Stormwater facts

Runoff from rain and melting snow is one of the leading causes of pollution in Puget Sound. Here are selected facts related to stormwater, its prevalence, how it affects the Puget Sound ecosystem, and its environmental and economic impacts.

Stormwater flowing into catch basin carries contaminants to our waterways. Photo: Ben McLeod (CC BY-NC-SA 2.0) <https://www.flickr.com/photos/benmcleod/420158390>

**Overview**

Stormwater runoff plays a major role, both directly and indirectly, in the declining health of Puget Sound (PSAT, 2005). Stormwater degrades habitat, affects aquatic environments, and contributes to flooding. It is considered by the Washington State Department of Ecology to be the biggest water pollution problem in the urban areas of Washington State.

**Annual rainfall**

1. Puget Sound's urban areas receive up to 40 inches of rain each year (NOAA National Climatic Data Center, 2015). Historically, most of this water soaked into the ground or was taken up by plants. Over the past 100 years, human development has drastically altered this natural pattern by creating impervious surfaces that cause stormwater runoff. This runoff collects and carries toxic chemicals into Puget Sound.

**Impervious surfaces and stormwater runoff**

2. The total amount of impervious surface in the Puget Sound drainage basin increased from 319,409 acres in 1996 to 357,840 acres in 2006 (Parametrix, 2010). This represents an increase from 3.7% of the total basin to 4.1% of the total basin. Impervious coverage of approximately 10% within a watershed typically leads to measurable and often irreversible loss of functioning of aquatic systems (Booth and Reinelt, 1993).

3. The Puget Sound drainage basin encompasses 8,768,000 acres (USGS, 2000), of which 357,840 acres are made up of impervious surfaces (Parametrix, 2010). With an average annual rainfall at SeaTac airport of 38.2-inches (Rosenberg et al, 2009), Puget Sound basin sees an average of more than 370 billion gallons of stormwater runoff from these surfaces each year.

    a. The stormwater runoff value was calculated using 15,587,510,400 square feet (357,840 acres) of impervious surface multiplied by 3.183 feet of annual rainfall multiplied by 7.48 gallons/cubic feet.

**Known pollutants in stormwater**

4. At least 33 known pollutants are measured in Western Washington stormwater at a 50% or greater detection frequency (Ecology, 2015). This includes a group of polycyclic aromatic hydrocarbons that are categorized as carcinogenic. An additional 16 known pollutants were detected at frequencies of 20-49%. The most common pollutants, detected in 90% of all samples analyzed, include metals, nutrients, suspended solids, and fecal coliform (Ecology, 2015).

    a. This data was summarized from stormwater samples collected under the NPDES Phase I Municipal Permit between 2007 and 2013. The data represents 598 storm events, with up to 85 parameters analyzed in samples collected during these events. For statistical analyses Ecology followed a method outlined by Helsel (2012) which divided the results up in categories depending on detection frequencies. These categories included pollutants with <50% frequency of nondetects; pollutants with 50-80% frequency of non-detects; and pollutants with >80% frequency of non-detects.

5. On average, more than 52,000 – 66,000 lbs of pollutants are released into the Puget Sound Ecosystem each day (Ecology, 2011b). This includes oils and grease, petroleum, zinc, copper, and polycyclic aromatic hydrocarbons. In addition, an estimated 1,189,880 lbs of total suspended sediment enters the Puget Sound Ecosystem each day from surface runoff (Ecology 2011b).

It should be noted, however, that only roughly 10% of the pollutant loadings for oils and grease, petroleum (TPH), zinc, copper, and polycyclic aromatic hydrocarbons are
attributable to commercial/industrial, residential, or agricultural land uses. The majority of the loads come from lands categorized as forested/field/other. Furthermore, Oil and Grease and TPH concentrations from forested lands, which make up more than 80% of the total pollutant loads, have low frequency of detection. Load calculations for these parameters were strongly influenced by how the non-detects were treated in the analysis.

    a. Loading estimates were calculated using contaminant levels from samples collected for the study Toxics in Surface Runoff to Puget Sound: Phase 3 Data and Load Estimates. Contaminant levels were measured in baseflow and stormflow samples from 16 streams within the Puyallup River and Snohomish River watersheds. The total loading rates from the Phase 3 study were lower than initial estimates developed in Phase 1 and Phase 2 of the study (2011b). Phase 1 and Phase 2 relied on literature searches of data from stormwater conveyance systems and instream samples, whereas Phase 3 loading estimates were based solely on instream samples which are expected to have lower concentrations.

**Stormwater effects on salmon**

6. For more than a decade urban watersheds in Puget Sound have seen 60 to 100% of coho salmon die off before spawning (Scholz et al., 2011). Mortality rates this high have very negative impacts on maintaining coho salmon runs. Research has eliminated nonchemical explanations, and indicates the toxic effects of pollutants in stormwater runoff are the likely cause (Scholz et al., 2011). Within the urban watersheds a correlation was observed between the mortality rate and land cover, with mortality rates higher in basins with a greater “urban” land cover and land uses (Fiest et al., 2011).

    a. Research and forensic studies into the cause of the pre-spawn mortality ruled out “stream temperature, dissolved oxygen, poor overall spawner condition, tissue pathology, pathogen prevalence or disease, and other factors commonly associated with fish kills in freshwater habitats” (Scholz et al., 2011). The forensic studies combined with the exhibited symptoms and rapid onset points to stormwater runoff from urban land cover and land uses as the likely cause of the high mortality rates (Fiest et al., 2011). Three variables within the urban watersheds were most important in predicting mortality rates: impervious surfaces, local roads, and commercial property type (Fiest et al., 2011).

7. Dissolved copper is a ubiquitous contaminant in stormwater runoff. Stormwater samples collected by NPDES Phase I Municipal Stormwater Permittees showed dissolved copper levels exceed acute aquatic life criteria 50% of the time and chronic aquatic life criteria 58% of the time. (Ecology, 2015). Median concentrations from industrial, commercial, high density residential, and low density residential land uses were 16.0 µg/L, 19.6 µg/L, 7.7 µg/L, and 2.8 µg/L, respectively. Copper can disrupt the salmon’s olfactory system, affecting their ability to imprint on their natal streams, navigate during migration, and detect and avoid predators (McCarthy et al., 2008). These disruptions can occur at concentrations of 3.0 µg/L over background in freshwater (Baldwin, 2003).

**Impaired waterbodies**

8. Five hundred twenty-five (525) streams, rivers, lakes and marine waterbodies across the Puget Sound region are impaired by poor water quality (Ecology, 2014).

    a. According to the Washington State Department of Ecology’s Puget Sound Characterization Project, there are 19 Water Resource Inventory Areas (WRIAs) within the Puget Sound drainage area (Ecology, 2013). These WRIAs (#1 through #19) include 544 fresh and marine waterbodies that are listed on Washington’s 303(d) list of polluted waters (Ecology, 2012).

    b. The 303(d) list is comprised of waters that are considered impaired or threatened by one or more pollutants. Waters placed on this list require the creation of a Total Maximum Daily Load (TMDL) or other approved water cleanup plan, outlining how much of the pollutant of concern needs to be reduced to achieve clean water. The vast majority of 303(d) listings within the Puget Sound Basin are for 3 parameters—dissolved oxygen (37%), bacteria (31%), and temperature (20%) (Ecology, 2012).

    c. In addition to the 544 waterbodies currently on the 303(d) list, there are 241 waterbodies listed as “Waters of Concern” (Ecology, 2012). These waters show some evidence of a water quality problem, but not enough to require a TMDL or water cleanup plan.

**Combined sewer overflows**

9. In 2012 and 2013 combined sewer overflows (CSOs) into Puget Sound have been in excess of 1,559 million gallons (MG) and 423 MG, respectively (King County 2013, 2014; Seattle Public Utilities 2013, 2014). The U.S. Environmental Protection Agency (2004) estimates that exposure to these types of CSOs at state-recognized beaches account for more than 800 gastrointestinal illnesses nationwide each year. These findings only include data from state-recognized beaches, and therefore only capture a portion of the likely number of annual illnesses attributed to CSOs (USEPA, 2004).

    a. There are 168 permitted combined sewer overflow (CSO) outfalls that drain into Puget Sound. (Ecology, 2014). Of these, 126 are within the jurisdictions of King County and Seattle Public Utilities. In 1987 Ecology adopted Chapter 173-245 WAC which implemented a Water Pollution Control Act requirement and stated all CSO sites must be controlled in a manner that results in an average of one untreated discharge event per year.

    b. In 1988 Ecology estimated that CSOs in Washington State discharged 3.3 billion gallons annually (Ecology 2011). Recent data from King County and SPU, the jurisdictions with 75% of the CSO outfalls, reported discharges of 1,559 MG in 2012 and 423 MG in 2013 (King County 2013, 2014; SPU 2013, 2014). While this is an improvement over estimated 1988 volumes, multiple outfalls are still seeing in excess of 15 untreated discharge events per year (King County 2013, 2014; SPU 2013, 2014).

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