UPDATE ON WATER QUALITY MONITORING AND SALMON STEWARDSHIP IN EDMONDS

EDMONDS -WOODWAY HIGH SCHOOL
STUDENTS SAVING SALMON

July 2018

EDMONDS STREAM TEAM

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INTRODUCTION

This report provides an update on the findings and activities of Students Saving Salmon involvement in the Edmonds Stream Team monitoring project and salmon stewardship in Edmonds. Details of the stream monitoring project are provided in prior year reports to the Edmonds City Council (see "Edmonds Water Quality Monitoring Project: Preliminary Report "(2016) and "Condition of Edmonds Streams for Salmon: Water Quality Monitoring and Salmon Stewardship" (2017)).

Students Saving Salmon is an Edmonds-Woodway High School club formed in 2014 by students concerned about the environment, especially salmon and their habitat. Students Saving Salmon objectives are to collect and disseminate scientific information on Edmonds watersheds; conduct outreach on salmon and their habitat; collect data on local salmon populations; improve streamside habitat and enhance salmon populations; and, participate in city government processes and community habitat enhancement efforts.

Since the start of the 2015/16 school year, students have been conducting monthly field work with the Edmonds Stream Team, a citizen science project led by Joe Scordino (a retired fishery biologist) to assess stream water quality and habitat in Edmonds. More recently, the students have expanded their salmon stewardship efforts to enhance salmon populations in Shell Creek in Edmonds by restoring stream habitat and helping raise coho salmon for release into the creek each year to bolster population numbers.

The purpose of the citizen science project is to advance our knowledge and understanding of the local environment. Students collected water quality measurements using scientific instruments in several streams (Willow, Shell and Shellabarger Creeks) that flow through or near the downtown area of Edmonds and from the Edmonds Marsh. Scientific information was collected every month on water parameters that are important for aquatic organism survival including temperature, pH, dissolved oxygen, salinity, turbidity and nutrients. Water samples were collected quarterly and during rainstorms for analysis by the Edmonds Wastewater Treatment Lab for fecal coliform, and by an accredited water analysis laboratory in Everett that tests for heavy metals and petroleum compounds.

MONITORING RESULTS

Water Temperature in Creeks

Overall average water temperatures in Shell, Hindley, Shellabarger and Willow Creeks ranged from 51.0°F in the fall to 47.0°F in the winter to 52.6°F in the spring and 56.8°F in the summer (Table 1). All of the recorded monthly water temperatures, except one, were below the maximum temperature requirement of 63.5°F for salmonid spawning, rearing and migration in the Washington Administrative Code. Hindley Creek had one summer high recording of 63.8°F.

Table 1. Seasonal Water Temperatures in Creeks (in degrees Fahrenheit)					
	fall	spring	summer	winter	average
Lower Hindley Creek	51.3	54.4	60.1	47.0	52.8
Lower Shell Creek	50.5	52.0	55.9	47.2	51.2
Middle Shell Creek	50.4	51.4	54.3	47.2	51.0
Upper Shell Creek	50.9	51.2	52.6	46.9	50.9
Lower Shellabarger Creek	53.8	54.6	60.3	47.6	54.4
Shellabarger Creek - Upper middle fork	52.6	55.2	59.4	48.5	54.1
Shellabarger Creek - Upper north fork	52.5	54.4	58.2	48.9	53.5
Shellabarger Creek - Upper south fork	52.4	53.7	58.7	47.4	53.4
Lower Willow Creek	51.5	51.6	57.2	46.1	52.5
Upper Willow Creek	53.2	52.8	56.3	50.4	53.3

Water Temperature in Edmonds Marsh

Overall average water temperatures for all sites in the Marsh ranged from 52.7°F in the fall to 45.8°F in the winter to 55.2°F in the spring and 62.4°F in the summer; all of which are below the maximum temperature requirement of 63.5°F for salmonid spawning, rearing and migration in the Washington Administrative Code. However, the water exiting the Marsh and along the north edge of the Marsh exceeded the standard in summer (Table 2). Highest water temperatures recorded at the Marsh outlet were 73.3°F in the summer and 68.5°F in the spring. The north edge of the Marsh had a summer high of 72.0°F.

Table 2. Seasonal Water Temperatures in Edmonds Marsh (in degrees Fahrenheit)					
	fall	spring	summer	winter	average
East edge at storm drain	51.0	52.2	58.9	45.4	53.0
Eastern edge	51.9	52.5	58.6	46.8	52.7
Eastern edge at Hwy 104 Culvert	52.7	54.5	60.0	47.0	54.1
Harbor Square east culvert	53.4	53.9	66.2	45.3	55.5
Harbor Square west culvert	53.4	55.4	66.7	45.6	55.8
Marsh outlet	52.9	60.3	64.2	44.9	55.4

Dissolved Oxygen in Creeks

Average dissolved oxygen levels in Shell, Hindley, Shellabarger and Willow Creeks ranged from a low of 10.0 mg/L in summer to a high of 11.3 mg/L in the winter (Table 3). The lowest average was 9.3 mg/L in the south fork of upper Shellabarger in the summer. These are well above the 8.0 mg/L for salmonid spawning, rearing and migration in the Washington Administrative Code. Further, the measured dissolved oxygen levels in lower Shell Creek, where salmon spawn in fall and winter, were above 11.0 mg/L which is an optimum level for salmon eggs in the gravel.

Table 3. Seasonal Dissolved Oxygen in Creeks (in mg/L)					
	fall	spring	summer	winter	average
Lower Hindley Creek	10.6	10.7	9.8	11.6	10.7
Lower Shell Creek	11.2	11.0	10.6	11.6	11.1
Middle Shell Creek	11.3	11.1	10.9	11.8	11.3
Upper Shell Creek	9.7	10.1	9.9	10.7	10.0
Lower Shellabarger Creek	10.2	10.2	9.5	11.3	10.3
Shellabarger Creek - Upper middle fork	10.9	10.4	10.0	11.4	10.7
Shellabarger Creek - Upper north fork	10.0	10.2	9.8	10.8	10.2
Shellabarger Creek - Upper south fork	10.1	10.2	9.4	11.1	10.1
Lower Willow Creek	10.9	10.5	10.0	11.4	10.6
Upper Willow Creek	10.3	10.5	10.2	10.6	10.4

Dissolved Oxygen in Edmonds Marsh

The main flow of water through the Edmonds Marsh (from Shellabarger inlet at the Hwy 104 culverts to the Marsh outlet) had dissolved oxygen averaging over 9.3 mg/L at the outlet which exceeds the 8.0 mg/L minimum for salmonids in the Washington Administrative Code. However, dissolved oxygen measured on the northern edge of the Marsh along Harbor Square and portions of the eastern edge of the Marsh along Highway 104 were below standards. The northern edge of the Marsh along Harbor Square averaged 3.0 mg/L of dissolved oxygen and was below 2.0 mg/L (which is lethal to most aquatic organisms) except during periods of rainfall. The southern sites of eastern edge of the Marsh, (south of the Shellabarger inlet culverts) averaged 5.0 mg/L and 1.6 mg/L of dissolved oxygen (which is far below the State standard).

Table 4. Seasonal Dissolved Oxygen in Edmonds Marsh (in mg/L)					
	fall	spring	summer	winter	average
East edge at storm drain	1.6	1.8	1.1	2.4	1.6
Eastern edge	5.1	4.5	3.1	7.7	5.0
Eastern edge at Hwy 104 Culvert	9.2	9.2	8.2	10.4	9.2

Harbor Square east culvert	3.6	0.4	1.0	2.	1.8
Harbor Square west culvert	4.7	1.6	1.3	4.6	3.0
Marsh outlet	8.6	10.6	8.4	10.0	9.4

pH

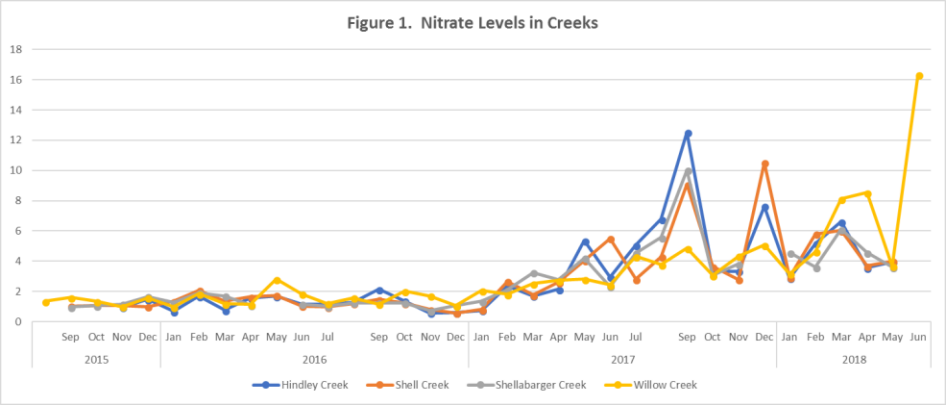
All of the observed pH levels in Shell, Hindley, Shellabarger and Willow Creeks were within the pH 6.5 to 8.5 range that is suitable for salmon and within the Washington Water Quality Standards for aquatic life. Average pH levels in these creeks ranged from 7.4 to 7.9. The Edmonds Marsh had an average pH of 7.0 for all sites with the incoming/outgoing water averaging 7.3 and the north edges along Harbor Square more acidic with pH averaging 6.7. Measured pH was below the Water Quality pH standard of 6.5 on multiple occasions on the northern edge of the Marsh site along Harbor Square.

Conductivity

Conductivity measurements in the creeks stayed relatively constant except during periods of rainfall which lowers the conductivity of water since rainwater is generally low in ions (thus low in conductivity). The conductivity measurements in the Marsh were affected by the opening of the tidegate with high conductivity levels recorded during saltwater intrusion (saltwater has much more dissolved ions and solids than freshwater).

Nitrates

Nitrate levels in Shell, Hindley, Shellabarger and Willow Creeks were generally below 2 mg/L from the fall of 2015 to the spring of 2017 and then increased (see Figure 1). Nitrates in the four creeks increased to an average of 4.0 mg/L in 2017 and 5.2 mg/L in 2018 (through June 2018). The Marsh had similar pattern of increased nitrates from 2015 to 2017 except that nitrates generally increased during the periods that the tidegate was secured open allowing saltwater to enter the Marsh during high tides. High nitrate levels can cause algal blooms which can deplete dissolved oxygen levels in water thus impacting fish and other aquatic organisms.

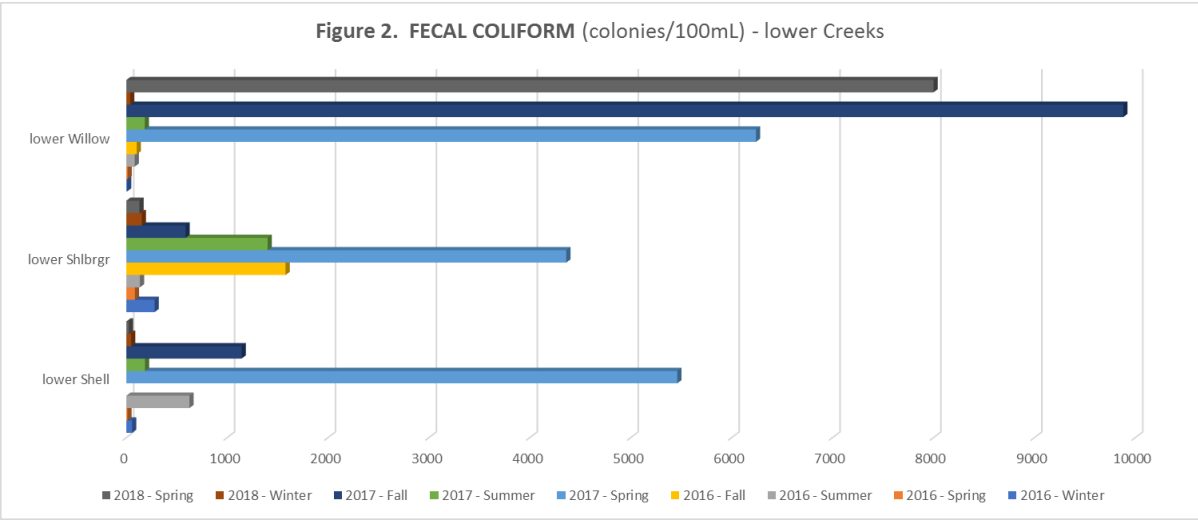


Salinity in Edmonds Marsh

The salinity of the water in the Marsh is affected by a tidegate located downstream of the Marsh outlet. The tidegate functions to prevent saltwater intrusion into the Marsh from mid-October to mid-March (to prevent flooding during periods of coinciding high rainfall and high tides). In about mid-March, the tidegate is secured in an open position to allow full tidal exchange of saltwater through the spring/summer months. The salinity measurements at the Marsh outlet (which is representative of the main body of the Marsh) from December to early March (averaging 0.15 ppt) reflect the low salinity of the incoming freshwater from the Shellabarger inlet and lower Willow Creek. When the tide gate is secured open, the salinity measurements were significantly greater in the main body of the Marsh. However, the salinity measurements along Harbor Square and Highway 104 did not increase when the tidegate was secured open indicating the saltwater did not reach these areas. It was also noted during the 2018 salinity measurements that higher salinity levels were occurring in the deeper water layers in the outlet basin during periods when the tidegate was closed suggesting some saltwater is entering the basin (i.e., the tidegate leaks during higher tides).

Fecal Coliform Bacteria

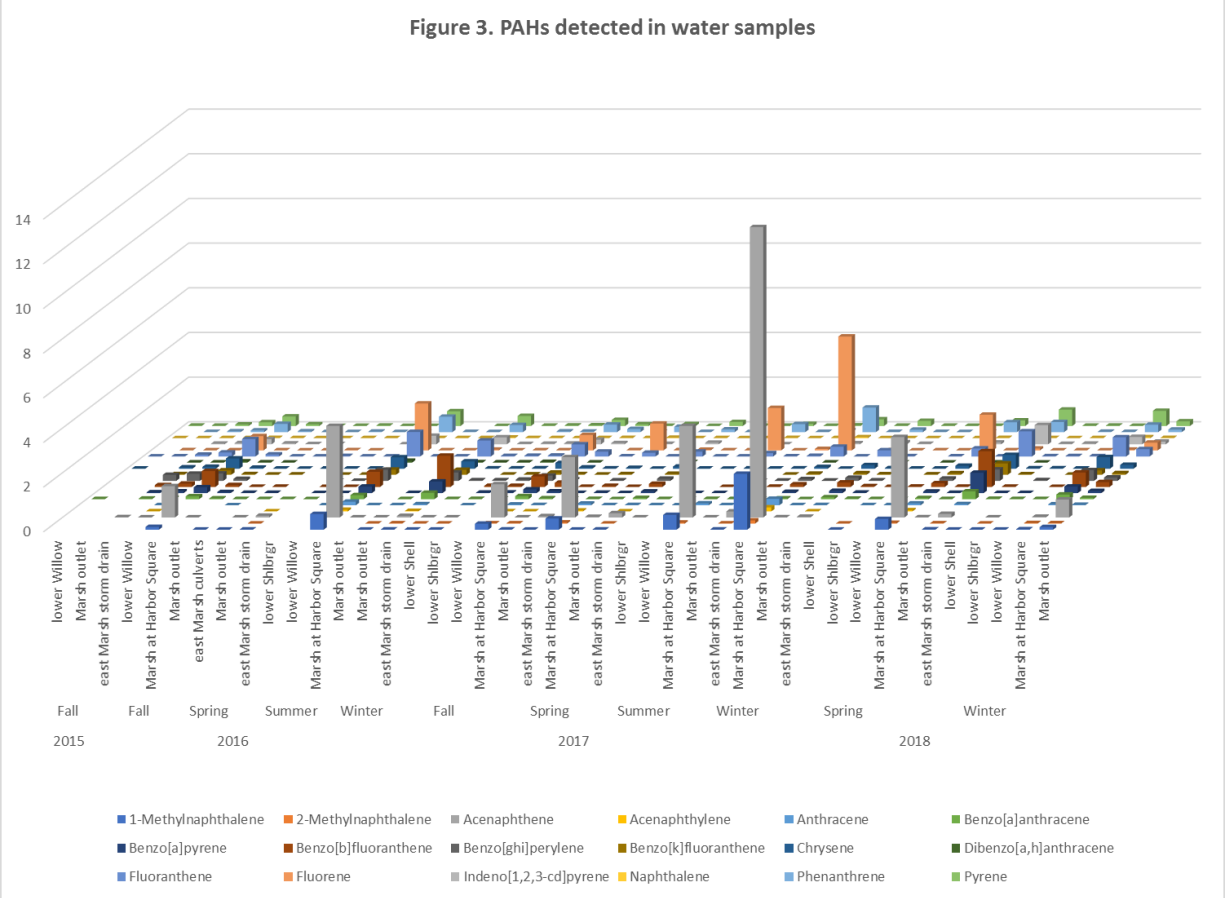
Counts of fecal coliform bacteria colonies cultured from water samples collected varied considerably by location/season/day. There are no Washington Water Quality Standards for fecal coliform for freshwater aquatic life. However, if we use the Washington criteria for water contact recreation (i.e., levels must not exceed a geometric mean value of 100 colonies/100 mL) as an indicator of a potential bacteria problem, then there are a number of samples that are of concern. Fecal coliform counts appear to be higher after a period of rain. Extremely high counts of fecal coliform bacteria exceeding 8000 colonies per 100mL occurred at Willow Creek in both the spring and the fall (see Figure 2).



Pollutants

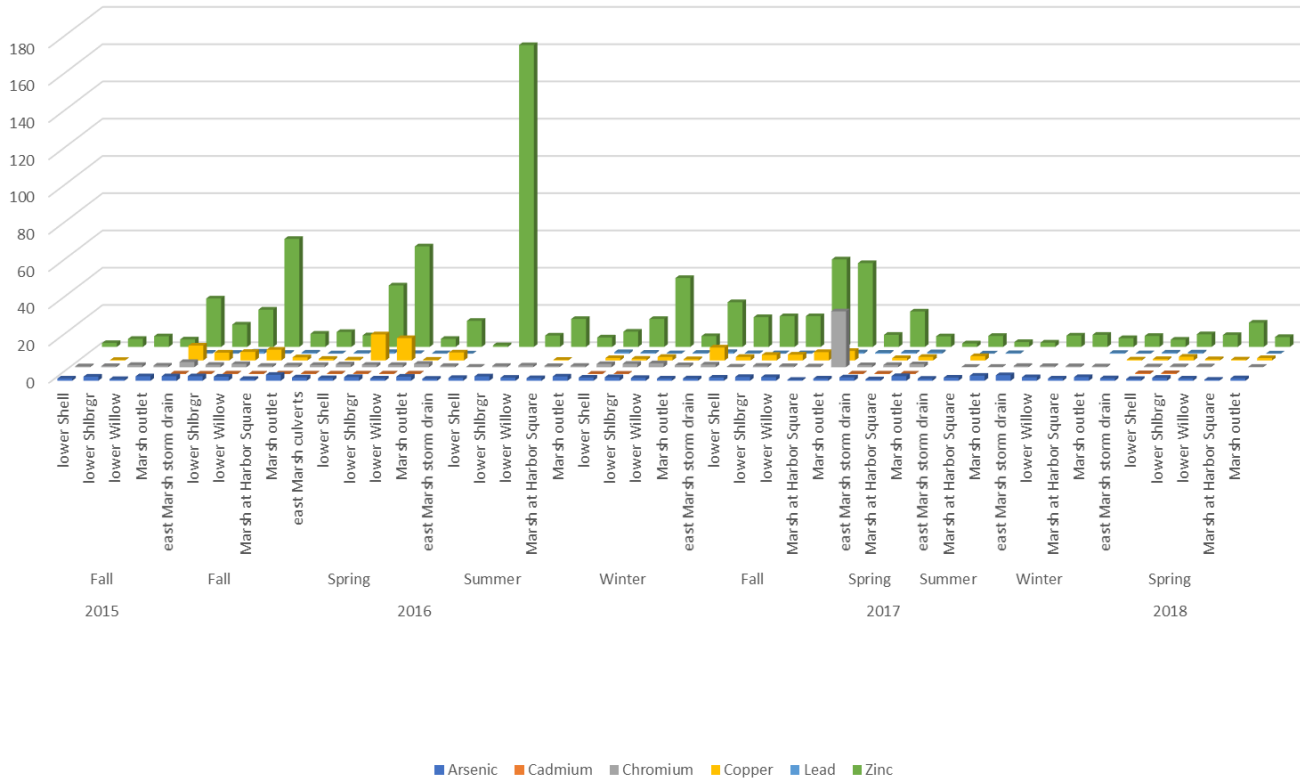
Water samples were collected over twelve seasons and two rainstorm events for analysis by the ALS Laboratory in Everett for heavy metals and petroleum derived compounds. Due to the high cost of pollutant analyses, not all sites could be sampled nor were all tests run on each sample collected.

Fifty-nine water samples were analyzed for 18 different polycyclic aromatic hydrocarbons (PAHs) that are identified as priority pollutants for analysis by the EPA (see Figure 3). Only 10 of these PAHs had WA water quality criteria (human health criteria) designated, and five carcinogenic PAHs (cPAHs) were found in water samples at levels that exceeded those criteria. The five cPAHs that exceeded WA State criteria in the samples were Benzo[a]anthracene, Benzo[a]pyrene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, and Indeno[1,2,3-cd]pyrene. Thirty-nine of the 59 samples (66%) had at least one of these five carcinogenic PAHs that exceeded state criteria. Benzo(a)Pyrene occurred above criteria in all, but five (87%) of the 39 samples.



Sixty-one water samples were analyzed for heavy metals (see Figure 4). All samples had low levels of arsenic, cadmium, chromium, cooper, and lead. Mercury was not detected at any of the sites. Iron and zinc had higher levels detected than the other metals. Further analysis of the occurrence of heavy metals relative to water quality and aquatic organism tolerance are ongoing.

Figure 4. Heavy Metals detected in Water Samples



Water samples were also analyzed for total petroleum hydrocarbons (TPH) and BTEX (Benzene, Ethylbenzene, Toluene, and Xylenes). TPH and BTEX were detected in some, but not all samples. These data will be further analyzed after collection of additional samples.

SHELL CREEK SALMON STEWARDSHIP

Students Saving Salmon began a Salmon Stewardship Project in Shell Creek in 2016 with the goal to enhance chum and coho salmon populations in Edmonds. The project started with students going door-to-door to all of the residences adjacent to lower Shell Creek where anadromous salmon are known to occur. Through contact with streamside residents, students are developing an information base of local knowledge on local salmon populations and engaging with local residents on measures to protect and enhance salmon and their habitat.

Students Saving Salmon efforts to enhance and restore salmon have included removing invasive species along streams, planting native plants to enhance streamside habitat, conducting stream surveys to document salmon and habitat conditions, documenting barriers to salmon passage, evaluating salmon egg hatchboxes to increase salmon production, assisting in juvenile coho salmon rearing at the Willow Creek Salmon Hatchery in Edmonds, and placing juvenile coho salmon from the hatchery in the upper reaches of Shell Creek.

Salmon Surveys - For the past two years, we have surveyed private property owners on lower Shell Creek to obtain local knowledge on coho and chum salmon spawning in the creek. During these surveys we also handed out informational pamphlets about protecting the habitat and distinguishing between the different types of salmon in our creeks. We also requested access to their property, to get salmon counts ourselves (from Oct to Dec) and assess habitat conditions in the spawning areas. Unfortunately, we saw very few salmon or redds this year. While the residents say there are generally more salmon every other year (so fewer salmon isn't too odd), some residents said this was the first time ever that they had seen no salmon at all.

Habitat Restoration - This last fall, Students Saving Salmon worked with Holy Rosary Church, the Edmonds Tree Board, and Sound Salmon Solutions to remove invasive plant species along Shell Creek on the church's property and to then plant native shrubs and trees along the creek. Through this community event, students learned effective methods to control invasive species and restore native vegetation, while helping enhance salmon habitat. The 80+ native plants (trees and shrubs) planted at Holy Rosary were from the 400 native plants funded by a Rose Foundation grant that Sound Salmon Solutions obtained for us. The other 320 native plants were planted by Students Saving Salmon working with Sound Salmon Solutions along Shell Creek at four private residences in April of 2017. Recent visits to the restoration sites indicate the plantings were successful though there were losses from animals (e.g., mountain beavers) eating the young plants (especially dogwoods).

Salmon Enhancement - The water quality data collected by Students Saving Salmon, demonstrating the good quality of water in Shell Creek, was used to convince the Washington Department of Fish and Wildlife to allow the placement of some of the juvenile coho from Willow Creek Salmon Hatchery into upper Shell Creek. The upper areas of Shell Creek have good habitat for spawning and rearing of juvenile salmon, but it has been blocked from access by spawning salmon for many years due to man-made obstacles such as impassable culverts, pipes,

and a five-foot waterfall. Starting in the spring of 2017, students began releasing juvenile coho salmon from the hatchery into Shell Creek. In the spring of 2018, over 1,000 juvenile coho salmon measuring 3-4 inches were released in Shell Creek at various locations including Yost Park, along Sprague Ave., on Holy Rosary Church property, and along Brookmere Drive. These juvenile coho salmon live and grow in freshwater streams for their first year of life and then migrate to the ocean the next year.

Willow Creek Salmon Hatchery - This season Students Saving Salmon started helping Walter Thompson at the Willow Creek Hatchery with incubating coho eggs, transferring coho fry to raceways, preparing the pond for rearing, and then feeding juvenile coho in the rearing pond. Students learned valuable skills about the handling of salmon and the importance of hatcheries in supplementation programs. Students plan to continue working with Walt and Sound Salmon Solutions at the hatchery in the future with hopes that more of the hatchery coho can be released in local creeks in Edmonds to help bring back salmon populations in our area.

OUTREACH

Students Saving Salmon were pleased to be asked to give presentations to a number of local clubs and participate in local events during the 2017/18 school year. We made presentations to the Edmonds Floretum Club, Rotary Club of Edmonds Daybreakers, the Edmonds Chapter of Trout Unlimited, the Puget Sound Anglers Club, and the Olympic Fly Fishers Club. Students also provided opening comments at the rally for the "Taming Bigfoot" effort in Edmonds to reduce our carbon footprint. Students Saving Salmon had booths at the Edmonds Watershed Fun Fair and the Edmonds Waterfront Festival where students interacted with kids and their parents on salmon and their habitat.

RECOMMENDATIONS

The current water quality monitoring project should continue so that annual trends can be evaluated and baseline information established. Having a long-term data series will allow for future comparisons to potential environmental or pollutant driven perturbations and potential effects of climate change. From the student's perspective, the project has provided them valuable field science experience that they can/will apply in the future. Each year new students join Students Saving Salmon to participate in the field studies and activities to conserve our environment.

We appreciate the continued support we've received from the Edmonds City Council and the City of Edmonds and hope the $2,500 provided each year will continue as those funds are critical for obtaining the supplies necessary to conduct this project.

Water quality monitoring to date indicates the principal water parameters (temperature, dissolved oxygen, and pH) in the Creeks adhere to the requirements of the Washington Water Quality standards for salmon. We applaud the residents of Edmonds in helping keep our streams in good condition. These data indicate water quality conditions in these creeks are suitable for salmon and efforts to re-establish viable coho and chum salmon runs should proceed.

The Edmonds Marsh did not conform with State standards in all months monitored. We hope these data will be considered in the studies on ecological functions and restoration planning for the Edmonds Marsh. Better freshwater circulation, increased vegetation (trees and shrubs), and year-round tidal influx of saltwater may help alleviate the Marsh problems.

The occurrence of carcinogenic pollutants that exceed state criteria is an area of concern that warrants further investigation. We will be collecting additional water and sediment samples this year with the $15,000 funding provided by the Edmonds City Council and will report the results of analyses to the Council next year.

Fecal coliform analysis needs to continue in order to better understand when and why the spikes in bacterial counts occur. Although bacterial DNA testing is expensive, it may be beneficial to determine the source of the fecal coliform bacteria in the higher count samples (i.e., is it from dogs, birds, people, or other warm-blooded animals).

The Shell Creek Salmon Stewardship project should continue because the outreach to residents and restoration efforts will benefit existing and future salmon that utilize Shell Creek. We plan to continue helping raise coho salmon at the Willow Creek Hatchery so that releases of juvenile coho salmon in the upper reaches of Shell Creek can further bolster the resident population. We hope to pursue avenues (such as grants) to determine the feasibility and costs of restoration projects to remove passage barriers in the creeks. We also hope to be able to reestablish coho and chum salmon in other creeks in Edmonds.

Continued outreach to our community on the importance of water quality and stream habitat is needed to help restore salmon populations in Puget Sound.