipswich River going?**

Wasteful use of water, "out-of-basin" transfers of water, and changes in land use – for example, from forest land (which percolates rainwater into the ground) to urban development (which tends to flush rainwater away during storms) – have all contributed to low-flow conditions in the Ipswich River watershed.

- The Ipswich River and its aquifers supply drinking water to 15 communities and 330,000 residents and businesses. However, nearly 80% of the water withdrawn is piped to areas outside of the watershed, either as drinking water or wastewater.



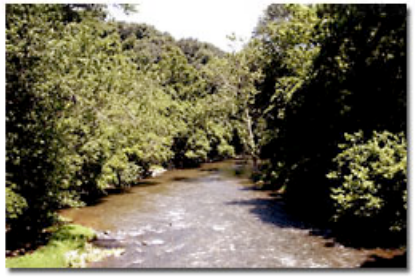

- Outdoor irrigation is a major stress on the Ipswich River. Studies indicate that the amount of water needed to restore natural flows is about equal to the estimated amount used for lawn watering (see the Ipswich River Watershed Action Plan in **Links**).
- The amount of water pumped in summer – reflecting uses for outdoor irrigation, pools, and car washing – is often twice the year-round average.
- Development continues at a rapid pace. Since 1971, an average of almost 1,000 acres per year have been developed in the Ipswich River watershed communities. Such development may alter the natural hydrologic cycle, increasing stormwater runoff and decreasing groundwater recharge. It is groundwater that feeds the river during periods of low precipitation. As groundwater dries up, so does the river.

**Source:** *Ipswich River Watershed Action Plan*. October 2003. Prepared by Horsley & Witten, Inc., for the Massachusetts Executive Office of Environmental Affairs (see **Links**).

Ipswich River Watershed Association
http://ipswichriver.org

# River Flow

Each day, billions of gallons of fresh water flow through thousands of streams and rivers that eventually empty into the Bay. That fresh water also carries polluted runoff from the Bay's 64,000 square-mile watershed. The amount of pollution in the Bay each year is largely determined by a combination of the amount of pollution on the land and the amount of water flowing into the Bay from its many tributaries.



Fresh water enters the Chesapeake Bay from thousands of rivers, creeks and streams throughout the Bay's 64,000-square-mile watershed.

Precipitation increases river flow because the water washes off the land and into streams and rivers. In addition, some water seeps into the soil and into groundwater. It can take years, even decades, for these waters — and the pollutants they may carry — to slowly travel through underground systems until they reach the streams that drain into the Bay.

**How does river flow impact the Bay?**

River flow impacts:

- The amount of nutrients, sediment and other pollutants delivered to the Bay from its watershed. As river flow increases, so does its potential to carry more pollutants from the watershed.
- The salinity of Bay waters. Under normal weather conditions, fresh water flowing from rivers and streams makes up about half the Bay's entire water volume. (The other half comes from sea water from the Atlantic Ocean.) Higher river flows cause more fresh water to reach the Bay, resulting in lower salinity levels; lower flows produce the opposite effect.
- Mixing of oxygen into the water. River flow is generally turbulent and fast-moving, which mixes in oxygen from the air. All Bay creature — from fish to crabs to worms — need oxygen to survive.

## See Also

- **About the Bay**: Watersheds, Streams and rivers
- **Bay Pressures**: Groundwater, Weather, Nutrients, Sediment

## Other Sites of Interest:

- Estimated Streamflow Entering Chesapeake Bay: Monthly data from the U.S. Geological Survey on the amount of water flowing from freshwater tributaries into the Bay.

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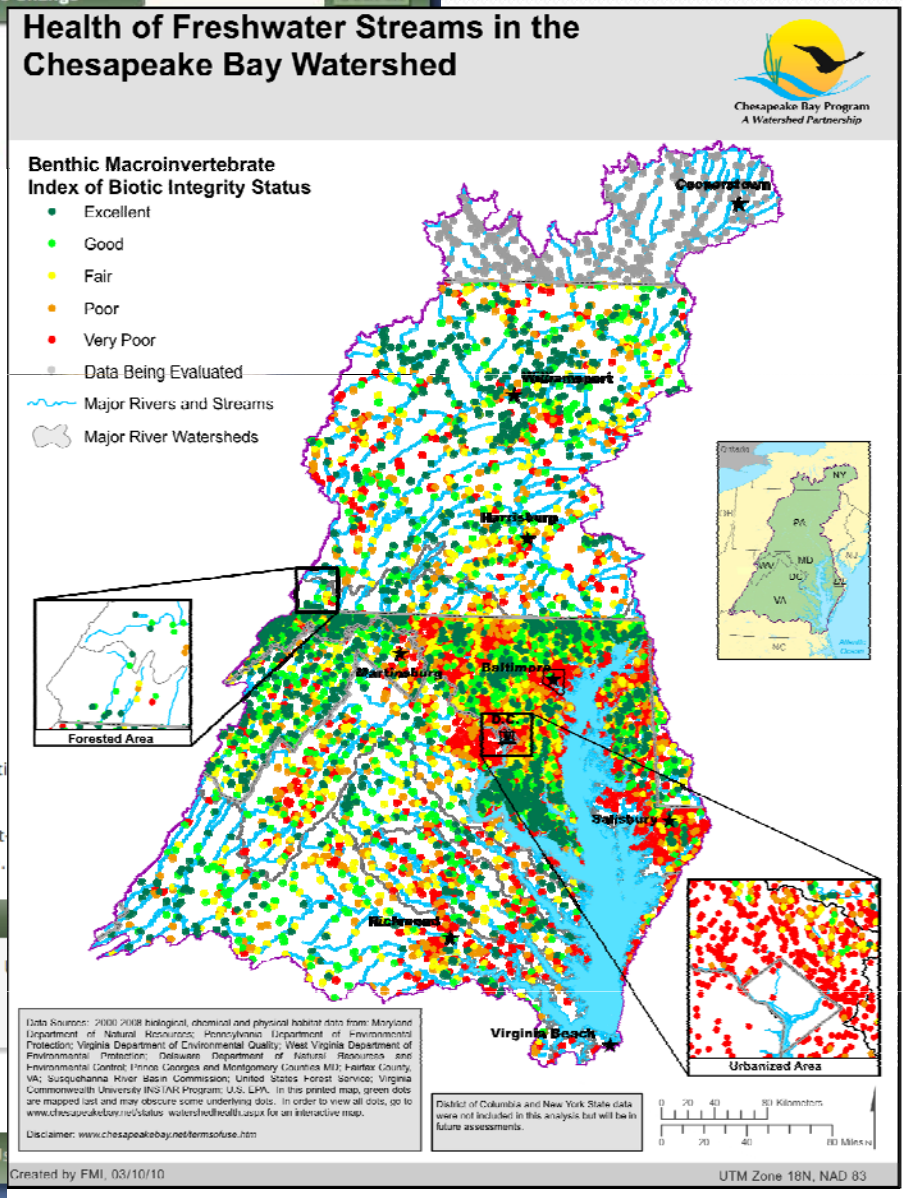

*Fresh Water Indicators*

# Fresh Water Flow

**On average, more than two billion gallons of fresh water flow into Narragansett Bay daily from its drainage basin or watershed—through major rivers such as the Blackstone, Taunton and Pawtuxet; smaller streams such as the Ten Mile and Hunt; and through ground water. These flows are critical components of the region's fresh water habitats, and contribute to the Bay's estuarine habitats as well.**

**The Narragansett Bay Region has abundant freshwater resources, but some areas are showing signs of stress linked to human withdrawals—for example, changes in riverine fish communities caused by low summer flows, and changes to wetlands caused by drawdown of local water tables by public wells.**

According to the R.I. Department of Environmental Management (RIDEM), the following Rhode Island watersheds are showing flow stress:

- **Wood-Pawcatuck watershed, Chipuxet sub-basin.** Private and public wells withdraw water for a variety of uses, including drinking water supply for several public water systems and the University of Rhode Island and irrigation for South County turf farms. A significant portion of the total water withdrawn is exported out of the basin via sewer systems that discharge directly into the Atlantic Ocean. According to USGS, the combined water withdrawals can exceed the river's capacity.
- **Hunt River.** Three public water suppliers withdraw water from the Hunt-Annaquatucket-Pettaquamcutt (HAP) aquifer. Extreme low flows occurred in the lower Hunt river during 2005 and 2007 and impacts to fish populations have been documented by RIDEM studies.
- Initial analyses by RIDEM suggest that water withdrawals in **Westerly, Jamestown, the Annaquatucket area of North Kingstown, Cumberland and Woonsocket** warrant further evaluation to address the potential for withdrawals exceeding levels considered sustainable.
- **Massachusetts** has developed the River Instream Flow Stewards (RIFLS) program to help local groups identify, document and restore rivers and streams suffering from abnormally low flows. They identify the following areas as impacted by low flow:
- **Blackstone River watershed.** The mainstem of the Blackstone River in Rhode Island has adequate water which is supplemented by the discharge from the Worcester and Woonsocket wastewater treatment plants. But many reaches of the rivers and streams throughout the upper Blackstone watershed in Massachusetts suffer from unusually low stream flows due to human activity.
- **Taunton River Watershed.** In summer, 2002, several tributaries of the Taunton were found to be completely dewatered by withdrawals.
- **Palmer River** due to inter-basin water transfer out of Shad Factory Pond into the Kickemuit Reservoir in Warren, R.I.

Photos show the Hunt River at Forge Road, East Greenwich, R.I., in September 2007 under extreme low-flow conditions and immediately after a small rainstorm. Water from the Hunt aquifer provides water to North Kingstown, Kent County and the Quonset Development Corporation.

- What can we say on April 22, 2011 about flow?
- What is our future vision for an indicator on flow conditions?