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# Benthic Macroinvertebrate Monitoring at Seahurst Park 2004, Pre-Construction of Seawall Removal

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Prepared for City of Burien

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## Key Words

Shoreline restoration, Puget Sound, benthic invertebrates, Talitridae, intertidal zone, shoreline modifications, juvenile salmon, Seahurst Park

# Executive Summary

This report describes the pre-construction monitoring of benthic invertebrates at Seahurst Park, located along Puget Sound in the City of Burien. Shoreline modifications have altered many of the natural habitats in nearshore areas of Puget Sound. Restoration efforts at Seahurst Park will remove a section of seawall along the shoreline and restore intertidal habitat. By incorporating a pre- and post-construction monitoring plan, we will be able to assess the restoration effort. The main goal of this study was to compare the benthic macroinvertebrates at the project restoration site (Proj) and a nearby reference beach (Ref) and provide a baseline for future post-construction monitoring.

Benthic cores were taken during 3 months (June, July, September) and at three different tidal heights (+12 MLLW at Ref, +8 and +5 at both sites). Results indicated that the Proj +8 site at the base of the seawall had low overall densities and was depleted in riparian invertebrates that were typical at the Ref +12 site. This is due to the Ref +12 site having abundant terrestrial vegetation and a gradual sloping beach for beach-wrack deposition. The Proj +5 site had abundant aquatic invertebrates, probably due to aquatic invertebrates not being able to colonize at the base of the seawall at Proj +8 due to physical alterations and thereby occupying lower tidal elevations, as well as changes in sediment sizes.

Pre-construction monitoring of benthic macroinvertebrates at the Seahurst Park seawall restoration site and the reference beach illustrates that there are differences both in the study sites and the three different tidal elevations. It will be important to continue to monitor the benthic invertebrates after removal of the seawall and regrading of the intertidal is complete, scheduled for the winter of 2004/2005. By continuing to monitor, we can assess how the invertebrate community responds after the initial disturbance of construction, and to what extent the invertebrate community develops to be similar to the adjacent reference beach habitat.

# Introduction

Studies of endangered populations of ocean-type juvenile Chinook salmon (*Oncorhynchus tshawytscha*) in the Pacific Northwest indicate that they use estuarine and nearshore habitats early in their outmigration and rearing period (Simenstad et al. 1982). Since Chinook and other nearshore fishes utilize shoreline areas, the different habitat types that are represented can affect fish abundance, distribution, and behavior patterns (Toft et al. 2003). This is also true for invertebrates, which are an important prey component of many fish (Sobocinski 2003). Such utilization places an emphasis on restoring nearshore habitats so that they can provide adequate ecological functions.

This study describes pre-construction monitoring of the benthic invertebrates along the shoreline at Seahurst Park in the City of Burien, where future restoration will remove a section of seawall and restore supratidal and intertidal habitat (Figs. 1, 2; USCOE 2003). By incorporating a pre- and post-construction monitoring plan, we will be able to assess the restoration effort. The main goal of this study was to compare the benthic invertebrates at the restoration site and a nearby reference beach and provide a baseline for future post-construction monitoring.

# Material and Methods

Two sites were sampled: (1) the project site at Seahurst Park (Proj) where the seawall will be removed, and (2) the reference beach (Ref) immediately south of Seahurst Park (Fig. 1). Invertebrates were collected at three different tidal heights to span the elevations that will be affected by restoration (Fig. 2), as different invertebrates occupy different tidal elevations:

(1) MHHW at the reference site, approximately +12’ MLLW. This area is where beach-wrack is typically formed (the accumulation of debris deposited by an ebbing tide, consisting of marine algae and organic matter from terrestrial riparian sources such as wood and leaves), and is at an elevation where material will be removed at the project site.

(2) The foot of the shoreline modification at the project site (approximately +8’ MLLW) and at the same tidal height in the reference site. This will provide comparable data at the elevation where the shoreline modification interacts with the water.

(3) +5’ MLLW at both sites, the low elevation of the proposed beach regrade.

Seven samples were randomly collected with a benthic core along a 100 ft transect at each site and tidal elevation (Figs. 3, 4). Benthic cores were 10 cm in diameter and taken to a depth of 15 cm (Fig. 5). Cores were taken once a month during June, July and September. June and July represent peak periods of juvenile Chinook and coho (*Oncorhynchus kisutch*) salmonid migration, and September represents high vegetation-wrack depositions. These months and methods are also comparable to previous datasets (Sobocinski 2003).

Samples were fixed in formalin and taken to the laboratory for analysis, where they were later transferred to isopropanol for preservation and dyed with rose-bengal to aid in taxa identification. Cobble, mud, wood, and other detritus were removed to the extent possible with sieving (to 500 microns), and macroinvertebrates were identified and counted using a dissecting microscope (Fig. 6).

Data was entered into Microsoft Excel, and univariate ANOVA tests (alpha = 0.05) were used to analyze densities in the statistical program S-Plus. When significance was found, the Tukey test for multiple comparisons was used to uncover specific differences between all possible pairs of means (Zar 1996). For example, the Tukey test can detect which means from the different habitats are significantly higher or lower from each of the other habitat types. Densities were also analyzed with multivariate nonmetric multidimensional scaling (NMDS) ordination using the statistical program PC-ORD, in order to uncover patterns in multivariate groupings of the data (McCune and Grace 2002). Indicator species analysis was also used in PC-ORD, in order to find the most influential taxa.

## Results

Total average densities for each site and month are shown in Figure 7, with taxa grouped into general categories. Details of taxa groupings are shown in subsequent graphs, with results and statistics described in the paragraphs below. Listings of individual taxa with average densities are detailed in Table 1. For total average densities, Proj +8 at the base of the seawall was always lower than the other sites. In June, Ref +12 had statistically higher densities than all sites except Ref +5. In July, Ref +12 and Proj +5 had statistically higher densities than the other sites. In September, Ref +12, Ref +8, and Proj +5 all had statistically higher densities than Proj +8.

Taxa Richness for each site and month is illustrated in Table 2. In June and July Ref +12 had the highest taxa richness, while in September Proj +5 had the highest. Taxa richness at the +8 tidal elevation was fairly similar between Ref and Proj, being slightly higher at Ref in June and September, and equal in July. Taxa richness was also similar at the +5 tidal elevation, being equal in June and July, with higher values in September at Proj +5.

Densities of terrestrial amphipods and isopods (mostly beachhopper amphipods in the family Talitridae) were always statistically more abundant at Ref +12 than all the other sites, both for each month and for combined months (Fig. 8). They were more abundant in June and July, with lower abundances in September. Adults were most abundant in June, juveniles in July and September. *Traskorchestia traskiana* was the most abundant species.

Insects and mites were also most abundant at Ref +12, with numbers decreasing through time (Fig. 9). Total insect densities were statistically higher at Ref +12 both combined for all months and specifically for June, in July Ref +12 was greater than Proj +8 and Ref +8, and there were no statistical differences in September. Acarina densities were statistically higher at Ref +12, both combined for all months and for June and July; Acarina were absent in September.

Although there were high abundances of oligochaetes, there were no consistent patterns with oligochaete or nematode densities (Fig. 7). Proj +5 had statistically higher densities of oligochaetes in July, and Ref +8 had higher densities than Proj +8 in September.

Turbellaria were relatively abundant at Ref +8 and Proj +5 (Fig. 7). In June, turbellarian densities were statistically higher at Ref +8 than all other sites except Proj

+5, in July Proj +5 and Ref +8 were higher than the rest, and in September Ref + 8 was higher than the rest.

As would be expected, aquatic crustaceans were more abundant at lower tidal elevations (Fig. 10). Overall densities in June were statistically higher at Ref +5 than Proj +8 and Ref +12, in July Ref +5 was higher than the rest, and in September Proj +5 was higher than the rest, and Ref +5 was higher than Ref +12. There were also some specific amphipod differences, as *Eogammarus confervicolus* was statistically greater at Ref +5 and *Allorchestes* spp. was statistically greater at Proj +5.

There were not that many differences in densities of aquatic mollusks; numbers were low compared to other taxa (Fig. 11). There were no statistically significant differences in June and July, and in September Proj +5 had greater densities than Ref +8 and +12.

Polychaetes had significantly higher densities at Proj +5 than the rest of the sites (Fig. 12). There were no significant differences in any of the individual taxa.

Multivariate Analysis of the data using NMDS ordination further illustrates the differences between the reference and project sites, as well as tidal elevations (Fig. 13). The final stress for a 2-dimensional solution with 200 iterations was 15.02, with a instability of 0.00350. Together, both axes explained 83% of the variation. Indicator species analysis showed that beachhoppers (Talitridae) were the major taxa driving the model (99.6%). Ref +12 grouped separately from the other sites and tidal elevations. Ref +8 and Proj +8 clustered slightly closer to each other, while Ref +5 and Proj +5 were more overlapping.

## Discussion

Pre-construction monitoring of benthic macroinvertebrates at the Seahurst Park seawall restoration site and the reference beach illustrates that there are differences both in the study sites and the three different tidal elevations. The Proj +8 site at the base of the seawall has low overall densities and is depleted in riparian invertebrates that are typical at the Ref +12 site. This is due to the Ref +12 site having abundant terrestrial vegetation and a gradual sloping beach for beach-wrack deposition. The presence of the seawall has dissipated these influences, and has caused other physical alterations such as coarsening of gravel and increased wave energy (Sobocinksi 2003).

Although invertebrates are low in abundance at Proj +8, the Proj +5 site has abundant aquatic invertebrates. This may be due to aquatic invertebrates not being able to colonize at the base of the seawall at Proj +8 due to physical alterations, and being forced to inhabit lower tidal elevations. Additionally, the area beneath the seawall has more rock and debris that have broken free from the seawall, which could lead to an increased diversity of habitat for invertebrates. This is supported by the sediment samples conducted by Sobocinski (2003), which showed higher sediment sizes (gravel) at the project site than at the reference site (medium sand).

It is important to compare these results to other studies, specifically a study by Sobocinski (2003) that utilized the same study site. Sobocinski sampled biweekly from late March to early June 2001 for 5 total sampling events, taking 5 benthic cores at each site. She examined 4 study sites, one of which was Seahurst Park, at two tidal elevations corresponding to Ref +12 and Proj +8. Her results showed that natural beaches had higher densities of Talitridae, arthropods, insects, and collembolans, while altered beaches had higher densities of crustaceans. At Seahurst, the reference beach had higher taxa richness than the seawall site. These results correspond to the data presented in this report. Our sampling at three different tidal elevations further demonstrates the ecological effects of the seawall, which are most prominent in the high intertidal but span into the mid-intertidal. Sobocinski also utilized insect fallout traps, which further illustrated that the Seahurst reference site has a productive riparian zone, as it had the greatest taxa richness and difference in density and diversity between the beach and seawall site.

Removal of the seawall is scheduled for the winter of 2004/2005. It will be important to continue to monitor the benthic invertebrates after restoration is complete, in order to assess how the invertebrate community responds after the initial disturbance of seawall removal and regrading of the intertidal habitat, and to what extent the ecological community develops to be similar to the adjacent reference beach habitat.

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Figure 1. Location of Project and Reference transects at Seahurst Park.

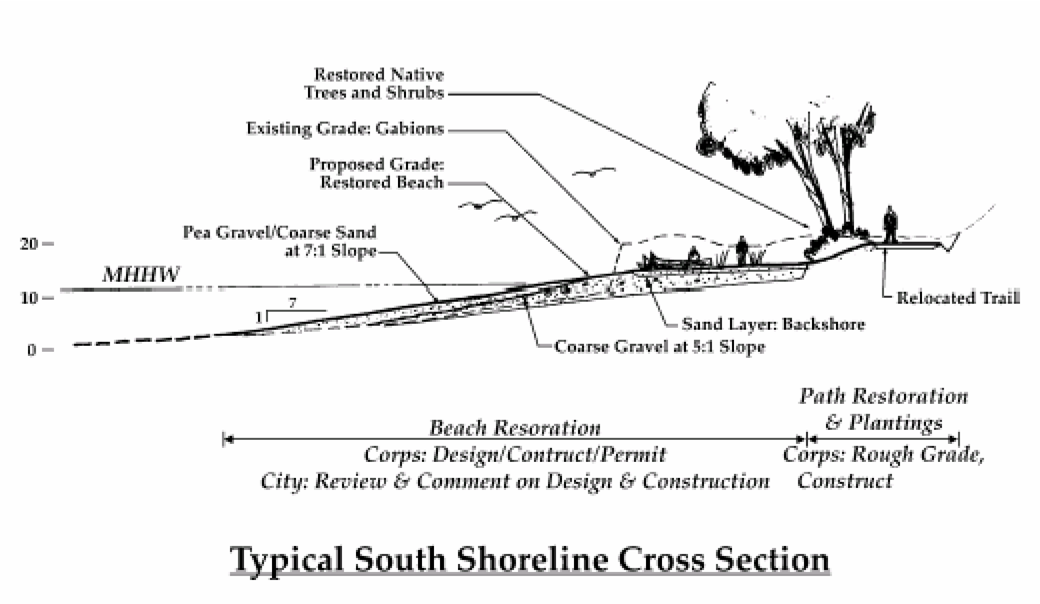

Figure 2. Plan for shoreline restoration at Seahurst Park (USCOE 2003).

Figure 3. Transect for benthic invertebrate sampling at the seawall restoration site.

Figure 4. Transect for benthic invertebrate sampling at the reference beach site.

Figure 5. 10 cm diameter core used for sampling benthic invertebrates to a 15 cm depth.

Figure 6. A benthic sample after sieving and removal of cobble and other detritus, with application of the red dye Rose Bengal to aid in processing. The large organisms are terrestrial amphipods (Talitridae).

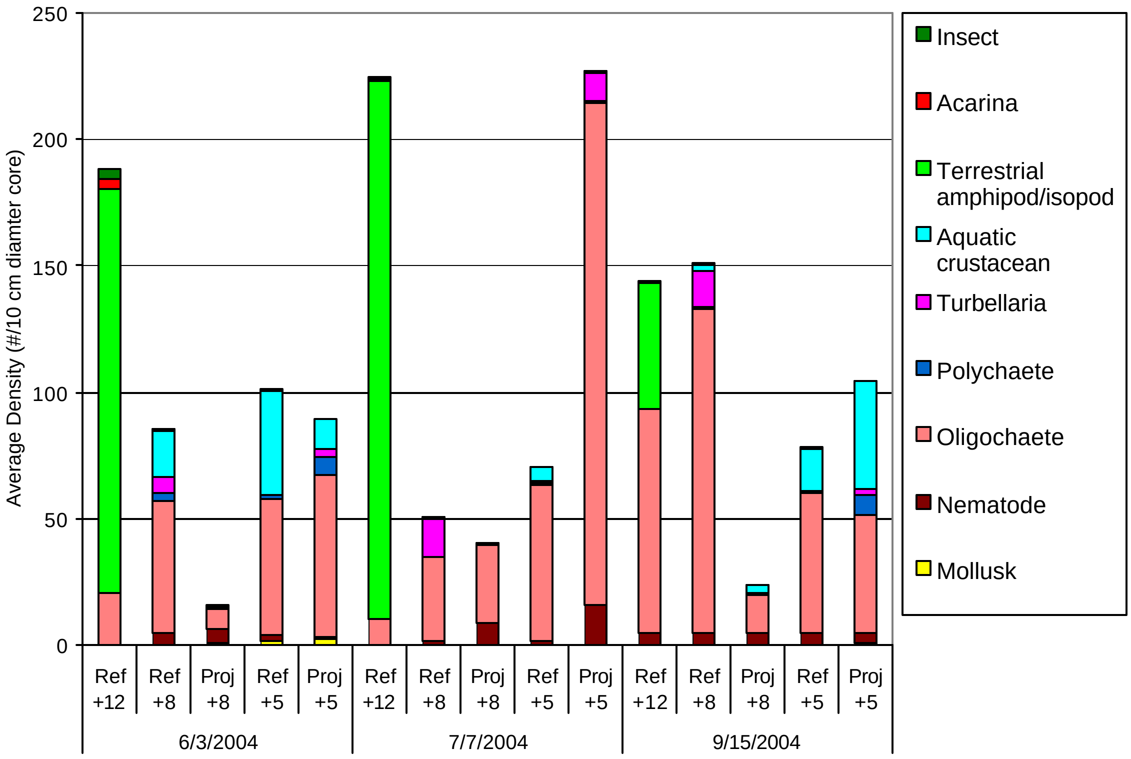

Figure 7. Average densities of all sampled invertebrates, each column is the average of seven samples. Ref=Reference, Proj=Project.

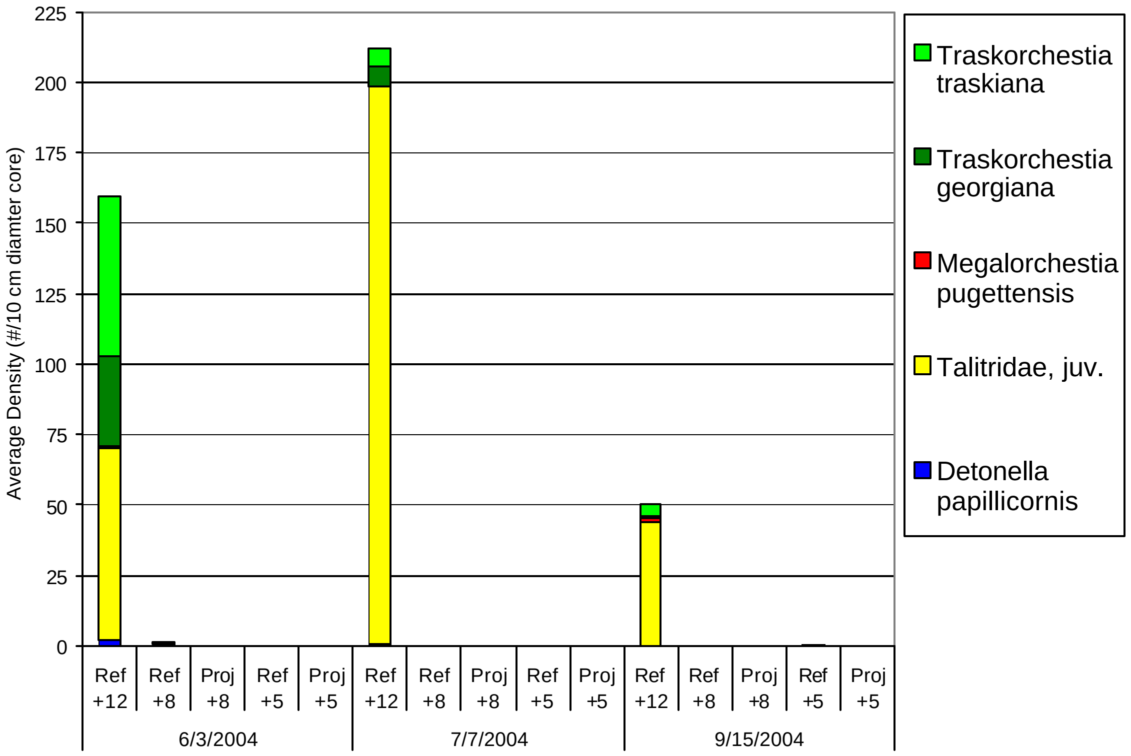

Figure 8. Average densities of terrestrial amphipods (three species of Talitridae) and isopods (*Detonella papillicornis*).

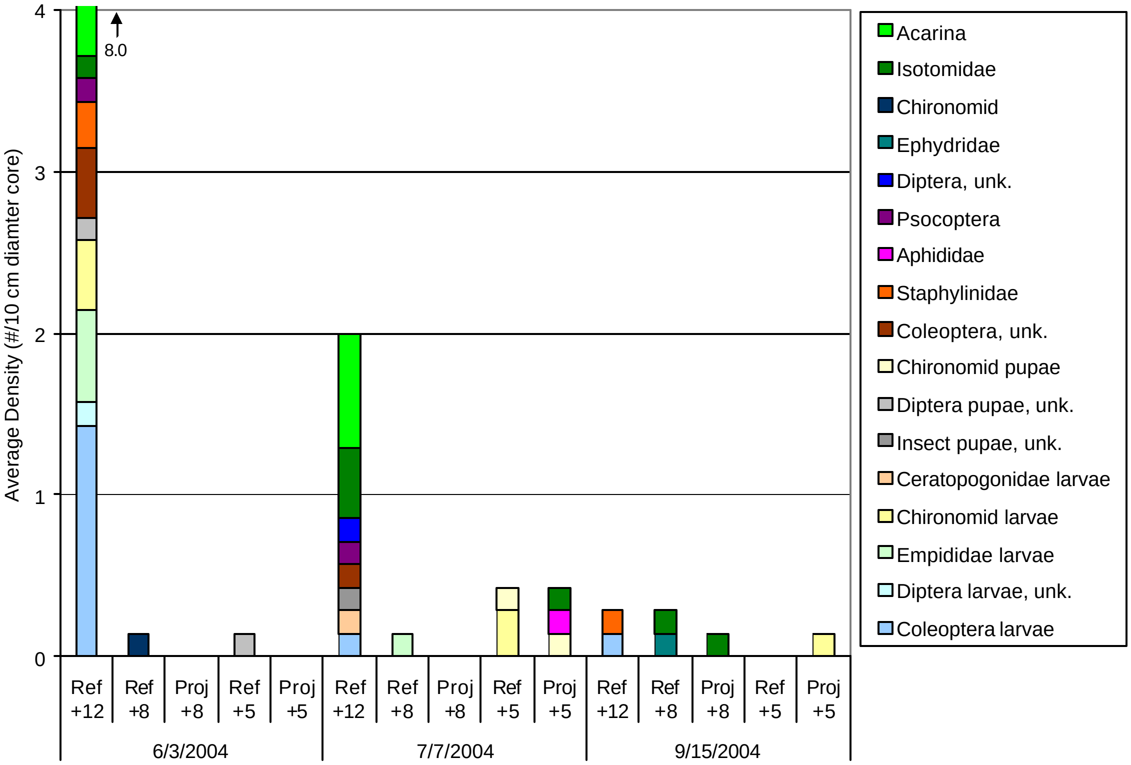

Figure 9. Average densities of insects and mites (Acarina).

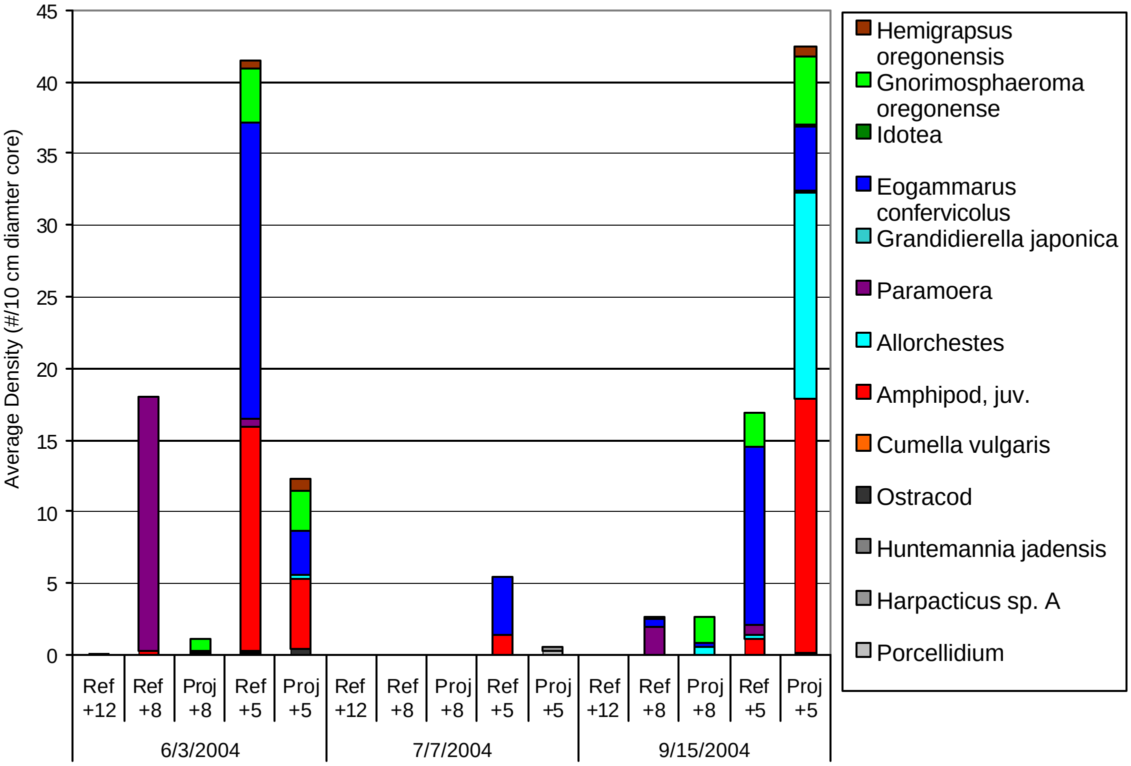

Figure 10. Average densities of aquatic crustaceans.

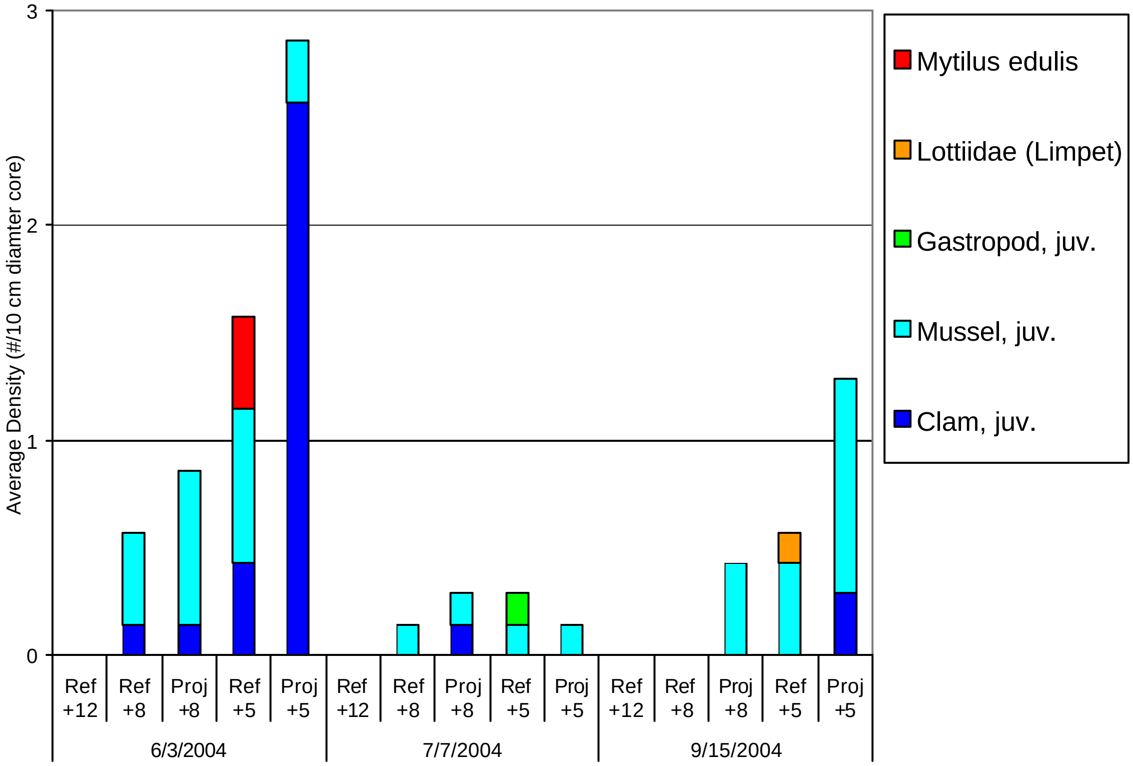

Figure 11. Average densities of aquatic molluscs.

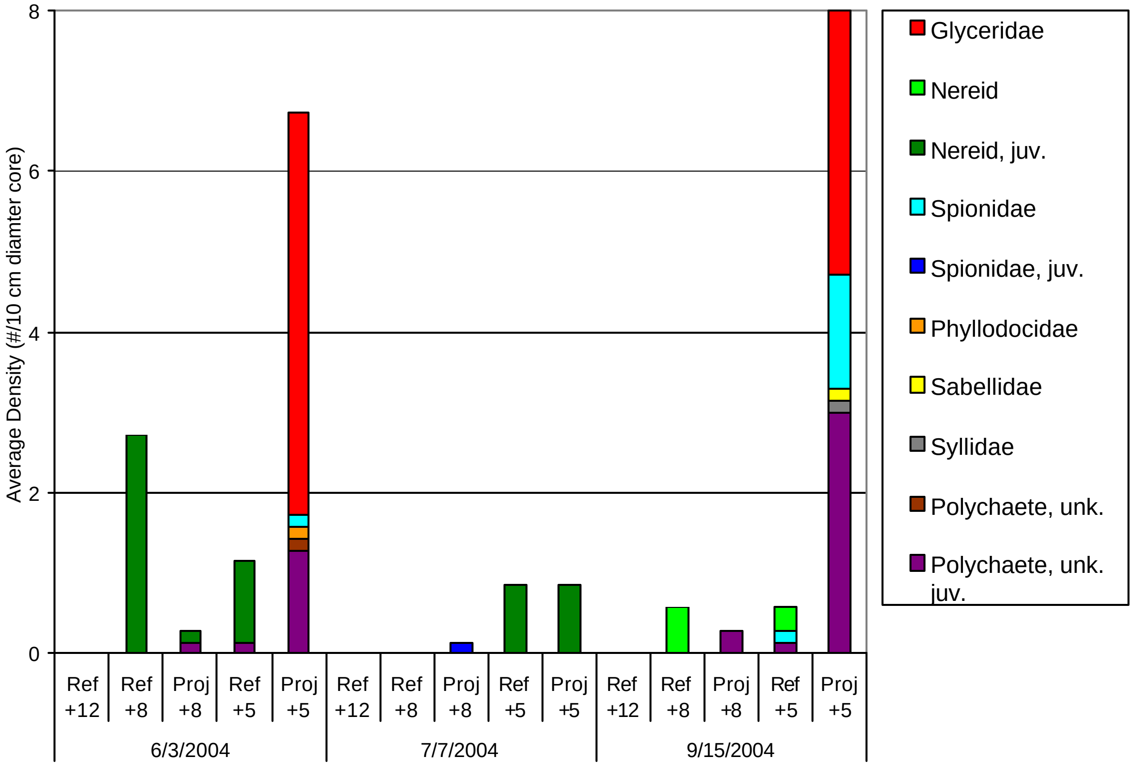

Figure 12. Average densities of polychaete worms.

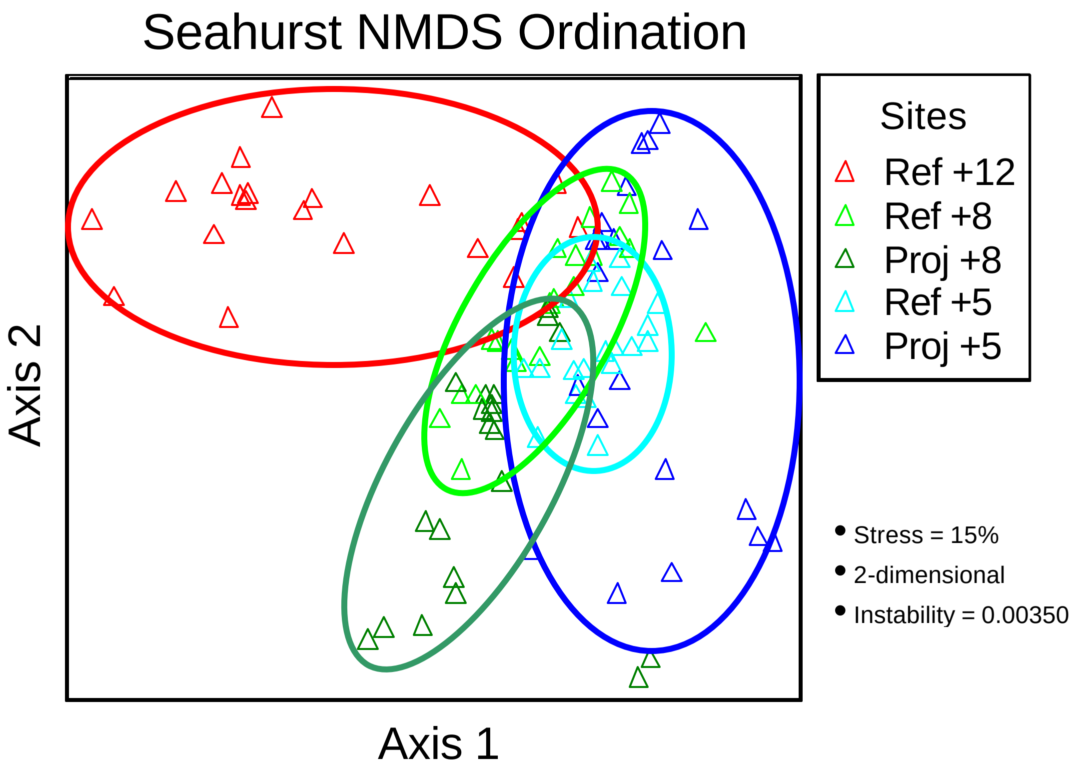

Figure 13. Multivariate analysis of the benthic invertebrate data, using NMDS ordination. Each triangle represents an individual sample.

Table 1. Average densities of benthic invertebrates, and taxa listings. R=Reference, P=Project.

| | | 6/3/04 | | | | | 7/7/04 | | | | | 9/15/04 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Taxa groupings | Taxa | R+12 | R+8 | P+8 | R+5 | P+5 | R+12 | R+8 | P+8 | R+5 | P+5 | R+12 | R+8 | P+8 | R+5 | P+5 |
| Terrestrial Amphipods | *Traskorchestia traskiana* | 57.0 | 0.1 | 0 | 0 | 0 | 6.6 | 0 | 0 | 0 | 0 | 4.1 | 0 | 0 | 0.1 | 0 |
| | *Traskorchestia georgiana* | 31.4 | 0 | 0 | 0 | 0 | 6.7 | 0 | 0 | 0 | 0 | 1.1 | 0 | 0 | 0.1 | 0 |
| | *Megalorchestia pugettensis* | 1.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.1 | 0 | 0 | 0 | 0 |
| | Talitridae, juv. | 68.1 | 0.9 | 0 | 0 | 0 | 198.4 | 0.1 | 0 | 0 | 0 | 43.7 | 0.1 | 0 | 0 | 0 |
| Terrestrial Isopod | *Detonella papillicornis* | 1.9 | 0 | 0 | 0 | 0 | 0.3 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 |
| Mites | Acarina | 4.3 | 0 | 0 | 0 | 0 | 0.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Insects | Isotomidae | 0.1 | 0 | 0 | 0 | 0 | 0.4 | 0 | 0 | 0 | 0.1 | 0 | 0.1 | 0.1 | 0 | 0 |
| | Chironomid | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Ephydridae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | 0 |
| | Diptera unk. | 0 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Psocoptera | 0.1 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Aphididae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 |
| | Staphylinidae | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 |
| | Coleoptera unk. | 0.4 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Chironomid pupae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0.1 | 0 | 0 | 0 | 0 | 0 |
| | Diptera pupae, unk. | 0.1 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Insect pupae, unk. | 0 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Ceratopogonidae larvae | 0 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Chironomid larvae | 0.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0.1 |
| | Empididae larvae | 0.6 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Diptera larvae, unk. | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Coleoptera larvae | 1.4 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 |
| Aquatic Crustaceans | *Hemigrapsus oregonensis* | 0 | 0 | 0 | 0.6 | 0.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.7 |
| | *Gnorimosphaeroma oregonense* | 0 | 0 | 0.9 | 3.7 | 2.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 1.9 | 2.3 | 4.7 |
| | Idotea | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 |
| | *Eogammarus confervicolus* | 0 | 0 | 0 | 20.7 | 3.1 | 0 | 0 | 0 | 4.0 | 0 | 0 | 0.6 | 0.3 | 12.4 | 4.4 |
| | *Grandidierella japonica* | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *Paramoera* spp. | 0 | 17.7 | 0 | 0.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.0 | 0 | 0.7 | 0.1 |
| | *Allorchestes* spp. | 0 | 0 | 0 | 0 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.6 | 0.3 | 14.4 |
| | Amphipod, juv. | 0 | 0.3 | 0.1 | 15.7 | 4.9 | 0 | 0 | 0 | 1.4 | 0 | 0 | 0 | 0.0 | 1.1 | 17.7 |
| | *Cumella vulgaris* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 |
| | Ostracod | 0 | 0 | 0 | 0.1 | 0.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *Huntemannia jadensis* | 0 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *Harpacticus* sp. A | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 0 | 0 | 0 | 0 |
| | Porcellidium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 0 | 0 | 0 | 0 |
| Aquatic Molluscs | *Mytilus edulis* | 0 | 0 | 0 | 0.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Lottiidae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0 |
| | Gastropod, juv. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Mussel, juv. | 0 | 0.4 | 0.7 | 0.7 | 0.3 | 0 | 0.1 | 0.1 | 0.1 | 0.1 | 0 | 0 | 0.4 | 0.4 | 1.0 |
| | Clam, juv. | 0 | 0.1 | 0.1 | 0.4 | 2.6 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 |
| Polychaetes | Glyceridae | 0 | 0 | 0 | 0 | 5.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.3 |
| | Nereid | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.6 | 0 | 0.3 | 0 |
| | Nereid, juv. | 0 | 2.7 | 0.1 | 1.0 | 0 | 0 | 0 | 0 | 0.9 | 0.9 | 0 | 0 | 0 | 0 | 0 |
| | Spionidae | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 1.4 |
| | Spionidae, juv. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Phyllodocidae | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Sabellidae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 |
| | Syllidae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 |
| | Polychaete unk. | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Polychaete, juv. | 0 | 0 | 0.1 | 0.1 | 1.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0.1 | 3.0 |
| Nematode | Nematode | 0.1 | 4.6 | 5.4 | 2.3 | 0.7 | 0.6 | 1.9 | 8.4 | 1.7 | 16.1 | 5.1 | 5.1 | 4.6 | 4.4 | 3.9 |
| Oligochaete | Oligochaete | 20.3 | 52.1 | 8.0 | 54.3 | 63.9 | 10.1 | 33.1 | 31.4 | 61.7 | 198.1 | 88.0 | 127.7 | 15.3 | 55.4 | 46.6 |
| Turbellaria | Turbellaria | 0 | 6.7 | 0.4 | 0.1 | 3.1 | 0.1 | 15.1 | 0.1 | 0.1 | 10.9 | 0 | 14.3 | 0.4 | 0.1 | 2.1 |

Table 2. Taxa Richness of benthic invertebrates.

| Date | Site | Taxa Richness |
|---|---|---|
| 6/3/2004 | Ref +12 | 18 |
| | Ref +8 | 11 |
| | Proj +8 | 10 |
| | Ref +5 | 16 |
| | Proj +5 | 16 |
| 7/7/2004 | Ref +12 | 15 |
| | Ref +8 | 6 |
| | Proj +8 | 6 |
| | Ref +5 | 10 |
| | Proj +5 | 10 |
| 9/15/2004 | Ref +12 | 9 |
| | Ref +8 | 10 |
| | Proj +8 | 9 |
| | Ref +5 | 15 |
| | Proj +5 | 19 |
| | Total | 53 |