YOUNGS BAY
BENTHIC INVERTEBRATE STUDY

2021

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INTRODUCTION

This report has been created to meet requirements described in the National Pollutant Discharge Elimination System (NPDES) permit #101767 for Clatsop County Fisheries' Tide Point, Bornsteins and Yacht Club net-pen sites in Youngs Bay (Figure 1). It will include an analysis of benthic invertebrate and sediment composition and *Beggiatoa* spp. (mold) presence/absence. Water temperature, pH and total dissolved solids (TDS) data was also collected. Clatsop County Fisheries (CCF) personnel were responsible for collecting all sediment, invertebrate and water quality samples, as well as benthic invertebrate enumeration and identification and determining presence/absence of *Beggiatoa* spp. Analytical Services Environmental (ALS) of Kelso, Washington analyzed sediment samples for grain size distribution and total organic carbon (TOC). Alexin Analytical Laboratories, Inc. of Tigard, Oregon provided total dissolved solids testing. All samples were collected in June/July of 2021.

METHODS

A homemade sampler was used in collecting the benthic data. The sampler was attached to a rope that was lowered into the water until it hit bottom. The rope was then pulled up and down several times along with the upper lead weights to help drive the sampler into the sediment. The sampler was then pulled out of the water. The 3-inch diameter aluminum tube was then loosened and a ring near the top of the sampler, which is attached to a small chain and rubber ball, was pulled to release the water pressure that was helping hold the sediment sample in the sampler. The sampler was pulled away from the aluminum tube while the tube was being held down firmly in a plastic tub. The bottom of the tube was then quickly lifted up while putting a hand under the bottom of the sediment sample. A plunger, which fits firmly inside the aluminum tube, gently pushed the sediment to the top of the tube. The sediment core was then pushed five centimeters beyond the top of the tube. The sediment core was then cut by a plastic scraper into the plastic tub along with the water from above the sediment core.

Each benthic replicate was deposited into a labeled small plastic bucket until all replicates were collected from each site. Each replicate was then rinsed through a 0.5- millimeter mesh screen with a small submersible water pump. The remaining debris and invertebrates were then rinsed into a labeled small plastic container. A buffered formalin solution was added to each replicate container. After one week, each replicate was rinsed and preserved in a Kahle's solution (protein stain) and ethanol until analyzed. The benthic invertebrates from each replicate were sorted and identified to the lowest possible taxonomic classification; usually species.

Sediment samples were taken with a 1 1/2-inch diameter aluminum core sampler approximately 5-centimeter deep for grain size distribution and total organic carbon content. This sampler was lowered into the water until it hit bottom. The sampler was then brought straight up and out of the water. The sediment was pushed out from the bottom by a plunger that fit firmly inside the aluminum tube. The sediment was cut into a small, labeled plastic container. Each container was placed in a cooler with frozen gel packs, then refrigerated until analysis.

Fish culture activities occur at three sites in Youngs Bay: Tide Point, Bornsteins and the Yacht Club (Figures 2 and 3). Sampling was done at the designated outfall, two perimeter, and three reference stations of each site. Three benthic invertebrate and two sediment grab samples were collected at each station.

A sedimentation log was established at the three Youngs Bay sites (Tables 1-3). One grab sample was taken under each net pen with a 1 1/2-inch core sampler. Each core sample was analyzed for presence of sulfur odor, black surface layer and benthic invertebrates. Each grab was deposited back into the water after the observations were completed.

A log that includes water temperature, pH and the presence/absence of the *Beggiatoa* spp. was established for the requirement of our new permit. The water temperature was measured by a hanging thermometer located four feet below the water's surface at the Yacht Club site. An Oakton ecoTestr pH meter stick was used to measure pH. The presence/absence of the mold *Beggiatoa* spp. was determined by lowering an underwater HD camera probe with an above the water viewing screen, Marcum Quest HD, to the bottom of each station.

RESULTS

Results of the Bornsteins, Tide Point and Yacht Club sedimentation observations under each net pen are detailed in Tables 1-3. No hydrogen sulfide odor or black surface layer was observed. All samples contained living organisms.

Table 4 shows that the amphipod *Americorophium salmonis* was the dominant species in five out of the six stations at the Yacht Club site. The largest concentration of the species occurred at perimeter station SUBC 010 with *A. salmonis* at 86,075 per square meter. The grain size distribution varied at the Yacht Club stations with the highest percent sand of 47.2 at the perimeter station 004 and the lowest also at reference station 001 with 13.1 percent. The highest percent silt/clay was found at reference station 001 at 81.3, while the lowest occurred at the reference station 002 with 19.5 percent. The total organic carbon (TOC) was the lowest at reference station 002 at 6.27 milligrams per liter (mg/L), while the highest occurred at the reference station outfall 001 at 20.51 mg/L.

Table 5 shows the aquatic earthworm Oligochaeta as being the dominant benthic invertebrate species in four out of the seven stations at the Tide Point/Bornsteins sites. The highest concentration of a species occurred at the perimeter station 010 with *A. salmonis* at 86,075 per square meter. The grain size distribution varied at each station. The highest percent gravel of 21.85 was at outfall station 003, while the lowest of 0.06 was at reference station 008. The highest percent sand of 61.48 was at reference station 007, and the lowest percent sand of 9.66 was at reference station 006. The highest percent silt/clay of 86.2 was at reference station 006, while the lowest percent silt/clay of 33.6 was at reference station 007. The total organic carbon (TOC) was the highest at perimeter station 010 at 35.0 mg/L, while the lowest was at reference station 007 at 6.02 mg/L.

Table 6 shows the average densities of the five most dominant species per outfall, perimeter, and reference stations in the Youngs Bay system for 2021. *A. salmonis* had

the highest average density of 49,092 per square meter for the outfall stations, 26,038 per square meter for the reference stations, and 35,684 per square meter for the perimeter stations. The highest overall average density for the Youngs Bay system was *A. salmonis* with 34,211 per square meter.

Table 7 shows the total organic carbon (mg/L) for each station since sampling period 2005. Most stations averaged 20 mg/L or less except outfall stations 001, 002, 003, and perimeter station 010.

Tables 8 and 9 show species diversity trends at the three net-pen sites. The outfall station at the Yacht Club site averaged 11 species; the three reference stations averaged 9.3 species, while the perimeter stations averaged 10.5 species. The outfall stations at the Bornsteins and Tide Point sites averaged 9 and 8 species, respectively, while the reference stations averaged 9.3 species and perimeter stations averaged 8.5 species.

Table 10 shows the average densities of the five most common benthic invertebrate species over the last 9 sampling periods in Youngs Bay. The top two benthic invertebrate species over the last 9 sampling periods have been the New Zealand mud snail *Potamopyrgus antipodarum* and *A. salmonis.*

Tables 11 and 12 show the average densities the most dominant benthic invertebrates per outfall, perimeter, and reference stations at both the Yacht Club and Tide Point/Bornstein net-pen sites over the past 5 sampling periods.

Table 13 shows the total dissolved solids measurements of the upstream and downstream side of each net pen site in Youngs Bay.

Table 14 shows the presence/absence results of the mold *Beggiatoa* spp., water temperature and pH readings of the Youngs Bay benthic stations. There was no mold growing under the net pens where the salmon are reared.

Tables 15-21 the statistical analysis using the Wilcoxon test for the Yacht Club site shows a significant difference for number of animals per sample being found between the outfall 001 and the reference stations SUBC 001, 002, and 003, with the most animals being found at the outfall station (Table 15). There was a significant difference found in the species isolation comparison for *P. antipodarum* and Oligochaeta between outfall 001 and the reference stations SUBC 001, 002, and 003, with the most being found at the outfall station (Table 15). There was a significant difference in the species isolation comparison for Oligochaeta between the perimeter station SUBC 004 and the reference stations SUBC 001, 002, and 003 with the most Oligochaeta being at the perimeter station (Table 16). There was a significant difference found in the species isolation comparison for *P. antipodarum* and Oligochaeta between the perimeter station SUBC 005 and the reference stations SUBC 001, 002, and 003, with the most being found at the perimeter station (Table 17). There was a significant difference found in the species isolation comparison for the amphipod *Eogammarus confervicolus* between the reference stations SUBC 001, 002, and 003 and the perimeter station SUBC 004, with the most *E. confervicolus* being found at the reference stations (table 16). There was a significant difference in the dominant species percent of sample between the reference stations

SUBC 001, 002, and 003 and perimeter station SUBC 005, with the perimeter station percent being higher than the reference stations. (Table 17).

The statistical analysis using the Wilcoxon test for the Bornsteins/Tide Point site shows a significant difference for number of animals per sample being found between the perimeter station SUBC 010 and the reference stations SUBC 006, 007, and 008, with the most animals per sample found at the perimeter station (Table 20). There was a significant difference found in the species isolation comparison for *P. antipodarum, A. salmonis,* and *E. confervicolus* between the perimeter station SUBC 010 and the reference stations SUBC 006, 007, and 008, with the most of each species being found at the perimeter station (Table 20). No significant differences were found between outfalls 002 and 003, perimeter station SUBC 009, and reference stations SUBC 006, 007, and 008 (Tables 18, 19, and 21).

DISCUSSION

Over the last 9 sampling periods (16 years), the average percent total organic carbon has been below 20 mg/L in 9 of the 13 stations. Total organic carbon is the amount of carbon found in an organic compound and is often used as a non-specific indicator of water quality. Low TOC can confirm the absence of potentially harmful organic chemicals in the water. It seems that the overall low TOC in Youngs Bay over the last 16 years indicates good water quality.

Since the net pen areas are located in a tidal zone the total dissolved solids measurements reveal that there is some salt-water present. Typically, brackish water ranges between 1000 to 10,000 mg/L. Our readings were between 3,000 and 3,600 mg/L. It would naturally increase with the incoming tide from the ocean and decrease as the salt water moves out and the more freshwater from the upstream streams take over.

The absence of the mold *Beggiatoa spp*. in and around the Youngs Bay net pens is a good indication that the salmon rearing is not affecting the benthic environment below. These sites have been in operation for over 20 years. The tidal movement is very strong in this area, at times, and has a good effect on keeping the extra nutrient waste from the fish being reared swept away from under the net pens.

The overall differences in species abundance and diversity in Youngs Bay can be attributed to many factors. The location of each site, tidal flows, daily movements of certain benthic invertebrates, lunar phases, amount of natural debris and sediment within the water column, the extra nutrient load of fish waste (both natural and net pen) and exotic species all influence species abundance and diversity within the Youngs Bay system.

This year's (2021) sampling results showed *A. salmonis* being the overall dominant benthic invertebrate in the Youngs Bay system. *A. salmonis* was dominant in eight out

of the thirteen total stations, followed by Oligochaeta being dominant in four stations and *P. antipodarum* being dominant in one station.

Since the first sampling period in 2005, *P. antipodarum* and *A. salmonis* have shared the role as being the most dominant benthic invertebrate species in the Youngs Bay system. The results of this sampling period showed that there were twice as many *A. salmonis* found than the previous sampling year, and very similar numbers of *P. antipodarum.* However, the results for both the *A. salmonis* and *P. antipodarum* were the second highest since the sampling began in 2005, and Oligochaeta coming in with the third highest number is as many years (Table 10). These 3 species of invertebrates are all bottom dwellers and it would seem logical that the 3 species would be competing for space on the bottom of the bay. The numbers between the 3 species are going to fluctuate naturally annually.

A. salmonis serves as an important food source for young salmon, both wild and hatchery, that are rearing in the estuary. As long as it remains as one of the dominant species in Youngs Bay, the overall condition of the bay seems to remain natural even with the existence of the exotic species *P. antipodarum*.

P. antipodarum is adaptable to a wide variety of environmental conditions. They have been known to be eaten by fish and survive to reproduce after going through the fish's digestive system. These characteristics alone are reasons why this invertebrate species have been prolific in the Youngs Bay system. Clatsop County Fisheries staff continues to notice the mud snails attached to the net-pen poles and nets hanging in the water. The overall high densities of this species have seemed consistent with previous sampling years.

Overall, the impact of the salmon net pens in Youngs Bay seem to stay within the allowable mixing zone of 50 feet surrounding each array of net pens. Species diversity seems to be consistent through the outfall, reference, and perimeter stations, although the abundances are higher at outfalls and perimeter stations. It was found that the reference stations have a lower abundance in comparison to the outfalls and perimeter stations. Nutrients from fish food and waste, along with a diversity of structures under and around the net pens, are possible reasons for this occurrence at all of the Youngs Bay net pens.

The next sampling will occur in the year 2023, unless fish production increases. If this occurs then the samplings will continue annually.

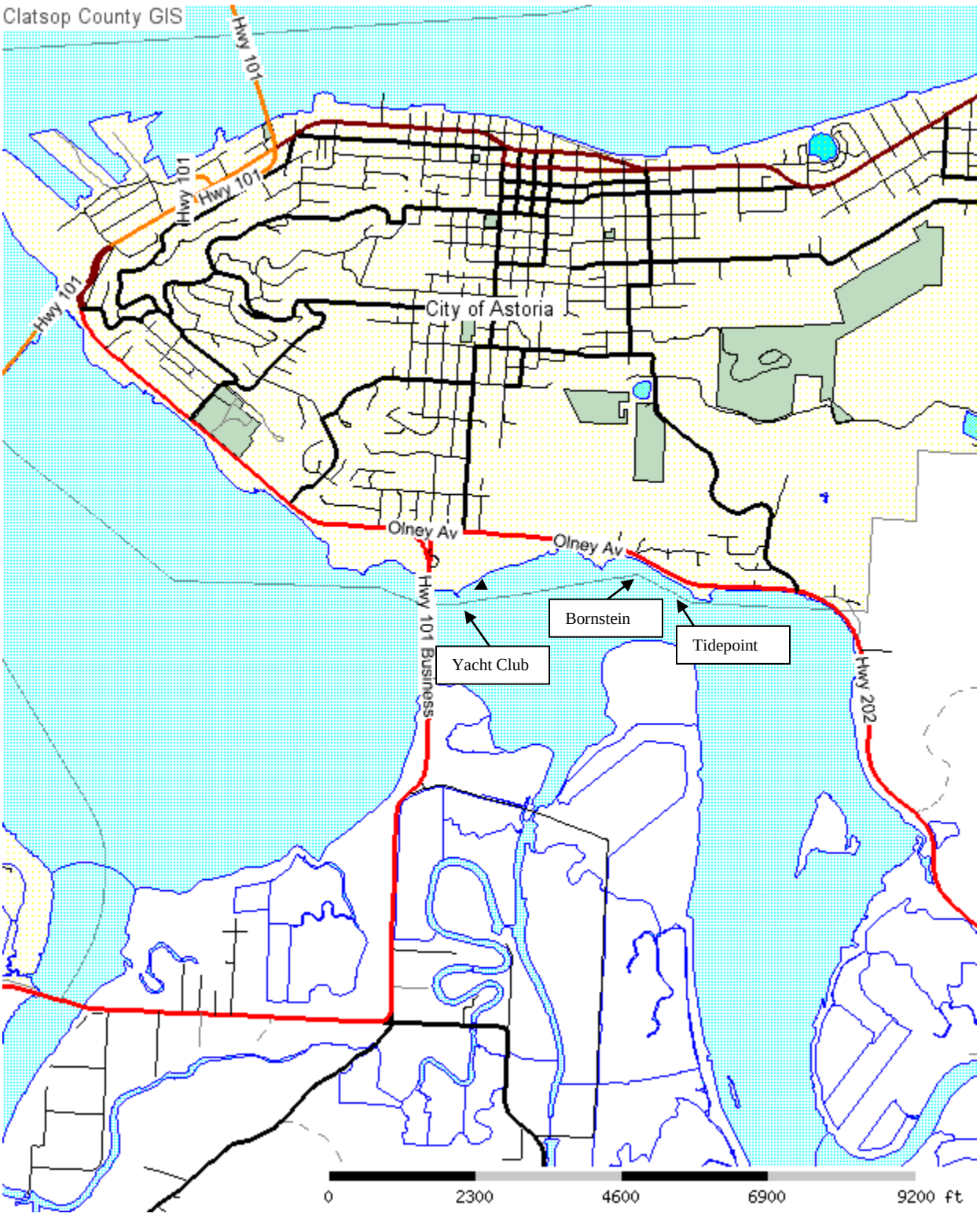


Figure 1. Youngs Bay Net-Pen Sites

YOUNGS BAY - TIDE POINT AND BORNSTEIN SITES

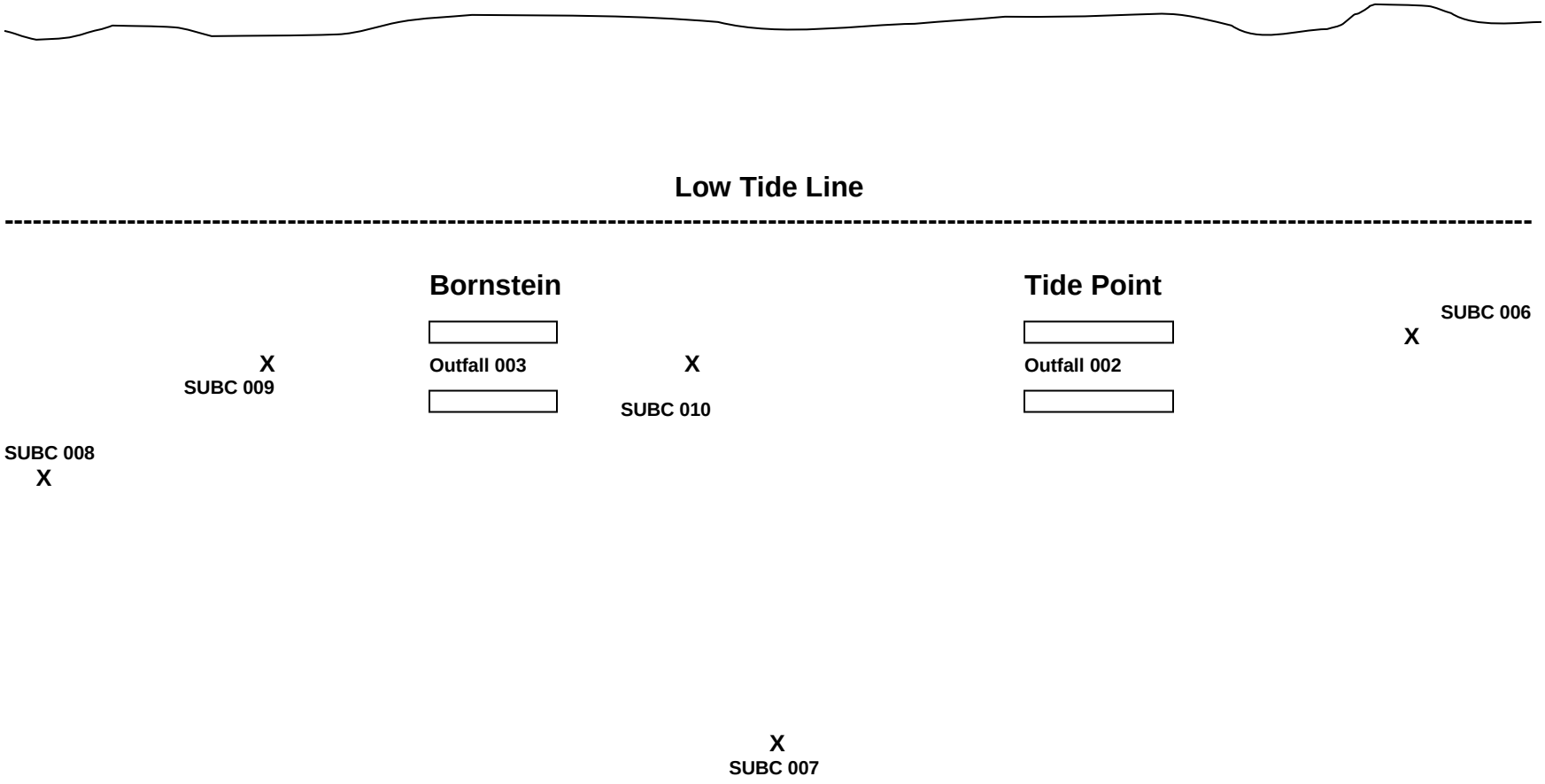


Figure 2. Tide Point/Bornstein Site Stations.

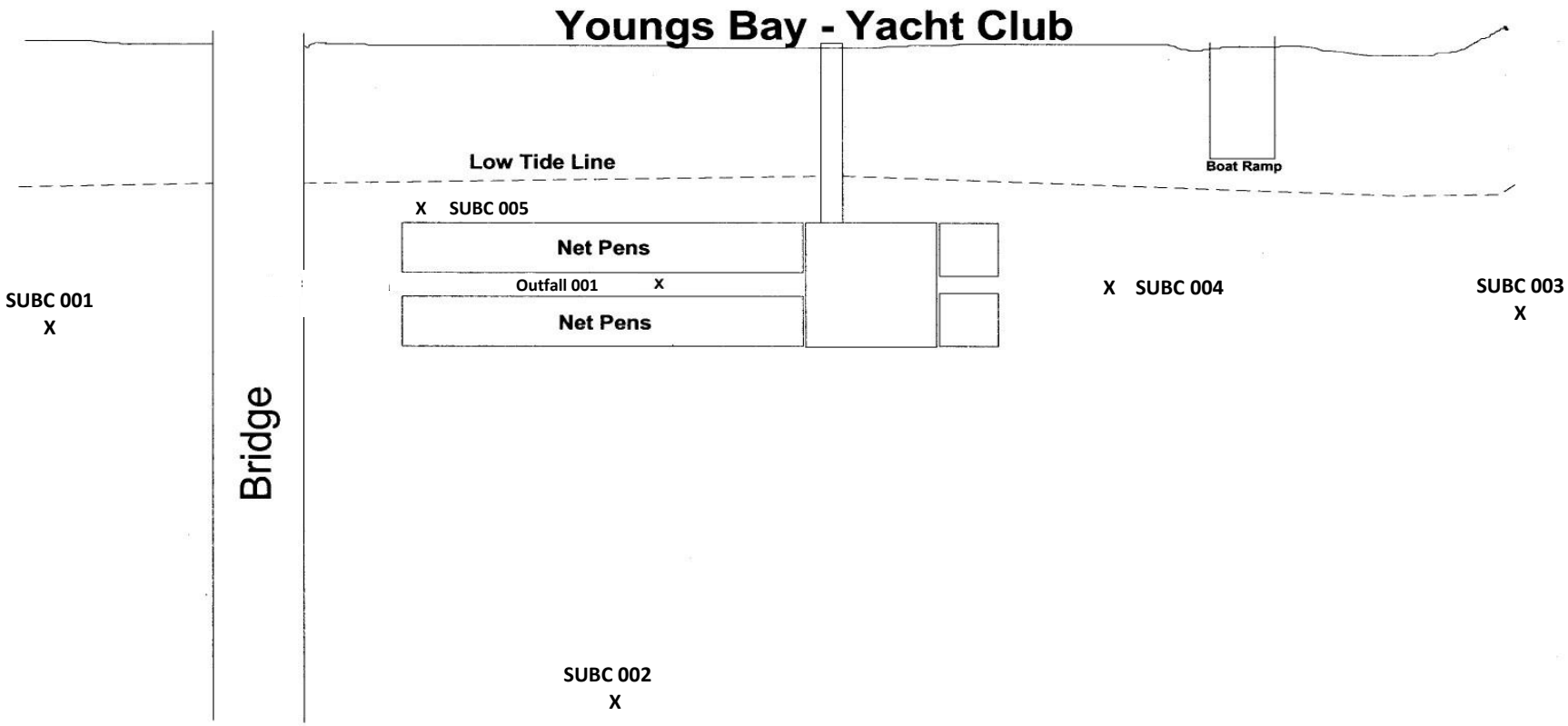
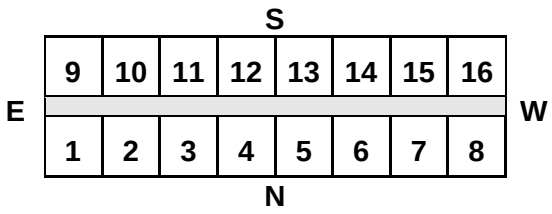


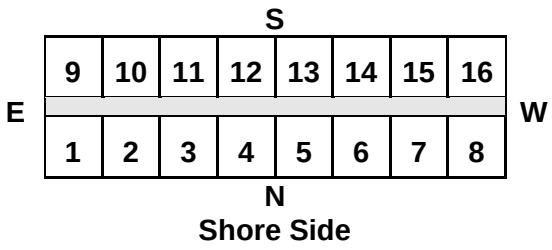
Figure 3. Yacht Club Site Stations

Table 1. Tide Point Sedimentation Log Sheet 2021.



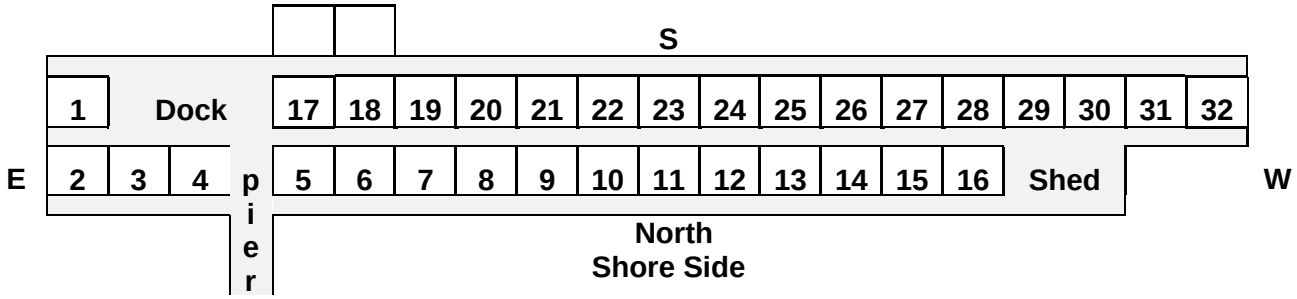
Pen #	H_2S odor	Black Surface Layer	Living Organisms Present	Depth of Oxidized Layer	Comments
1	No	No	Yes	1.5 cm	Lt brn top, two clams, sticky dk gry clay bottom, 4 cm
2	No	No	Yes	1.5 cm	Lt brn top, dk gry clay bottom w/ woody debris, 10 cm
3	No	No	Yes	1.5 cm	Lt brn top, plant debris, cordylophora, barnacles, dk gry clay bottom, 9 cm
4	No	No	Yes	1.5 cm	Lt brn top, cordylophora, clam, dk gry clay bottom, 9 cm
5	No	No	Yes	1.5 cm	Lt brn/ soft top, some wood chunks, hard bottom difficult to sample, 8 cm
6	No	No	Yes	2 cm	Lt brn top w/ cordylophora, dk gry clay bottom w/ wood chunks/gravel, 11 cm
7	No	No	Yes	1.5 cm	Lt brn top w/ plant debris, dk gry clay bottom w/ sticks, 7 cm
8	No	No	Yes	1.5 cm	Lt brn top w/ shale, hard dk gry clay bottom, 13 cm
9	No	No	Yes	2 cm	Lt brn top w/ cordylophora, dk gry clay w/ wood and brown clay, 7 cm
10	No	No	Yes	2 cm	Lt brn top, New Zealand mud snails, dk gry/ brown clay bottom, 9 cm
11	No	No	Yes	1 cm	Lt brn top w/ dead clam, dk gry clay w/ sticks, 7 cm
12	No	No	Yes	0.5 cm	Very hard layer to bust through, clay bottom w/ sticks, 7 cm
13	No	No	Yes	1 cm	Lt brn top w/ cordylophora, dk gry clay bottom, 11 cm
14	No	No	Yes	1.5 cm	Lt brn top w/ cordylophora, dk gry clay bottom w/ wood chips, 7 cm
15	No	No	Yes	1 cm	Lt brn top w/ cordylophora, dk/ light gry clay bottom, 8 cm
16	No	No	Yes	1 cm	Lt brn top w/ plant and sandstone, dk gry clay w/ detritus, 6 cm

Table 2. Bornsteins Sedimentation Log Sheet 2021



Pen #	H_2S odor	Black Surface Layer	Living Organisms Present	Depth of Oxidized Layer	Comments
1	No	No	Yes	3 cm	* Lt brn top with gravel, drk gry clay btm with shale 10 cm
2	No	No	Yes	2 cm	Lt brn top, clam, drk gry btm with hard black bits, 9 cm
3	No	No	Yes	2 cm	* Lt brn top, plants, drk gry clay btm w/ hard black bits, 10 cm
4	No	No	Yes	1.5 cm	Lt brn top, cordylophora, drk gry clay btm with gravel, 7 cm
5	No	No	Yes	1.5 cm	Lt brn top, drk gry btm with gravel, 4 cm
6	No	No	Yes	0.5 cm	Mostly gravel with minimal clay, 4 cm
7	No	No	Yes	1.5 cm	Lt brn top, little plant, drk gry clay with barnacles, 8 cm
8	No	No	Yes	2 cm	Lt brn top, very soft, thick and sticky gry clay btm, 9 cm
9	No	No	Yes	0.5 cm	Lt brn top, some gry clay, gravel, 4 cm
10	No	No	Yes	2 cm	* Lt brn top, some plants, drk gry clay btm with gravel, 14 cm
11	No	No	Yes	0.5 cm	Lt brn top, drk gry clay with woody debris, 5 cm
12	No	No	Yes	1 cm	Lt brn top, drk gry clay with sandstone, gravel, and shale, 6 cm
13	No	No	Yes	0.5 cm	Lt brn top, minimal clay with rock and shale, 5 cm
14	No	No	Yes	0.5 cm	Lt brn top, minimal clay with rock and shale, w/ small clam 5 cm
15	No	No	Yes	1.5 cm	Lt brn top, very soft with drk gry clay btm, 9 cm
16	No	No	Yes	1.5 cm	Lt brn top, very soft with gry clay btm with detritus, 10 cm

Table 3. Yacht Club Sedimentation Log Sheet 2021.



Pen #	H_2S odor	Black Surface Layer	Living Organisms Present	Depth of Oxidized Layer	Comments
1	No	No	Yes	1 cm	lt brn top, very soft dk gry clay w/ detritus and plant matter, 9 cm
2	No	No	Yes	1 cm	lt brn top, clam, plant/wood debris, dk grey btm, 12 cm
3	No	No	Yes	1 cm	lt brn top, some plant matter, dk grey btm, 10 cm
4	No	No	Yes	1.5cm	lt brn top, some detritus, extra soft dk grey btm, 9 cm
5	No	No	Yes	2 cm	lt brn top, plant debris, dk clay btm w/ wood, 14.5 cm
6	No	No	Yes	1 cm	lt brn top, brkn clam shells, lt woody debris, dk grey btm, 6 cm
7	No	No	Yes	1.5 cm	lt brn top, woody and plant debris, dk grey btm, 5 cm
8	No	No	Yes	1.5 cm	lt brn top, thin plants, dk grey btm, 10.5 cm
9	No	No	Yes	1 cm	lt brn top, fine woody debris, dk grey btm, 6.5 cm
10	No	No	Yes	1 cm	lt brn top, fine woody debris, dk grey btm, 5.5 cm
11	No	No	Yes	1 cm	lt brn top, thin plant matter, dk grey clay btm, 7.5 cm
12	No	No	Yes	1 cm	lt brn top, plant matter, detritus, dk clay btm, 9 cm
13	No	No	Yes	1 cm	lt brn top, woody debris, clay btm w/ detritus, 4 cm
14	No	No	Yes	1 cm	lt brn top, plat matter, dk grey clay btm, 8 cm
15	No	No	Yes	1 cm	lt brn top, dk grey clay btm, 7.5 cm
16	No	No	Yes	1 cm	lt brn top, very little plat on top, dk grey clay btm, 7 cm
17	No	No	Yes	2 cm	lt brn top, some plants, dk grey clay btm w/ detritus, 12 cm
18	No	No	Yes	2 cm	lt brn top, some plant debris, dk grey clay btm w/ wood, 9 cm
19	No	No	Yes	1 cm	lt brn top, some plant debris, dk clay btm w/ detritus, 9 cm
20	No	No	Yes	2 cm	lt brn top, woody debris, dk clay btm, 8 cm
21	No	No	Yes	0.5 cm	lt brn top, minimal debris, dk clay btm, 9 cm
22	No	No	Yes	1 cm	lt brn top, little plant debris, softer dk clay btm, 8 cm
23	No	No	Yes	0.5 cm	lt brn top, plant debris, dk clay btm, 10 cm
24	No	No	Yes	3 cm	lt brn top, woody detritus, dk grey clay btm, 6 cm
25	No	No	Yes	1 cm	lt brn top, w/ black detritus, barnacles, dk grey clay btm, 13 cm
26	No	No	Yes	3 cm	lt brn top, w/ plants, dk grey clay btm, 10 cm
27	No	No	Yes	1.5 cm	lt brn top, w/ plant/ woody debris, dk grey clay btm, 10 cm
28	No	No	Yes	2 cm	lt brn top w/ woody debris, grey clay btm, 6 cm
29	No	No	Yes	3 cm	lt brn top w/ barnacles, some plant debris, sandy clay btm, 15 cm
30	No	No	Yes	1 cm	lt brn top, black detritus w/ clay btm, 5 cm
31	No	No	Yes	1.5 cm	lt brn top w/ some detritus, dk grey clay btm, 7 cm
32	No	No	Yes	5 cm	lt brn top w/ detritus, dk grey clay btm, 7 cm

Table 4. 2021 Yacht Club Percent Grain Size Distribution and Total Organic Carbon.

STATION	%Gravel	%Sand	%Silt/Clay	TOC mg/L	Most Dominant Species	Density #/sq.meter
Outfall 001	0.20%	31.93%	59.02%	20.51	Americorophium salmonis	85,298
SUBC 001	0.08%	13.10%	81.31%	12.90	Americorophium salmonis	74,706
SUBC 002	1.00%	80.13%	19.46%	6.27	Americorophium salmonis	7,759
SUBC 003	0.03%	31.91%	63.30%	11.20	Americorophium salmonis	25,022
SUBC 004	0.07%	47.20%	53.56%	12.90	Americorophium salmonis	16,601
SUBC 005	0.19%	42.07%	60.11%	18.80	Potamopyrgus antipodarum	54,857

Table 5. 2021 Tide Point/Bornsteins Percent Grain Size Distribution and Total Organic Carbon.

STATION	%Gravel	%Sand	%Silt/Clay	TOC mg/L	Most Dominant Species	Density #/sq.meter
Outfall 002	2.24%	18.81%	79.62%	25.60	Oligochaeta	24,120
SUBC 008	0.06%	13.22%	79.17%	18.40	Oligochaeta	19,308
SUBC 009	0.11%	16.81%	78.93%	16.00	Oligochaeta	13,474
Outfall 003	21.85%	43.13%	35.22%	28.70	Americorophium salmonis	58,466
SUBC 006	0.12%	9.66%	86.18%	15.90	Americorophium salmonis	47,759
SUBC 007	0.13%	61.48%	33.61%	6.02	Oligochaeta	9,444
SUBC 010	9.27%	29.79%	55.87%	35.00	Americorophium salmonis	86,075

Table 6. 2021 Average densities of Youngs Bay dominant species.

SPECIES	OUTFALL	REFERENCE	PERIMETER	OVERALL
Potamopyrgus antipodarum	34,967	12,632	34,489	25,434
Americorophium salmonis	49,092	26,038	35,684	34,211
Oligochaeta	21,473	6,576	16,120	12,131
Eogammarus confervicolis	2,065	1,424	2,135	1,772
Nereis limnicola	681	1,073	842	1,596

Table 7. 2005-2021 Youngs Bay Total Organic Carbon Measurements (mg/L).

STATION	2005	2007	2009	2011	2013	2015	2017	2019	2021	AVERAGE
Outfall 001	11.00	23.70	20.40	24.00	17.50	18.20	23.00	18.30	25.10	20.13
SUBC 001	11.50	13.70	10.60	14.60	18.20	10.00	9.70	2.00	12.90	11.47
SUBC 002	9.10	12.10	16.60	12.90	14.00	9.00	13.90	12.00	6.27	11.76
SUBC 003	16.90	12.10	12.80	14.70	14.80	12.30	12.00	25.40	11.20	14.69
SUBC 004	13.70	12.60	13.60	13.10	22.70	14.70	14.80	11.90	12.90	14.44
Outfall 002	24.70	20.20	21.60	67.50	N/A	N/A	N/A	18.90	25.60	29.75
SUBC 006	18.60	18.10	19.10	17.90	22.40	18.20	17.90	15.70	15.90	18.20
SUBC 007	14.80	8.30	10.70	7.40	10.30	8.70	9.20	7.30	6.02	9.19
SUBC 008	11.40	16.30	19.00	17.80	27.60	14.60	15.60	15.30	18.40	17.33
SUBC 009	18.20	16.20	14.90	16.60	16.40	15.40	17.10	19.60	16.00	16.71
SUBC 010	12.90	10.10	9.30	53.10	18.60	21.30	53.20	120.90	35.00	37.16
Outfall 003	31.1	19.5	44.5	44.90	21.3	27.70	14.50	56.80	28.70	32.11

Table 8. 2021 Yacht Club Benthic Invertebrate Denstities and Diversities.

	Outfall 001	SUBC 001	SUBC 002	SUBC003	SUBC 004
TAXON	**#/Sq.M**	**#/Sq.M**	**#/Sq.M**	**#/Sq.M**	**#/Sq.M**
Potamopyrgus antipodarum	54135	20932	4211	11368	9744
Hobsonia florida	722	120	602	2707	2226
Oligochaeta	37714	120	481	301	8421
Americorophium salmonis	85293	74706	7759	25022	16601
Eogammarus confervicolus	3789	5714	361	1323	60
Nereis limnicola	1805	361	2226	602	1564
Coullana canadensis	60	0	301	0	0
Nemertinea	0	0	0	0	0
Turbellaria, Rhabdocoela	0	0	0	0	0
Corbicula fluminea	120	0	60	0	180
Marenzelleria viridis	0	0	0	0	0
Gnorimospaeroma insulare	60	60	0	0	0
Hydroida colony	0	0	0	0	0
Macoma balthica	0	0	60	60	60
Nematoda	180	60	180	0	60
Cumacea	120	60	60	60	421
Insecta, terrestrial adult	0	0	0	0	0
Idotea sp.	0	0	0	0	0
Saduria entomon	0	0	0	0	60
Total/Sq.M	**183999**	**102135**	**16301**	**41443**	**39398**
Number of Species	**11**	**9**	**11**	**8**	**11**
1st Species % of Population	**46.4**	**73.1**	**47.6**	**60.4**	**42.1**
1st + 2nd % of Population	**75.8**	**93.6**	**73.4**	**87.8**	**66.9**
1st+ 2nd + 3rd % of Population	**52.0**	**99.2**	**87.1**	**94.3**	**88.2**

Table 9. 2021 Tide Point/Bornsteins Benthic Invertebrate Densities and Diversities.

	Outfall 003	SUBC 006	SUBC 007	SUBC 008	SUBC 009	SUBC 010	Outfall 002
TAXON	**#/Sq.M**	**#/Sq.M**	**#/Sq.M**	**#/Sq.M**	**#/Sq.M**	**#/Sq.M**	**#/Sq.M**
Potamopyrgus antipodarum	31158	28271	7278	3729	12511	72842	19609
Oligochaeta	2586	9804	9444	19308	13474	13413	24120
Americorophium salmonis	58466	47759	662	481	1865	86075	7519
Eogammarus confervicolis	2165	1143	0	0	0	4090	241
Hobsonia florida	962	6617	722	1805	1865	662	361
Nereis limnicola	541	722	2286	421	541	842	60
Cumacea	120	60	0	361	842	120	0
Corbicula fluminea	301	60	120	180	120	241	0
Macoma bathica	0	0	0	0	0	0	0
C. canadensis	0	60	120	120	0	0	60
Chironomidae larvae	0	0	0	0	0	0	0
Balanus	0	0	0	0	0	0	0
Gnorimosphaeroma insulare	180	60	0	0	0	120	0
Hydracarina	0	0	0	0	0	0	0
Nematoda	0	481	0	120	0	541	120
Nemertinea	0	0	0	0	0	0	0
Entomobryidae	0	0	0	0	0	0	0
Hemimysis anamola	0	0	0	60	0	0	0
Total/Sq.M	**96481**	**95097**	**20631**	**26586**	**31218**	**179006**	**52090**
Number of Species	**9**	**11**	**7**	**10**	**7**	**10**	**8**
1st Species % of Population	**60.6**	**50.2**	**45.8**	**72.6**	**43.2**	**48.1**	**46.3**
1st + 2nd % of Population	**92.9**	**79.9**	**81.0**	**86.7**	**83.2**	**88.8**	**83.9**
1st+ 2nd + 3rd % of Population	**95.6**	**90.3**	**92.1**	**93.4**	**89.2**	**96.3**	**98.4**

Table 10. Youngs Bay Benthic Invertebrate Densities Per Station, 2005-21.

Species	2005	2007	2009	2011	2013	2015	2017	2019	2021
Potamopyrgus antipodarum	24,941	26,721	20,601	15,699	11,325	21,223	8,186	21,214	25,434
Americorophium salmonis	15,377	20,854	22,115	8,692	18,723	35,873	5,020	17,839	34,211
Oligochaeta	13,160	12,969	10,471	4,426	9,662	4,969	1,039	2,260	12,131
Eogammarus confervicolis	12,929	2,698	907	767	60	1,704	421	1,213	1,772
Hobsonia florida	13,074	2,697	907	767	87	2,142	421	360	1,596
Nereis limnicola	670	1,138	416	1,117	661	1,897	355	1,072	990

Table 11. Yacht Club Most Dominant Benthic Invertebrate Species Per Station, 2011-21.

Station	2011 Species	2011 Density	2015 Species	2015 Density	2017 Species	2017 Density	2019 Species	2019 Density	2021 Species	2021 Density
Outfall 001	P. antipodarum	67,127	P. antipodarum	60,872	P. antipodarum	16180	P. antipodarum	43,970	A. salmonis	85,293
SUBC 001	A. salmonis	15,880	A. salmonis	25,985	A. salmonis	12271	P. antipodarum	11,007	A. salmonis	74,706
SUBC 002	A. salmonis	16,782	A. salmonis	51,128	P. antipodarum	962	A. salmonis	7,759	A. salmonis	7,759
SUBC 003	A. salmonis	15,398	A. salmonis	22,316	P. antipodarum	8000	P. antipodarum	22,195	A. salmonis	25,022
SUBC 004	P. antipodarum	16,962	A. salmonis	38,075	A. salmonis	13594	P. antipodarum	42,827	A. salmonis	16,601
SUBC 005	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	P. antipodarum	54,857

Table 12. Tide Point/Bornsteins Most Dominant Benthic Invertebrate Species Per Station, 2011-21.

Station	2011 Species	2011 Density	2015 Species	2015 Density	2017 Species	2017 Density	2019 Species	2019 Density	2021 Species	2021 Density
Outfall 002	P. antipodarum	8,000	N/A	N/A	N/A	N/A	A. salmonis	37,293	Oligochaeta	24,120
Outfall 003	Oligochaeta	11,188	A. salmonis	60,872	P. antipodarum	10,226	A. salmonis	31,338	A. salmonis	58,466
SUBC 006	A. salmonis	2,346	A. salmonis	26,105	P. antipodarum	6,015	A. salmonis	35,970	A. salmonis	47,759
SUBC 007	N. limnicola	5,835	A. salmonis	20,571	P. antipodarum	3,970	Oligochaeta	5,053	Oligochaeta	9,444
SUBC 008	P. antipodarum	3,429	A. salmonis	19,428	P. antipodarum	3,609	P. antipodarum	12,692	Oligochaeta	19,308
SUBC 009	A. salmonis	9,564	A. salmonis	14,737	P. antipodarum	6,316	P. antipodarum	21,714	Oligochaeta	13,474
SUBC 010	P. antipodarum	48,661	A. salmonis	33,263	P. antipodarum	13,474	P. antipodarum	37,534	A. salmonis	86,075

Table 13. Total Dissolved Solids Measurements Of Each Net Pen Site in Youngs Bay, 2021.

Net Pen Site	Upstream (mg/L)		Downstream (mg/L)
Tide Pt.	3,340		3,150
Bornstein's	3,310		3,480
Yacht Club	3,470		3,560

Table 14. Youngs Bay *Beggiatoa* spp.,Water Temperature, pH Log Sheet, 2021.

Station	Beggiatoa sp. Present	Water Temp C.	pH
Outfall 001	No	18.3	7.2
SUBC 001	No	18.3	7.2
SUBC 002	No	18.3	7.2
SUBC 003	No	18.3	7.2
SUBC 004	No	18.3	7.2
SUBC 005	No	18.3	7.2
Outfall 003	No	18.3	7.2
SUBC 007	No	18.3	7.2
SUBC 008	No	18.3	7.2
SUBC 009	No	18.3	7.2
SUBC 010	No	18.3	7.2
Outfall 002	No	18.3	7.2
SUBC 006	No	18.3	7.2

Table 15 Outfall 001 / Reference Condition Comparisons

Null Hypothesis: There is no difference between the Reference Stations and Outfall 001 in the Number of Animals/Sample

Station Designation	SUBC 001			SUBC 002			SUBC003			Outfall 001					
Number of Animals/Sample	461	357	880	23	91	157	192	228	269	1926	529	604	✂ =	0.05	
Excel Rank	8	7	11	1	2	3	4	5	6	12	9	10		8	Tabular Value
Matches	1	1	1	1	1	1	1	1	1	1	1	1	T=	31	
Wilcoxon Rank	8	7	11	1	2	3	4	5	6	12	9	10	T'=	8	
				T=	47					T=	31				**Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and Outfall 001 in the Number of Species/Sample

Station Designation	SUBC 001			SUBC 002			SUBC003			Outfall 001					
Number of Species/Sample	5	7	6	5	9	8	7	6	6	9	9	8	✂ =	0.05	
Excel Rank	1	6	3	1	10	8	6	3	3	10	10	8		8	Tabular Value
Matches	2	2	3	2	3	2	2	3	3	3	3	2	T=	30.5	
Wilcoxon Rank	1.5	6.5	4	1.5	11	8.5	6.5	4	4	11	11	8.5	T'=	8.5	
				T=	47.5					T=	30.5				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and Outfall 001 in the Dominant Species % of Sample

Station Designation	SUBC 001			SUBC 002			SUBC003			Outfall 001					
Dominant Species % of Sample	15	18.8	24.1	17.4	24.2	28	12	29.4	36.8	25.3	27.6	44	✂ =	0.05	
Excel Rank	2	4	5	3	6	9	1	10	11	7	8	12		8	Tabular Value
Matches	1	1	1	1	1	1	1	1	1	1	1	1	T=	27	
Wilcoxon Rank	2	4	5	3	6	9	1	10	11	7	8	12	T'=	12	
				T=	51					T=	27				**Do Not Reject Null Hypothesis**
					N=9						N=3				

The dominant species may not be the same for every station

Null Hypothesis: There is no difference between the Reference Stations and Outfall 001 in the Species indicated

Station Designation	SUBC 001			SUBC 002			SUBC003			Outfall 001					
Potamopyrgus antipodarum	69	67	212	4	22	44	23	67	99	488	146	266	✂ =	0.05	
Excel Rank	7	5	10	1	2	4	3	5	8	12	9	11		8	Tabular Value
Matches	1	2	1	1	1	1	1	2	1	1	1	1	T=	32	
Wilcoxon Rank	7	5.5	10	1	2	4	3	5.5	8	12	9	11	T'=	7	
				T=	46					T=	32				**Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and Outfall 001 in the Species indicated

Station Designation	SUBC 001			SUBC 002			SUBC003			Outfall 001					
Hobsonia florida	2	0	0	2	6	2	21	12	12	2	6	4	✂ =	0.05	
Excel Rank	3	1	1	3	8	3	12	10	10	3	8	7		8	Tabular Value
Matches	4	2	2	4	2	4	1	2	2	4	2	1	T=	20	
Wilcoxon Rank	4.5	1.5	1.5	4.5	8.5	4.5	12	10.5	10.5	4.5	8.5	7	T'=	19	
				T=	58					T=	20				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and Outfall 001 in the Species indicated

Station Designation	SUBC 001			SUBC 002			SUBC003			Outfall 001					
Oligochaeta	0	1	1	2	6	0	1	4	0	19	354	254	✂ =	0.05	
Excel Rank	1	4	4	7	9	1	4	8	1	10	12	11		8	Tabular Value
Matches	3	3	3	1	1	3	3	1	3	1	1	1	T=	33	
Wilcoxon Rank	2	5	5	7	9	2	5	8	2	10	12	11	T'=	6	
				T=	45					T=	33				**Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and Outfall 001 in the Species indicated

Station Designation	SUBC 001			SUBC 002			SUBC003			Outfall 001					
Americorophium salmonis	367	268	607	3	30	96	137	127	152	1351	2	65	✂ =	0.05	
Excel Rank	10	9	11	2	3	5	7	6	8	12	1	4		8	Tabular Value
Matches	1	1	1	1	1	1	1	1	1	1	1	1	T=	17	
Wilcoxon Rank	10	9	11	2	3	5	7	6	8	12	1	4	T'=	22	
				T=	61					T=	17				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and Outfall 001 in the Species indicated

Station Designation	SUBC 001			SUBC 002			SUBC003			Outfall 001					
Eogammarus confervicolus	20	18	57	0	4	2	6	13	3	59	0	4	✂ =	0.05	
Excel Rank	10	9	11	1	5	3	7	8	4	12	1	5		8	Tabular Value
Matches	1	1	1	2	2	1	1	1	1	1	2	2	T=	19	
Wilcoxon Rank	10	9	11	1.5	5.5	3	7	8	4	12	1.5	5.5	T'=	20	
				T=	59					T=	19				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Table 16 SUBC 004 / Reference Condition Comparisons

Null Hypothesis: There is no difference between the Reference Stations and SUBC 004 in the Number of Animals/Sample

Station Designation	SUBC 001			SUBC 002			SUBC 003			SUBC 004					
Number of Animals/Sample	461	357	880	23	91	157	192	228	269	231	236	188	✂ =	0.05	
Excel Rank	11	10	12	1	2	3	5	6	9	7	8	4		8	Tabular Value
Matches	1	1	1	1	1	1	1	1	1	1	1	1	T=	19	
Wilcoxon Rank	11	10	12	1	2	3	5	6	9	7	8	4	T'=	20	
				T=	59					T=	19				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and SUBC 004 in the Number of Species/Sample

Station Designation	SUBC 001			SUBC 002			SUBC 003			SUBC 004					
Number of Species/Sample	5	7	6	5	9	8	7	6	6	8	7	8	✂ =	0.05	
Excel Rank	1	6	3	1	12	9	6	3	3	9	6	9		8	Tabular Value
Matches	2	3	3	2	1	3	3	3	3	3	3	3	T=	27	
Wilcoxon Rank	1.5	7	4	1.5	12	10	7	4	4	10	7	10	T'=	12	
				T=	51					T=	27				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and SUBC 004 in the Dominant Species % of Sample

Station Designation	SUBC 001			SUBC 002			SUBC 003			SUBC 004					
Dominant Species % of Sample	15	18.8	24.1	17.4	24.2	28	12	29.4	36.8	29.9	22.9	20.7	✂ =	0.05	
Excel Rank	2	4	7	3	8	9	1	10	12	11	6	5		8	Tabular Value
Matches	1	1	1	1	1	1	1	1	1	1	1	1	T=	22	
Wilcoxon Rank	2	4	7	3	8	9	1	10	12	11	6	5	T'=	17	
				T=	56					T=	22				**Do Not Reject Null Hypothesis**
					N=9						N=3				

The dominant species may not be the same for every station

Null Hypothesis: There is no difference between the Reference Stations and SUBC 004 in the Species indicated

Station Designation	SUBC 001			SUBC 002			SUBC 003			SUBC 004					
Potamopyrgus antipodarum	69	67	212	4	22	44	23	67	99	69	54	39	✂ =	0.05	
Excel Rank	9	7	12	1	2	5	3	7	11	9	6	4		8	Tabular Value
Matches	2	2	1	1	1	1	1	2	1	2	1	1	T=	19.5	
Wilcoxon Rank	9.5	7.5	12	1	2	5	3	7.5	11	9.5	6	4	T'=	19.5	
				T=	58.5					T=	19.5				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and SUBC 004 in the Species indicated

Station Designation	SUBC 001			SUBC 002			SUBC 003			SUBC 004					
Hobsonia florida	2	0	0	2	6	2	21	12	12	9	13	15	✂ =	0.05	
Excel Rank	3	1	1	3	6	3	12	8	8	7	10	11	🖋	8	Tabular Value
Matches	3	2	2	3	1	3	1	2	2	1	1	1	T=	28	
Wilcoxon Rank	4	1.5	1.5	4	6	4	12	8.5	8.5	7	10	11	T'=	11	
				T=	50					T=	28				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and SUBC 004 in the Species indicated

Station Designation	SUBC 001			SUBC 002			SUBC 003			SUBC 004					
Oligochaeta	0	1	1	2	6	0	1	4	0	44	54	42	✂ =	0.05	
Excel Rank	1	4	4	7	9	1	4	8	1	11	12	10	🖋	8	Tabular Value
Matches	3	3	3	1	1	3	3	1	3	1	1	1	T=	33	
Wilcoxon Rank	2	5	5	7	9	2	5	8	2	11	12	10	T'=	6	
				T=	45					T=	33				**Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and SUBC 004 in the Species indicated

Station Designation	SUBC 001			SUBC 002			SUBC 003			SUBC 004					
Americorophium salmonis	367	268	607	3	30	96	137	127	152	99	102	75	✂ =	0.05	
Excel Rank	11	10	12	1	2	4	8	7	9	5	6	3	🖋	8	Tabular Value
Matches	1	1	1	1	1	1	1	1	1	1	1	1	T=	14	
Wilcoxon Rank	11	10	12	1	2	4	8	7	9	5	6	3	T'=	25	
				T=	64					T=	14				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and SUBC 004 in the Species indicated

Station Designation	SUBC 001			SUBC 002			SUBC 003			SUBC 004					
Eogammarus confervicolus	20	18	57	0	4	2	6	13	3	0	0	1	✂ =	0.05	
Excel Rank	11	10	12	1	7	5	8	9	6	1	1	4	🖋	8	Tabular Value
Matches	1	1	1	3	1	1	1	1	1	3	3	1	T=	8	
Wilcoxon Rank	11	10	12	2	7	5	8	9	6	2	2	4	T'=	31	
				T=	70					T=	8				**Reject Null Hypothesis**
					N=9						N=3				

Table 17 SUBC 005 / Reference Condition Comparisons

Null Hypothesis: There is no difference between the Reference Stations and SUBC 005 in the Number of Animals/Sample

Station Designation	SUBC 001			SUBC 002			SUBC 003			SUBC 005				
Number of Animals/Sa	461	357	880	23	91	157	192	228	269	747	518	640	✂ = 0.05	
Excel Rank	8	7	12	1	2	3	4	5	6	11	9	10	8	Tabular Value
Matches	1	1	1	1	1	1	1	1	1	1	1	1	T= 30	
Wilcoxon Rank	8	7	12	1	2	3	4	5	6	11	9	10	T'= 9	
				T=	48					T=	30			**Do Not Reject Null Hypothesis**
					N=9						N=3			

Null Hypothesis: There is no difference between the Reference Stations and SUBC 005 in the Number of Species/Sample

Station Designation	SUBC 001			SUBC 002			SUBC 003			SUBC 005				
Number of Species/Sa	5	7	6	5	9	8	7	6	6	10	8	8	✂ = 0.05	
Excel Rank	1	6	3	1	11	8	6	3	3	12	8	8	8	Tabular Value
Matches	2	2	3	2	1	3	2	3	3	1	3	3	T= 30	
Wilcoxon Rank	1.5	6.5	4	1.5	11	9	6.5	4	4	12	9	9	T'= 9	
				T=	48					T=	30			**Do Not Reject Null Hypothesis**
					N=9						N=3			

Null Hypothesis: There is no difference between the Reference Stations and SUBC 005 in the Dominant Species % of Sample

Station Designation	SUBC 001			SUBC 002			SUBC 003			SUBC 005				
Dominant Species % c	14.97	18.768	24.09	17	24.18	28.03	12	29.4	36.8	56.49	54.25	32.7	✂ = 0.05	
Excel Rank	2	4	5	3	6	7	1	8	10	12	11	9	8	Tabular Value
Matches	1	1	1	1	1	1	1	1	1	1	1	1	T= 32	
Wilcoxon Rank	2	4	5	3	6	7	1	8	10	12	11	9	T'= 7	
				T=	46					T=	32			**Reject Null Hypothesis**
					N=9						N=3			

The dominant species may not be the same for every station

Null Hypothesis: There is no difference between the Reference Stations and SUBC 005 in the Species indicated

Station Designation	SUBC 001			SUBC 002			SUBC 003			SUBC 005				
Potamopyrgus antipoc	69	67	212	4	22	44	23	67	99	422	281	209	✂ = 0.05	
Excel Rank	7	5	10	1	2	4	3	5	8	12	11	9	8	Tabular Value
Matches	1	2	1	1	1	1	1	2	1	1	1	1	T= 32	
Wilcoxon Rank	7	5.5	10	1	2	4	3	5.5	8	12	11	9	T'= 7	
				T=	46					T=	32			**Reject Null Hypothesis**
					N=9						N=3			

Null Hypothesis: There is no difference between the Reference Stations and SUBC 005 in the Species indicated

Station Designation	SUBC 001			SUBC 002			SUBC 003			SUBC 005				
Hobsonia florida	2	0	0	2	6	2	21	12	12	21	2	0	✂ = 0.05	
Excel Rank	4	1	1	4	8	4	11	9	9	11	4	1	𝒮 8	Tabular Value
Matches	4	3	3	4	1	4	2	2	2	2	4	3	T= 19	
Wilcoxon Rank	5.5	2	2	5.5	8	5.5	12	9.5	9.5	11.5	5.5	2	T'= 20	
				T=	59					T=	19			**Do Not Reject Null Hypothesis**
					N=9						N=3			

Null Hypothesis: There is no difference between the Reference Stations and SUBC 005 in the Species indicated

Station Designation	SUBC 001			SUBC 002			SUBC 003			SUBC 005				
Oligochaeta	0	1	1	2	6	0	1	4	0	39	121	148	✂ = 0.05	
Excel Rank	1	4	4	7	9	1	4	8	1	10	11	12	𝒮 8	Tabular Value
Matches	3	3	3	1	1	3	3	1	3	1	1	1	T= 33	
Wilcoxon Rank	2	5	5	7	9	2	5	8	2	10	11	12	T'= 6	
				T=	45					T=	33			**Reject Null Hypothesis**
					N=9						N=3			

Null Hypothesis: There is no difference between the Reference Stations and SUBC 005 in the Species indicated

Station Designation	SUBC 001			SUBC 002			SUBC 003			SUBC 005				
Americorophium salme	367	268	607	3	30	96	137	127	152	222	92	227	✂ = 0.05	
Excel Rank	11	10	12	1	2	4	6	5	7	8	3	9	𝒮 8	Tabular Value
Matches	1	1	1	1	1	1	1	1	1	1	1	1	T= 20	
Wilcoxon Rank	11	10	12	1	2	4	6	5	7	8	3	9	T'= 19	
				T=	58					T=	20			**Do Not Reject Null Hypothesis**
					N=9						N=3			

Null Hypothesis: There is no difference between the Reference Stations and SUBC 005 in the Species indicated

Station Designation	SUBC 001			SUBC 002			SUBC 003			SUBC 005				
Eogammarus confervi	20	18	57	0	4	2	6	13	3	18	19	32	✂ = 0.05	
Excel Rank	10	7	12	1	4	2	5	6	3	7	9	11	𝒮 8	Tabular Value
Matches	1	2	1	1	1	1	1	1	1	2	1	1	T= 27.5	
Wilcoxon Rank	10	7.5	12	1	4	2	5	6	3	7.5	9	11	T'= 11.5	
				T=	50.5					T=	27.5			**Do Not Reject Null Hypothesis**
					N=9						N=3			

Table 18 Outfall 003 / Reference Condition Comparisons

Null Hypothesis: There is no difference between the Reference Stations and Outfall 003 in the Number of Animals/Sample

Station Designation	SUBC 006			SUBC 007			SUBC 008			Outfall 003					
Number of Animals/Sample	905	518	158	158	110	75	82	261	99	1015	67	522	<	0.05	
Excel Rank	11	9	6	6	5	2	3	8	4	12	1	10		8	Tabular Value
Matches	1	1	2	2	1	1	1	1	1	1	1	1		T= 23	
Wilcoxon Rank	11	9	6.5	6.5	5	2	3	8	4	12	1	10		T'= 16	
				T=	55					T=	23				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and Outfall 003 in the Number of Species/Sample

Station Designation	SUBC 006			SUBC 007			SUBC 008			Outfall 003					
Number of Species/Sample	8	8	9	6	5	6	7	9	7	9	5	8	<	0.05	
Excel Rank	7	7	10	3	1	3	5	10	5	10	1	7		8	Tabular Value
Matches	3	3	3	2	2	2	2	3	2	3	2	3		T= 20.5	
Wilcoxon Rank	8	8	11	3.5	1.5	3.5	5.5	11	5.5	11	1.5	8		T'= 18.5	
				T=	57.5					T=	20.5				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and Outfall 003 in the Dominant Species % of Sample

Station Designation	SUBC 006			SUBC 007			SUBC 008			Outfall 003					
Dominant Species % of Sample	31.5	25.3	34.2	31	33.6	46.7	19.5	12.6	13.1	30.6	79.1	29.5	<	0.05	
Excel Rank	8	4	10	7	9	11	3	1	2	6	12	5		8	Tabular Value
Matches	1	1	1	1	1	1	1	1	1	1	1	1		T= 23	
Wilcoxon Rank	8	4	10	7	9	11	3	1	2	6	12	5		T'= 16	
				T=	55					T=	23				**Do Not Reject Null Hypothesis**
					N=9						N=3				

The dominant species may not be the same for every station

Null Hypothesis: There is no difference between the Reference Stations and Outfall 003 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			Outfall 003					
Potamopyrgus antipodarum	285	131	54	49	37	35	16	33	13	311	53	154	<	0.05	
Excel Rank	11	9	8	6	5	4	2	3	1	12	7	10		8	Tabular Value
Matches	1	1	1	1	1	1	1	1	1	1	1	1		T= 29	
Wilcoxon Rank	11	9	8	6	5	4	2	3	1	12	7	10		T'= 10	
				T=	49					T=	29				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and Outfall 003 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			Outfall 003					
Oligochaeta	32	124	7	80	51	26	45	199	77	12	10	21	<	0.05	
Excel Rank	6	11	1	10	8	5	7	12	9	3	2	4		8	Tabular Value
Matches	1	1	1	1	1	1	1	1	1	1	1	1		T= 9	
Wilcoxon Rank	6	11	1	10	8	5	7	12	9	3	2	4		T'= 30	
				T=	69					T=	9				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and Outfall 003 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			Outfall 003					
Americorophium salmonis	558	199	37	6	3	2	2	5	1	654	0	318	<	0.05	
Excel Rank	11	9	8	7	5	3	3	6	2	12	1	10		8	Tabular Value
Matches	1	1	1	1	1	2	2	1	1	1	1	1		T= 23	
Wilcoxon Rank	11	9	8	7	5	3.5	3.5	6	2	12	1	10		T'= 16	
				T=	55					T=	23				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and Outfall 003 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			Outfall 003					
Eogammarus confervicolis	15	3	1	0	0	0	0	0	0	20	0	16	<	0.05	
Excel Rank	10	9	8	1	1	1	1	1	1	12	1	11		8	Tabular Value
Matches	1	1	1	7	7	7	7	7	7	1	7	1		T= 27	
Wilcoxon Rank	10	9	8	4	4	4	4	4	4	12	4	11		T'= 12	
				T=	51					T=	27				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and Outfall 003 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			Outfall 003					
Hobsonia florida	7	51	52	7	4	1	14	14	2	8	1	7	<	0.05	
Excel Rank	5	11	12	5	4	1	9	9	3	8	1	5		8	Tabular Value
Matches	3	1	1	3	1	2	2	2	1	1	2	3		T= 15.5	
Wilcoxon Rank	6	11	12	6	4	1.5	9.5	9.5	3	8	1.5	6		T'= 23.5	
				T=	62.5					T=	15.5				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and Outfall 003 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			Outfall 003					
Nereis limnicola	4	5	3	14	15	9	2	2	3	5	2	2	<	0.05	
Excel Rank	7	8	5	11	12	10	1	1	5	8	1	1		8	Tabular Value
Matches	1	2	2	1	1	1	4	4	2	2	4	4		T= 13.5	
Wilcoxon Rank	7	8.5	5.5	11	12	10	2.5	2.5	5.5	8.5	2.5	2.5		T'= 25.5	
				T=	64.5					T=	13.5				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and Outfall 003 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			Outfall 003					
Cumacea	0	0	1	0	0	0	2	2	2	1	1	0	<	0.05	
Excel Rank	1	1	7	1	1	1	10	10	10	7	7	1		8	Tabular Value
Matches	6	6	3	6	6	6	3	3	3	3	3	6		T= 19.5	
Wilcoxon Rank	3.5	3.5	8	3.5	3.5	3.5	11	11	11	8	8	3.5		T'= 19.5	
				T=	58.5					T=	19.5				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Table 19 SUBC 009 / Reference Condition Comparisons

Null Hypothesis: There is no difference between the Reference Stations and SUBC 009 in the Number of Animals/Sample

Station Designation	SUBC 006			SUBC 007			SUBC 008			SUBC 009					
Number of Animals/Sample	905	518	158	158	110	75	82	261	99	131	116	272	<	0.05	
Excel Rank	12	11	7	7	4	1	2	9	3	6	5	10		8	Tabular Value
Matches	1	1	2	2	1	1	1	1	1	1	1	1		T= 21	
Wilcoxon Rank	12	11	7.5	7.5	4	1	2	9	3	6	5	10		T'= 18	
				T=	57					T=	21				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and SUBC 009 in the Number of Species/Sample

Station Designation	SUBC 006			SUBC 007			SUBC 008			SUBC 009					
Number of Species/Sample	8	8	9	6	5	6	7	9	7	6	7	6	<	0.05	
Excel Rank	9	9	11	2	1	2	6	11	6	2	6	2		8	Tabular Value
Matches	2	2	2	4	1	4	3	2	3	4	3	4		T= 14	
Wilcoxon Rank	9.5	9.5	11.5	3.5	1	3.5	7	11.5	7	3.5	7	3.5		T'= 25	
				T=	64					T=	14				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and SUBC 009 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			SUBC 009					
Dominant Species % of Sample	31.5	25.3	34.2	31	33.6	46.7	19.5	12.6	13.1	45.8	24.1	44.1	<	0.05	
Excel Rank	7	5	9	6	8	12	3	1	2	11	4	10		8	Tabular Value
Matches	1	1	1	1	1	1	1	1	1	1	1	1		T= 25	
Wilcoxon Rank	7	5	9	6	8	12	3	1	2	11	4	10		T'= 14	
				T=	53					T=	25				**Do Not Reject Null Hypothesis**
					N=9						N=3				

The dominant species may not be the same for every station

Null Hypothesis: There is no difference between the Reference Stations and SUBC 009 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			SUBC 009					
Potamopyrgus antipodarum	285	131	54	49	37	35	16	33	13	60	28	120	<	0.05	
Excel Rank	12	11	8	7	6	5	2	4	1	9	3	10		8	Tabular Value
Matches	1	1	1	1	1	1	1	1	1	1	1	1		T= 22	
Wilcoxon Rank	12	11	8	7	6	5	2	4	1	9	3	10		T'= 17	
				T=	56					T=	22				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and SUBC 009 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			SUBC 009					
Oligochaeta	32	124	7	80	51	26	45	199	77	41	65	118	<	0.05	
Excel Rank	3	11	1	9	6	2	5	12	8	4	7	10		8	Tabular Value
Matches	1	1	1	1	1	1	1	1	1	1	1	1	T=	21	
Wilcoxon Rank	3	11	1	9	6	2	5	12	8	4	7	10	T'=	18	
				T=	57					T=	21				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and SUBC 009 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			SUBC 009					
Americorophium salmonis	558	199	37	6	3	2	2	5	1	14	2	15	<	0.05	
Excel Rank	12	11	10	7	5	2	2	6	1	8	2	9		8	Tabular Value
Matches	1	1	1	1	1	3	3	1	1	1	3	1	T=	20	
Wilcoxon Rank	12	11	10	7	5	3	3	6	1	8	3	9	T'=	19	
				T=	58					T=	20				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and SUBC 009 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			SUBC 009					
Eogammarus confervicolis	15	3	1	0	0	0	0	0	0	0	0	0	<	0.05	
Excel Rank	12	11	10	1	1	1	1	1	1	1	1	1		8	Tabular Value
Matches	1	1	1	9	9	9	9	9	9	9	9	9	T=	15	
Wilcoxon Rank	12	11	10	5	5	5	5	5	5	5	5	5	T'=	24	
				T=	63					T=	15				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and SUBC 009 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			SUBC 009					
Hobsonia florida	7	51	52	7	4	1	14	14	2	6	12	13	<	0.05	
Excel Rank	5	11	12	5	3	1	9	9	2	4	7	8		8	Tabular Value
Matches	2	1	1	2	1	1	2	2	1	1	1	1	T=	19	
Wilcoxon Rank	5.5	11	12	5.5	3	1	9.5	9.5	2	4	7	8	T'=	20	
				T=	59					T=	19				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Table 20 SUBC 010 / Reference Condition Comparisons

Null Hypothesis: There is no difference between the Reference Stations and SUBC 010 in the Number of Animals/Sample

Station Designation	SUBC 006			SUBC 007			SUBC 008			SUBC 010					
Number of Animals/Sample	905	518	158	158	110	75	82	261	99	622	720	1634	<	0.05	
Excel Rank	11	8	5	5	4	1	2	7	3	9	10	12		8	Tabular Value
Matches	1	1	2	2	1	1	1	1	1	1	1	1		T= 31	
Wilcoxon Rank	11	8	5.5	5.5	4	1	2	7	3	9	10	12		T'= 8	
				T=	47					T=	31				**Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and SUBC 010 in the Number of Species/Sample

Station Designation	SUBC 006			SUBC 007			SUBC 008			SUBC 010					
Number of Species/Sample	8	8	9	6	5	6	7	9	7	9	10	8	<	0.05	
Excel Rank	6	6	9	2	1	2	4	9	4	9	12	6		8	Tabular Value
Matches	3	3	3	2	1	2	2	3	2	3	1	3		T= 29	
Wilcoxon Rank	7	7	10	2.5	1	2.5	4.5	10	4.5	10	12	7		T'= 10	
				T=	49					T=	29				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and SUBC 010 in the Dominant Species % of Sample

Station Designation	SUBC 006			SUBC 007			SUBC 008			SUBC 010					
Dominant Species % of Sample	31.5	25.3	34.2	31	33.6	46.7	19.5	12.6	13.1	33	29.6	48.5	<	0.05	
Excel Rank	7	4	10	6	9	11	3	1	2	8	5	12		8	Tabular Value
Matches	1	1	1	1	1	1	1	1	1	1	1	1		T= 25	
Wilcoxon Rank	7	4	10	6	9	11	3	1	2	8	5	12		T'= 14	
				T=	53					T=	25				**Do Not Reject Null Hypothesis**
					N=9						N=3				

The dominant species may not be the same for every station

Null Hypothesis: There is no difference between the Reference Stations and SUBC 010 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			SUBC 010					
Potamopyrgus antipodarum	285	131	54	49	37	35	16	33	13	205	213	793	<	0.05	
Excel Rank	11	8	7	6	5	4	2	3	1	9	10	12		8	Tabular Value
Matches	1	1	1	1	1	1	1	1	1	1	1	1		T= 31	
Wilcoxon Rank	11	8	7	6	5	4	2	3	1	9	10	12		T'= 8	
				T=	47					T=	31				**Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and SUBC 010 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			SUBC 010					
Oligochaeta	32	124	7	80	51	26	45	199	77	45	142	36	<	0.05	
Excel Rank	3	10	1	9	7	2	5	12	8	5	11	4		8	Tabular Value
Matches	1	1	1	1	1	1	2	1	1	2	1	1	T=	20.5	
Wilcoxon Rank	3	10	1	9	7	2	5.5	12	8	5.5	11	4	T'=	18.5	
				T=	57.5					T=	20.5				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and SUBC 010 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			SUBC 010					
Americorophium salmonis	558	199	37	6	3	2	2	5	1	348	324	759	<	0.05	
Excel Rank	11	8	7	6	4	2	2	5	1	10	9	12		8	Tabular Value
Matches	1	1	1	1	1	2	2	1	1	1	1	1	T=	31	
Wilcoxon Rank	11	8	7	6	4	2.5	2.5	5	1	10	9	12	T'=	8	
				T=	47					T=	31				**Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and SUBC 010 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			SUBC 010					
Eogammarus confervicolis	15	3	1	0	0	0	0	0	0	10	25	33	<	0.05	
Excel Rank	10	8	7	1	1	1	1	1	1	9	11	12		8	Tabular Value
Matches	1	1	1	6	6	6	6	6	6	1	1	1	T=	32	
Wilcoxon Rank	10	8	7	3.5	3.5	3.5	3.5	3.5	3.5	9	11	12	T'=	7	
				T=	46					T=	32				**Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and SUBC 010 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			SUBC 010					
Hobsonia florida	7	51	52	7	4	1	14	14	2	1	4	6	<	0.05	
Excel Rank	7	11	12	7	4	1	9	9	3	1	4	6		8	Tabular Value
Matches	2	1	1	2	2	2	2	2	1	2	2	1	T=	12	
Wilcoxon Rank	7.5	11	12	7.5	4.5	1.5	9.5	9.5	3	1.5	4.5	6	T'=	27	
				T=	66					T=	12				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Table 21 Outfall 002 / Reference Condition Comparisons

Null Hypothesis: There is no difference between the Reference Stations and Outfall 002 in the Number of Animals/Sample

Station Designation	SUBC 006			SUBC 007			SUBC 008			Outfall 002					
Number of Animals/Sample	905	518	158	158	110	75	82	261	99	809	84	287	<	0.05	
Excel Rank	12	10	6	6	5	1	2	8	4	11	3	9		8	Tabular Value
Matches	1	1	2	2	1	1	1	1	1	1	1	1		T= 23	
Wilcoxon Rank	12	10	6.5	6.5	5	1	2	8	4	11	3	9		T'= 16	
				T=	55					T=	23				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and Outfall 002 in the Number of Species/Sample

Station Designation	SUBC 006			SUBC 007			SUBC 008			Outfall 002					
Number of Species/Sample	8	8	9	6	5	6	7	9	7	9	5	6	<	0.05	
Excel Rank	8	8	10	3	1	3	6	10	6	10	1	3		8	Tabular Value
Matches	2	2	3	3	2	3	2	3	2	3	2	3		T= 16.5	
Wilcoxon Rank	8.5	8.5	11	4	1.5	4	6.5	11	6.5	11	1.5	4		T'= 22.5	
				T=	61.5					T=	16.5				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and Outfall 002 in the Dominant Species % of Sample

Station Designation	SUBC 006			SUBC 007			SUBC 008			Outfall 002					
Dominant Species % of Sample	31.5	25.3	34.2	31	33.6	46.7	19.5	12.6	13.1	60	12	44	<	0.05	
Excel Rank	7	5	9	6	8	11	4	2	3	12	1	10		8	Tabular Value
Matches	1	1	1	1	1	1	1	1	1	1	1	1		T= 23	
Wilcoxon Rank	7	5	9	6	8	11	4	2	3	12	1	10		T'= 16	
				T=	55					T=	23				**Do Not Reject Null Hypothesis**
					N=9						N=3				

The dominant species may not be the same for every station

Null Hypothesis: There is no difference between the Reference Stations and Outfall 002 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			Outfall 002					
Potamopyrgus antipodarum	285	131	54	49	37	35	16	33	13	274	62	133	<	0.05	
Excel Rank	12	9	7	6	5	4	2	3	1	11	8	10		8	Tabular Value
Matches	1	1	1	1	1	1	1	1	1	1	1	1		T= 29	
Wilcoxon Rank	12	9	7	6	5	4	2	3	1	11	8	10		T'= 10	
				T=	49					T=	29				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and Outfall 002 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			Outfall 002					
Oligochaeta	32	124	7	80	51	26	45	199	77	20	9	14	<	0.05	
Excel Rank	6	11	1	10	8	5	7	12	9	4	2	3		8	Tabular Value
Matches	1	1	1	1	1	1	1	1	1	1	1	1	T=	9	
Wilcoxon Rank	6	11	1	10	8	5	7	12	9	4	2	3	T'=	30	
				T=	69					T=	9				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and Outfall 002 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			Outfall 002					
Americorophium salmonis	558	199	37	6	3	2	2	5	1	484	10	126	<	0.05	
Excel Rank	12	10	8	6	4	2	2	5	1	11	7	9		8	Tabular Value
Matches	1	1	1	1	1	2	2	1	1	1	1	1	T=	27	
Wilcoxon Rank	12	10	8	6	4	2.5	2.5	5	1	11	7	9	T'=	12	
				T=	51					T=	27				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and Outfall 002 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			Outfall 002					
Eogammarus confervicolis	15	3	1	0	0	0	0	0	0	15	0	0	<	0.05	
Excel Rank	11	10	9	1	1	1	1	1	1	11	1	1		8	Tabular Value
Matches	2	1	1	8	8	8	8	8	8	2	8	8	T=	20.5	
Wilcoxon Rank	11.5	10	9	4.5	4.5	4.5	4.5	4.5	4.5	11.5	4.5	4.5	T'=	18.5	
				T=	57.5					T=	20.5				**Do Not Reject Null Hypothesis**
					N=9						N=3				

Null Hypothesis: There is no difference between the Reference Stations and Outfall 002 in the Species indicated

Station Designation	SUBC 006			SUBC 007			SUBC 008			Outfall 002					
Hobsonia florida	7	51	52	7	4	1	14	14	2	7	1	2	<	0.05	
Excel Rank	6	11	12	6	5	1	9	9	3	6	1	3		8	Tabular Value
Matches	3	1	1	3	1	2	2	2	2	3	2	2	T=	12	
Wilcoxon Rank	7	11	12	7	5	1.5	9.5	9.5	3.5	7	1.5	3.5	T'=	27	
				T=	66					T=	12				**Do Not Reject Null Hypothesis**
					N=9						N=3				