THE UNIVERSITY OF RHODE ISLAND
COLLEGE OF THE ENVIRONMENT AND LIFE SCIENCES

What is a Watershed?

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WHAT IS A WATERSHED?

Have you ever wondered why rainwater drains a certain way off of your property and where it goes? Or why some waterbodies seem to be fed by rivers and streams and others don't? Or how Narragansett Bay can be impacted by pollutants deposited far away from its banks? The answer to all these questions is that the land we live on is divided into drainage basins called watersheds.

The term **watershed** refers to any area of land that drains to a common body of water like a lake, river, or stream at the watershed's lowest point. Every piece of land is part of a major watershed and successively smaller sub-watersheds, and each watershed is divided from the next by a **drainage divide** formed by the ridges and hills surrounding a waterbody. Every one of us lives in a watershed!

The most famous drainage divide is the Continental Divide, the ridge running north-south through the peaks of the Rocky Mountains that separates the watersheds of the Gulf of Mexico, which is connected to the Atlantic Ocean, from those of the Pacific Ocean. One major watershed of the Atlantic Ocean is the New England watershed, which contains many sub-watersheds nested within it, including the sixteen watersheds that constitute the land area of Rhode Island (figure 1).

Understanding what watersheds are and how they work is essential to improving water quality throughout Rhode Island and beyond. During a rain event like a storm, rainwater that isn't taken by evaporation or used by plant life travels over the surface or seeps into the ground to recharge each of a watershed's waterbodies. As this water travels over the surface, it picks up contaminants like sediment, chemicals, and waste in its path, depositing pollutants in a watershed's bodies of water, which sometimes prompts the beach closings and shellfish bans we have become all too familiar with in Rhode Island.

Figure 1: The state of Rhode Island contains sixteen sub-watersheds, many of which drain to Narragansett Bay.

PARTS OF A WATERSHED

Because of gravity, precipitation follows the lay of the land, known as the land's topography, collecting in natural and man-made drainage pathways like streams, wetlands, man-made channels, and storm drains. Some precipitation runs off the higher upland areas of a watershed, through wetlands like wooded swamps and marshes, and into each watershed's rivers, streams and lakes. Other precipitation seeps into the ground where it moves through soil and may emerge at a nearby lake or pond or stream, while some infiltrates more deeply to replenish regional groundwater supplies.

Uplands

Uplands are the drier, well-drained areas of the watershed. Because of their frequent distance from the watershed's main waterbody, their importance in the watershed is often overlooked. However, uplands drain to wetlands and other waterbodies by discrete channels. In some instances, upland sites have a positive impact on watersheds. Upland sites with sandy, coarse-textured soil readily allow precipitation to infiltrate, thereby serving as important groundwater recharge areas. In other cases, uplands can have negative impacts on the health of their watersheds. Uplands with fine-textured, less permeable soil may not provide significant groundwater recharge, for instance. Uplands with extensive paved surfaces, known as impervious surfaces, pose a special threat: precipitation falling on paved surfaces quickly washes downstream, carrying sediment and other pollutants, eroding streambanks, and increasing flooding.

Figure 2 (top right): Upland areas surrounding a waterbody can have a great deal of impact on its water quality.
Figure 3 (bottom right): Healthy wetlands help remove sediment and pollutants from water before it enters a waterbody. Photo by Pete Pattavina, USFWS Georgia Ecological Services Field Office
Figure 4 (below): Flooding on the bike path in Lincoln, RI in 2005.

Wetlands

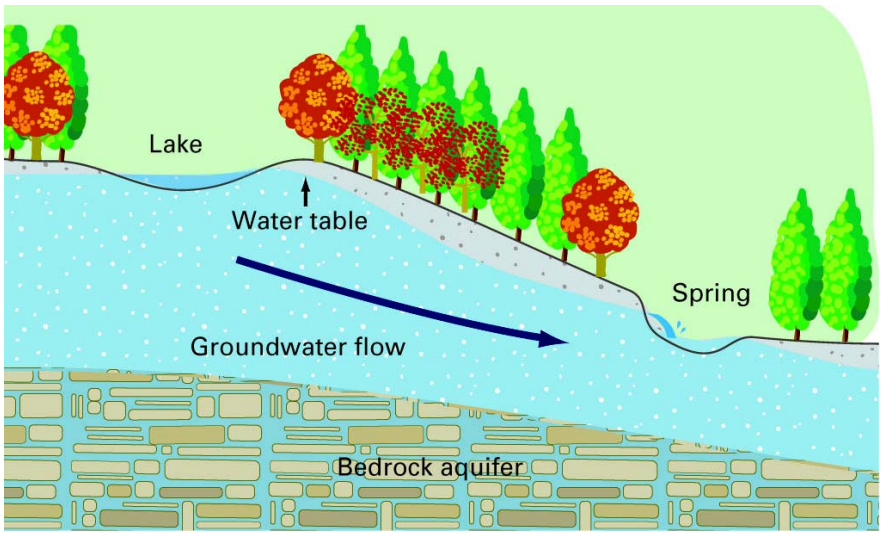
Wetlands, which are saturated areas such as wooded swamps, marshes, and bogs, have important hydrologic and water quality functions, as well as fish and wildlife habitat value. Wetlands work like giant sponges, slowing the flow of incoming water and temporarily storing this water before slowly releasing it downstream or into groundwater reservoirs. By doing so, wetlands protect downstream areas from flooding, an increasingly important function during the more frequent and intense storm events of recent years. Slow movement of water through wetland vegetation also helps to settle sediment and remove certain pollutants, thereby improving water quality downstream. But the positive water flow and water quality benefits provided by wetlands are lost when they are filled or channelized for man-made uses. This was made evident in 2010 by the severe flooding in filled wetlands along the Pawtuxet and other Rhode Island rivers.

Groundwater

A groundwater reservoir, or **aquifer**, is a geologic formation that can store and release large amounts of subsurface water. In Rhode Island, the most productive aquifers consist of deep sand and gravel deposits, commonly referred to as glacial outwash or stratified drift (left from the recession of the last glacial period), where water is stored among grains of sand. Groundwater reservoirs have their own watersheds, known as recharge areas, which consist of all the land contributing subsurface flow to a common location. The boundaries of a surface watershed and groundwater recharge area can, but do not always, coincide.

In recharge areas, surface waterbodies and groundwater are often interconnected. Occasionally, surface waters can provide a source of flow, or recharge, to the aquifer, especially when the top of the aquifer, also known as the **water table**, is low or deep in the ground. When the water table is closer to the surface, groundwater can flow into lakes and streams and help maintain surface water levels. Lakes that seem to have no major inlet, like Larkin Pond and Silver Lake in South Kingstown, may be fed primarily by groundwater. These waterbodies, known as seepage lakes or kettle hole ponds, actually represent the top of the groundwater table in the area.

Figure 5: Groundwater flows through underground aquifers.



AQUATIC ECOSYSTEMS

All materials that reach a lake or river or even Narragansett Bay through uplands, wetlands, and groundwater impact their **aquatic ecosystem**: the chemical and physical environment and its complex association of soil, water, microorganisms, plants, and animals. Changes in any part of the watershed will influence other parts of the ecosystem downstream, for better or worse.

The watershed drainage network makes it possible for point source and nonpoint source pollutants to reach a waterbody that may be located many miles from the pollution source. While point source pollution comes from discrete, identifiable sources like industry or sewage treatment plants, nonpoint source pollution comes from diffuse sources like farms and housing developments. Nonpoint source pollution from farms in the upper Midwest, for example, has an effect on the Gulf of Mexico, a thousand miles away, because agricultural fertilizers and pesticides are carried by rainwater over the surface of the land, into local creeks and then rivers, until the Mississippi River carries them downstream to the Gulf. Although subsurface water moves much more slowly than surface water, groundwater recharge areas, too, can be polluted by a source many miles away.

HOW PEOPLE AFFECT AQUATIC ECOSYSTEMS

Not everyone lives next to a pond or stream, but all of us live in a watershed. All of our activities, like residential and commercial construction, road and highway expansion, lawn maintenance, crop and livestock production, family pet care, and sewage treatment, can intentionally or unintentionally affect aquatic ecosystems, even when these activities occur far from any shore. These activities can directly contribute nutrients, sediment, bacteria, and toxins to our waterbodies. But they also can have more subtle effects, changing the pattern of water flow in a drainage network, thereby increasing the amount of water that reaches a waterbody and the speed by which it gets there. Without enough time for toxins to infiltrate into the soil, these nutrients, sediment, and toxic substances can seriously impair ponds, streams, groundwater resources, and, as we are seeing, Narragansett Bay.

Figure 6 (above): Contaminants such as road salt enter waterbodies quickly from impervious surfaces such as roads.

Impervious Cover

Impervious cover refers those hard surfaces like roads, paved sidewalks, driveways, and roofs that don't allow rainwater to soak into the ground to be filtered and cleaned. These hard surfaces become funnels for stormwater, routing unfiltered stormwater very quickly across the landscape and into the nearest body of water with all of the contaminants, sediment, and debris it picked up on the way. We now know that it doesn't take much impervious cover to affect stream water quality. Water degradation starts when 10% of the landscape contains impervious cover, while only 4-8% impervious cover prompts degradation in sensitive wetlands and trout waters. In Rhode Island only 17 of our 39 cities and towns have less than 10% impervious cover; the other 22 contain enough impervious cover to degrade streamwater. And while degradation may begin at 4% impervious cover, streams surrounded by more than 25% impervious cover, like those flowing into Mt. Hope Bay and northern sections of Narragansett Bay, are considered severely impaired.

Figure 7 (right): Algae caused by eutrophication in Yawgoo Pond.

Nutrient Enrichment

Nutrient enrichment is a major threat to aquatic ecosystems. In undisturbed watersheds, nutrient enrichment, also known as **eutrophication**, is a very slow, naturally occurring process. However, as a watershed becomes more agricultural or urbanized, increased nutrient runoff from chemicals and fertilizers speeds the process of eutrophication. Nutrients are not harmful in and of themselves, but have a negative impact on water quality when a waterbody contains too much of a good thing.

Freshwater resources can suffer from too much phosphorous. As phosphorous levels within a lake increase, algae and aquatic plant growth increase, reducing water clarity and causing the water to appear green and murky. Dense growth of rooted aquatic plants can make boating and swimming difficult or unpleasant, and when these aquatic plants die, their decomposition can reduce the amount of oxygen in the water. As lakes become more nutrient enriched, or **eutrophic**, fish more tolerant of low oxygen conditions, such as carp, become more successful and other fish populations decrease. A similar situation occurs in coastal salt ponds and Narragansett Bay, where excessive nitrogen in the water causes eutrophication, subsequently depriving some species of the oxygen they need for life. This was the case in the Greenwich Bay fish kill of 2003 when roughly one million fish died and washed ashore along Greenwich Bay in just one day (figure 8).

Figure 8 (below): Excess nutrients from coastal watersheds may cause nutrient overenrichment leading to lack of oxygen and fish kills. Photo by Narragansett Bay Estuary Program.

WATERSHED MANAGEMENT PLANNING

Because rivers, ponds, wetlands, and groundwater aquifers are located in watersheds that rarely follow political boundaries, these resources can be effectively protected only through a combination of state and municipal policies and regulations, watershed and environmental organizations' efforts, and individual actions.

The first step in watershed protection is to recognize that our aquatic resources are vulnerable and that we, both individually and collectively, must assume responsibility for their care. No matter our distance from a waterbody, we all make individual and collective decisions that impact its health. We must do a better job of balancing our needs with the needs of our aquatic resources.

Because watershed borders don't necessarily align with jurisdictional boundaries, interested stakeholders throughout the state have joined forces to create a number of watershed councils and organizations to protect Rhode Island's sixteen watersheds. The most visible of these groups is Save the Bay, which was founded in 1970 in opposition to the development of energy facilities on the banks of Narragansett Bay. Over the past several decades, Save the Bay has turned into a dynamic advocacy and education organization, involving citizens from Mt. Hope Bay to Westerly in the protection, enjoyment, and use Narragansett Bay and its watershed through its legislative work, restoration activities, and public events.

Rhode Island also has a number of additional active watershed organizations doing important work. The Wood-Pawcatuck Watershed Association in southwestern Rhode Island, the Woonasquatucket River Watershed Council in northern Rhode Island, and the Narrow River Preservation Association in southern Rhode Island all work to protect the waters of their particular watersheds by emphasizing their value as ecological, environmental, and recreational resources. Save the Lakes and the Salt Ponds Coalition, among others, are also working to protect and restore waterbodies throughout the state.

Each of these groups advocates for protection and restoration through some combination of education, research, and outreach, and are supported in that effort by the work of the URI Watershed Watch (URIWW). URIWW recruits and trains volunteer citizen scientists to do on-the-water monitoring and water sample collection throughout Rhode Island. Their data allows watershed councils, government agencies, and legislators through the state to know which waterbodies are doing well, which are degraded, and where restoration efforts are having the most success. URIWW's success in the long-term ecological monitoring of Rhode Island's fresh and salt water resources – and, ultimately, in supporting the health of these waterbodies and their watersheds – depends upon the work of its network of passionate, engaged volunteers. Everyone has a role to play in protecting Rhode Island's waters!

Local Watershed Organizations

- **Blackstone River Watershed Council**
  http://blackstoneriver.org/blackstone/
- **Buckeye Brook Coalition**
  http://www.buckeyebrook.org/
- **Clean up Sounds and Harbors (CUSH)**
  http://www.cushinc.org/
- **Committee for the Great Salt Pond**
  http://www.cgspblockisland.org/
- **Friends of the Hunt River Watershed**
  http://mysite.verizon.net/vzeyphac/
- **Friends of the Moshassuck**
  http://www.themoshassuck.org/
- **Greenwich Bay Watershed Group**
  http://www.greenshed.org/
- **Hunt River Watershed Association**
  http://www.huntriver.org/
- **Kickemuit River Council**
  http://www.kickemuitriver.org/
- **Narragansett Bay Estuary Program**
  http://www.nbep.org/
- **Narrow River Preservation Association**
  http://www.narrowriver.org/
- **Pawtuxet River Authority and Watershed Council**
  http://www.pawtuxet.org
- **Rhode Island Rivers Council**
  www.ririvers.org
- **Salt Ponds Coalition**
  http://www.saltpondscoalition.org/
- **Save Bristol Harbor**
  http://www.savebristolharbor.com/
- **Save The Bay**
  http://www.savebay.org
- **Save The Lakes**
  www.stlri.org
- **Taunton River Watershed Alliance**
  http://savethetaunton.org/
- **Ten Mile River Watershed Association**
  http://www.tenmileriver.net/
- **Wood-Pawcatuck Watershed Council**
  http://www.wpwa.org/
- **Woonasquatucket River Watershed Council**
  http://www.woonasquatucket.org/

Rhode Island Stormwater Solutions
http://www.ristormwatersolutions.org/

STEPS INDIVIDUALS CAN TAKE TO PROTECT WATER QUALITY

In your yard:

- Don't dump anything into storm drains.
- Water your lawn wisely and fertilize sparingly.
- Keep fertilizer off sidewalks and driveways.
- Pick up and dispose of animal waste.
- Retain and recycle rainwater for your garden.
- Maintain your septic system.
- Find and use pesticide alternatives, only as needed.
- Properly dispose of toxic household materials.
- Create a rain garden to keep runoff in your yard and beautify it at the same time.
- Plant bare areas to prevent erosion.

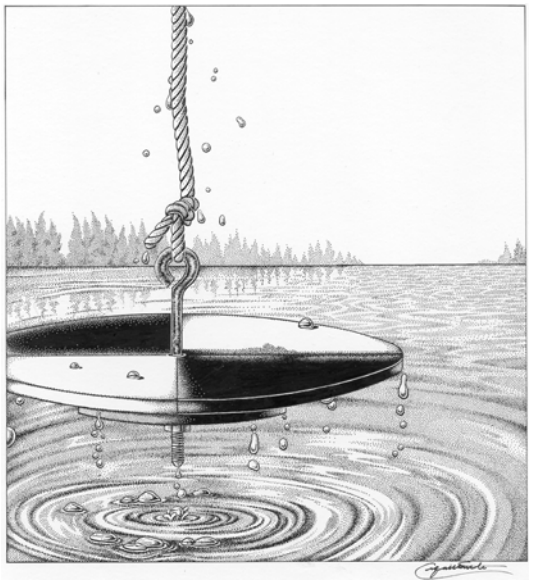
Around town:

- Sign up to monitor a waterbody through URIWW.
- Establish a waterfront buffer of native vegetation along streams, lakes, and bay shores.
- Protect wetlands.
- Don't feed waterfowl.
- Watch for and prevent activities that have the potential to affect water quality.
- Join your local watershed organization.
- Volunteer for your town conservation commission.

In the legislature:

- Support local, state, and federal legislation that protects water resources.
- Become actively involved in water resource issues in your community.

See *Rhode Island Stormwater Solutions* for a more detailed list and links to resources to help you take action (http://www.ristormwatersolutions.org/SW_takeaction.html)



Get Involved!

To learn more about the URI Watershed Watch program and its water monitoring efforts, or for more fact sheets about water quality, visit the URI Watershed Watch web site:

http://www.uri.edu/ce/wq/ww/

Or please contact:

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Northeast States & Caribbean Islands Regional Water Center
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