Teacher Background

**A WATERSHED** is the land area that drains to a stream, lake or river and affects the water quality in the water body that it surrounds. Every inch of the United States is part of a watershed – in other words, all land drains into a lake, river, stream or other water body and directly affects its quality. For example, the Mississippi River has a huge watershed that covers all or parts of 33 states. Someone might live in that watershed, but at the same time, he/she lives in a smaller watershed associated with a local stream or river that flows eventually into the Mississippi. Water from the Mississippi River watershed flows to the Gulf of Mexico carrying any pollution with it, unfortunately, the Gulf of Mexico contains a large dead zone from its watershed’s industrial and agricultural waste.

*Because we all live on the land, we all live in a watershed — thus watershed condition is important to everyone.*

**SALEM SOUND WATERSHED** consists of land in 6 communities – Marblehead, Salem, Peabody, Danvers, Beverly and Manchester. Rain, snow, and groundwater if not evaporated or captured flow downhill into brooks, ponds, lakes, and rivers - eventually ending in estuaries and embayments such as Salem Sound. Rivers that flow into the Salem Sound watershed include the Danvers River (Danvers), Bass River (Beverly), North River (Peabody & Salem), South River (Salem), Chubbs Creek (Beverly & Manchester-by-the-Sea), Sawmill Brook (Manchester-by-the-Sea).

The Forest River, is an estuarine river within the Salem Sound watershed. It begins west of Highland Avenue and the Salem Woods in Salem, MA. An estuary is a partially enclosed coastal body of brackish water with one or more rivers or streams flowing into it, and with a free connection to the open sea. Estuaries form a transition zone between river and maritime environments. The Forest River estuary includes 2 very small tributary streams that flow down through the upland woods to salt marshes (Forest River Conservation Area and Old Creek Salt Marsh) and eventually empty into Salem Harbor. In contrast, the Danvers River estuary has seven major tributaries from Beverly, Danvers, Peabody and Salem.
WATERSHED SYSTEM

Streams, lakes, rivers and other waters are interconnected with the landscape and all its activities through the watershed. Naturally varying lake levels, water movement to and from groundwater, and amount of stream flow are determined by the watershed. Other factors, such as drought, stormwater runoff patterns, and the location and amount of pollution sources, influence the health of our waters.

The system of the watershed consists of all of the abiotic of air, water and soil upon which the the biotic – living organisms exist. The physical structure of the watershed is determined by a combination of climatic, geomorphic and hydrologic processes - landscape, sediment, light and temperature conditions, and dynamics of flowing water (as well as engineered characteristics, discussed later as human influence. The dynamics of all of these factors working together determine the characteristics of the ecosystem – as these factors transition within the system so do the habitats and thereby plants and animals living in them. In a coastal watershed system, the higher elevations of wooded uplands transition down to ponds, streams, salt marshes and eventually to beaches and the coastal embayments. These changes are due to the topography of the land, the size of the sediment on the land, the amount of sunlight that reaches the surface of the land or water body, and the salinity of the water.

The abiotic factor of erosion plays a huge role in the habitat type within the system. As rocks are broken into smaller and smaller bits from weathering and erosion, they are carried by wind and water downhill through the watershed and deposited. These sediments become the substrate for plants to take hold, whether it be rocky, sandy soil for a pine tree or a muddy, brackish substrate for marsh grass to take hold.

SALT MARSHES

Salt marshes develop in coastal habitats where slow-moving water leads to the accumulation of fine sediments eroded off the land where unique salt marsh plants can become established. The mouths of estuaries and protected back side of barrier islands are common sites of sediment accumulation conducive to marsh development.

Salt marshes are extremely productive ecosystems that perform many services valued by society.

Salt marshes are coastal wetlands dominated by grasses that have evolved to need tidal flooding. Their character is strongly influenced by tidal flooding and freshwater input. Tidal marshes range in salinity from salt marsh to brackish and fresh marshes farther inland. Within a salt marsh, elevation increases from bay or creek edge to upland.

Salt marshes are common all along the Atlantic Coast of North America but are particularly abundant on the coasts of the Carolinas and Georgia, where sediment from continental erosion has accumulated for over 150 million years. Farther north, lack of suitable habitats and heavy winter ice scour limit salt marsh development. Not enough time has passed since the Pleistocene ice sheets covered the New England, scouring hard substrates of sediments, for soft sediments to accumulate (Bertram 1999).

On the Atlantic coast of North America, the smooth cordgrass, *Spartina alterniflora*, is the plant that colonizes the intertidal zone and initiates the marsh development process. Cordgrass is extremely tolerant of flooding conditions and once established, it spreads vegetatively by sending rhizomes into surrounding sediments.

1. On the marsh surface, dead plant matter is colonized by bacteria, fungi, and protozoans, making a rich food called detritus.
2. Small invertebrates living in the marsh consume detritus and other invertebrates. These may include craps, amphipods, shrimp and worms.
3. At high tide, mummichogs, silversides, and other small fish swim from the creeks onto the flooded marsh to feed on the detritus and invertebrates.
4. Fished species such as striped bass and winter flounder eat small fish and invertebrates in the marsh and then leave the marsh, bringing nutrients to offshore food webs.
The health of clean water is heavily influenced by the condition of the watershed system, mainly because pollutants can wash from the land to the water and cause substantial harm. These dynamics between the land and the water largely determine the health of our waterways and the types of aquatic life found in a particular area. Effective protection of aquatic ecosystems recognizes their connectivity with each other and with their surrounding watersheds. Unfortunately, human activities have greatly altered many waters and their watersheds.

During the past four hundred years, many salt marshes on the Gulf of Maine's coast from Massachusetts to Nova Scotia (Gulf of Maine watershed) were degraded or destroyed. Salt marshes were filled and drained, and tidal flooding was blocked by roads, railroads, and dikes. Loss of intact salt marshes impairs the health of the Gulf of Maine ecosystem and the economic activities that depend on it.

- Major human impacts and threats to salt marshes
- Restriction of tidal flooding with roads, railroad embankments, and undersized culverts
- Filling with dredge or other material
- Drainage of surface water by ditching
- Invasion by exotic forms of common reed (*Phragmites australis*)
- Increased freshwater runoff and pollution
- Conversion of diked marsh to upland pasture
- Development along upland edge of marsh and loss of vegetated buffer
- Climate change and sea level rise

**URBAN WATERSHED**

In urban and suburban areas, much of the land surface is covered by buildings and pavement, which do not allow rain and snowmelt to soak into the ground. Instead, most developed areas rely on storm drains to carry large amounts of runoff from roofs and paved areas to nearby waterways. The stormwater runoff carries pollutants such as oil, dirt, chemicals, and lawn fertilizers directly to streams and rivers, where they seriously harm water quality. To protect surface water quality and groundwater resources, development should be designed and built to minimize runoff.

Like other developments, the North Shore Mall turned hundreds of acres of farmland into paved, impermeable surface in the 1950's. This development came at the same time as a housing boom and road widening – adding to the amount of impermeable surface in the area.

Developed land reduces the amount of water that can infiltrate into the ground – these surfaces of pavement, concrete and rooftops create more runoff of the surface water rather than filtering into the ground. Impervious cover that exceeds 10 – 15% can stress streams, impairing ecosystem health and biodiversity. For example, the City of Salem has 40% impermeable surface, which decreases the amount of precipitation that infiltrates into the ground creating a high amount of stormwater run-off. This is dealt with through engineered systems that are constantly improving. The sewer and stormwater system in Salem was created over 100 years ago with wooden and iron pipes that are now being replaced with plastic. In some places, to reduce flooding, large stormwater retention basins are being installed underground to store or slow down the stormwater discharge.
DRINKING WATER
Healthy watersheds provide critical services, such as clean drinking water, productive fisheries and outdoor recreation, which support our economies, environment and quality of life. For example, in Beverly, tap water is sourced from three reservoirs (Wenham Lake, Longham Reservoir and Putnamville Reservoir). About half of the water is pumped from the Ipswich River in Topsfield via a canal, and stored in Putnamville Reservoir and/or Wenham Lake. Pumping from the river may occur from December 1-May 31st; the rest of the water comes from the Miles River sub-basin, where Longham Reservoir and Wenham Lake are located.
WASTEWATER
Prior to the 1890’s, centralized sewage treatment was nonexistent. Sewage from each household was simply dumped directly into adjacent streets and onto shores. Consequently, many health problems occurred, and diseases such as cholera were common. Beverly deposited its sewage very close to its beaches. Danvers had no outlet for a system and depended on cesspools. At the height of the industrial revolution, the many tanneries of Salem and Peabody horribly polluted local rivers. The North River in Salem suffered extensive pollution. Public health was jeopardized by the overflowing raw sewage and intolerable odors.

It had become clear to officials of the local towns that there was a definite need to have a centralized sewage system that could carry sewage away from the proximity of the populace and protect public health.

Beginning in about 1900, each community on Salem Sound began building their own local sewage systems and outfalls to combat the public health problem. Salem built their own pumping station and outfall to Great Haste Island in 1910, and Manchester built their own outfall in 1914. Still, the heavy volume of industrial and household waste was overwhelming.

To handle the growing volume of sewage waste, the South Essex Sewage District was created in 1925 to build a centralized system for the communities of Salem, Peabody, Beverly, Danvers and Middleton. A major sewer trunk line was built connecting Danvers State Hospital to Salem pumping station. This new 6-mile system provided sewage service to the entire area and, by its completion in 1930, was discharging nearly 13 million gallons of raw sewage daily into Salem Sound, 1,800 feet beyond Great Haste. Public health improved dramatically; though the problem was far from over.

In 1972, the Clean Water Act made it illegal for communities to dump raw sewage into local waterways and mandated that federal funds would be available for the construction of waste treatment plants. The Clean Water Act illustrates the shift in the American consciousness to a new emphasis on protecting the quality of the environment. Today, the South Essex Sewage District represents five communities – Salem, Peabody, Danvers, Beverly and Marblehead. These five communities are combined into one central system that discharges off Great Haste Island in the middle of Salem Sound. SESD services approximately 600,000 thousand people and processes nearly 30 million gallons of household and industrial sewage daily. The present SESD plant in Salem began primary treatment of sewage in 1978 (removal of floatables and sludge) and a secondary treatment system (removal of floatables and sludge, biological action, chlorination) was added in 1998.

A sewer main pipe crisis began in March 2014 when fisherman spotted an unusual amount of bird activity near the shore in Marblehead section of Salem Harbor. Divers found a small breach in one of the ductile iron pipes that carried sewage from Marblehead to the SESD plant, which is located on Fort Avenue along the Salem waterfront.
In 2015, new pipes were laid under Salem Harbor to carry the sewage from Marblehead to SESD. The new pipes are made of thick, high-density polyethylene, a plastic advertised to last 100 years. The pipes they replace were installed in the late 1970s and never reached its advertised lifespan of 50 years. They were made of ductile iron, a product that was new at the time. As it turned out, that was not the best material because the mud of Salem Harbor proved more corrosive than anyone anticipated.

Another source of bacterial pollution may come from boaters. Salem Sound Coastwatch is pleased to have worked on behalf of Salem Sound with the Salem Sound Harbormasters and the five communities: Marblehead, Salem, Danvers, Beverly and Macheester-by-the-Sea to become the first North Shore No Discharge Area (NDA) on June 23, 2008. Massachusetts Coastal Zone Management and EPA Region 1 designated Salem Sound as an area where boaters with MSD Type I & II (marine sanitation device - heads) can no longer dump within 3 miles of shore.

Additional RESOURCES/Bibliography


(https://www.epa.gov/hwp/basic-information-and-answers-frequent-questions) 2017

Watershed Background Reading:


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