INTERTIDAL BIOTIC COMMUNITY MONITORING: 2007 LONG TERM MONITORING AND FOCUS STUDIES

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SUMMARY

The Washington State Department of Natural Resources and the University of Washington participate in a long-term collaborative project to monitor intertidal biotic communities as indicators as ecosystem condition. In June-August 2007, the collaborative team undertook three separate sampling efforts, two of which are reported here.

Seasonal and Interannual Variation: We evaluated seasonal and interannual variation at two sites in Puget Sound: Case Inlet in south Puget Sound and Edmonds in north Puget Sound. At each site, we sampled three nearby beaches in June 2007, and compared the results to seasonal samples collected in 2006 (February, April-May, June, and August). The purpose was to test whether the communities undergo a relatively predictable annual cycle bringing them back to a similar composition each June. We used multidimensional scaling (MDS) to examine seasonal patterns in community structure. None of the beaches at Case and Edmonds followed a clear, repeated pattern throughout the season or returned to a similar position in June of the following year. The observed patterns differed substantially in the two locations. At Edmonds, the beaches clustered primarily by sampling date (month), and the structure of the beaches gradually shifted through time in a trajectory. Seasonality at Edmonds was driven largely by significant changes in surface biota. In contrast, the biotic communities in Case Inlet did not show seasonality, they showed high among-beach variation. Overall lower diversity at Case (especially algal diversity) and large beach-to-beach variation obscured any seasonal pattern there.

We examined long-term patterns in species richness for Case and Edmonds, and compared results to 3 beaches at Possession Point, a site with a continuous nine-year annual sampling record. Richness at Edmonds beaches has increased since 1999, while at Case richness increased at one beach, and did not change at two beaches. We conclude that the observed changes in richness are real, rather than an artifact, because 1) the species driving the observed differences among years occurred in taxa that were not rare or likely to be confused; 2) a different trend was observed at Possession during the same time period, which suggests that the increase in richness is not attributable to systematic errors associated with methodological changes over time. At Possession during the same time period, there was a strikingly regular alternation among years in high and low richness. We attribute these patterns to interannual variability because no trajectory over time is evident.

Bulkhead Removal Effects: We re-sampled a set of beaches adjacent to a site where shoreline armoring was removed at Woodard Bay Natural Resource Conservation Area (NRCA). Transects were monitored at 2 tidal heights (Mean Lower Low Water and +1.5 meters) at each of 3 locations. The site was first sampled in August 2005, several months prior to bulkhead removal. It was sampled again in August 2007. We compared results to samples collected at beaches in Case Inlet, while the beaches in Case Inlet are clearly dissimilar due to higher sand content, they provide a context for comparing relative amount of change among years. As expected, we did not see effects of seawall removal on beach biota after 1.5 years. Variation between years at Woodard was similar in scale to variation at Case, and no pattern was observed. This suggests interannual

variation rather than changes related to bulkhead removal. One slight shift that could relate to seawall removal is that biota at the adjacent beach (beach B) became more similar to biota in beach A.

Based on these findings, we make the following general conclusions and recommendations:

- As expected, seasonal changes were observed in the biota of pebble-sand beaches of Puget Sound, mostly in the surface flora and fauna. Constraining sampling to June eliminates one variable (seasonal change) and allows us to focus on the other major variable (interannual change). Long-term consistency in seasonal sampling allows us to reduce (but not eliminate) confounding factors.
- Species richness remains a reasonable indicator of some biotic differences, both among sites and among sites. Long term patterns in richness are intriguing but not yet understood.
- Continuing to sample some sites annually such as Possession Point is likely to prove valuable in terms of seeing long-term effects. However, in general, we recommend spreading out monitoring effort at most sites over space and time, in order to allocate effort into short-term focus studies.
- We recommend continuing to monitor biota at the Woodard restoration site periodically. Additionally, we recommend that another group re-quantify grain sizes, because this variable is expected to respond most quickly to the restoration action.

INTRODUCTION

Intertidal biotic communities can be used as broad indicators of environmental health because they are impacted by natural and anthropogenic conditions in both marine and terrestrial ecosystems. Since 1997, a collaborative team from University of Washington (UW) and the Washington State Department of natural Resources (DNR) has participated in a collaborative effort to monitor shoreline communities in Greater Puget Sound. This work is part of a multi-agency monitoring effort known as the Puget Sound Assessment and Monitoring Program (PSAMP).

In June-August 2007, the collaborative team completed three separate sampling efforts (Figure 1). The first project examined seasonal vs. interannual variation through sampling two sets of three beaches (Edmonds and Case) seasonally throughout a year, and compared results to one other site for which we have continuous multi-year data (Possession). The second project re-sampled beaches adjacent to a site where shoreline armoring was removed at Woodard Bay Natural Resource Conservation Area (NRCA). Project methods are discussed generally below, followed by separate discussion of specific objectives and results for the first two projects. The third project departed from our customary long term monitoring focus on mixed sand-pebble beaches in central and southern Puget Sound. It sampled mud-cobble beaches in San Juan County, in the northern Puget Trough to compare current biota with communities sampled in the 1990s. This project is reported elsewhere (Dethier and Berry 2008).

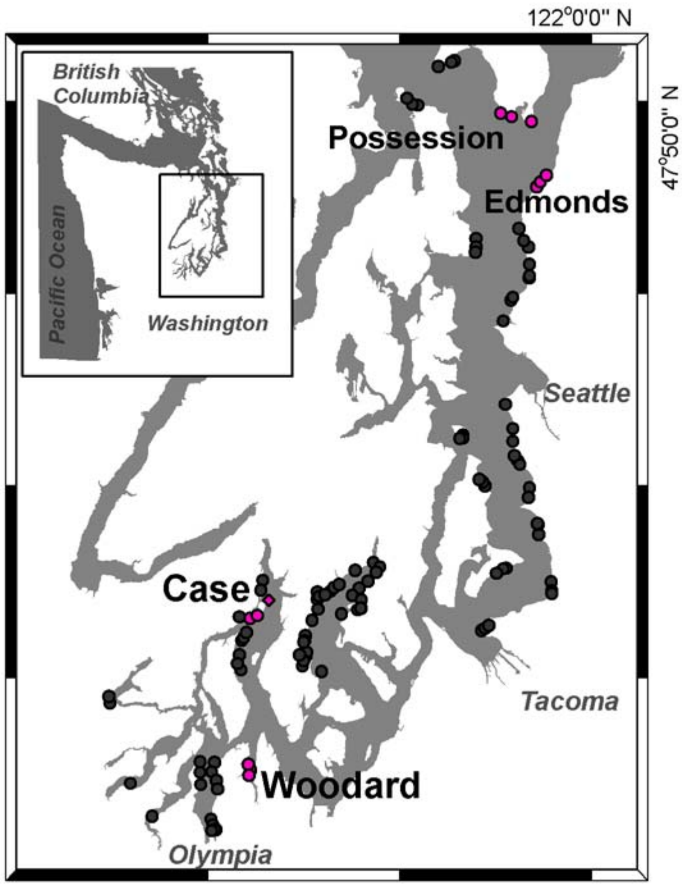


Figure 1. Study area map showing intertidal biotic community monitoring locations sampled in this study (Case, Woodard, Possession, and Edwards; shown in pink), and since project inception (shown in black).

METHODS

We sampled intertidal biotic communities using methods employed since 1997. Sampling methods are summarized here, they are also described in other publications and regular monitoring reports (e.g., Dethier and Schoch, 2005).

For large area, long-term monitoring, we selected beaches with highly similar physical characteristics in order to minimize differences in community composition associated with physical characteristics. Three replicate shore segments were selected within a distance of approximately 1 km in order to characterize variation over small spatial scales. Sites were selected by comparing a suite of fine-scale physical attributes, including grain size, wave energy, slope angle, pore water salinity, temperature, permeability, and percolation. We selected a common beach type in central and southern Puget Sound for monitoring; mixed sand-pebble beaches at Mean Lower Low Water (MLLW) elevation.

At long term monitoring sites, all biotic sampling was completed between mid-June and early July to minimize seasonal differences in biota (except in noted cases). At each beach, we used predicted tide charts to identify MLLW elevation. Along MLLW, we laid out a 50-meter transect and randomly selected 10 sampling stations. Each sample unit consisted of a $0.25m^2$ quadrat to quantify abundance of surface macroflora and epifauna, plus a 10 cm diameter by 15 cm deep core for macroinfauna. Percent cover was estimated for all sessile taxa in the quadrats, and all motile epifauna were counted. Core samples were washed through 4 and 2mm mesh sieves and taxa were counted. We used 2 mm mesh sieves for this general survey because we were more interested in adult macroinfauna than juveniles and meiofauna, and because this pebbly–sandy sediment would clog smaller sieve sizes. All organisms not identifiable to the species level in the field were placed in formalin and identified in the lab. Taxonomic references were Kozloff (1996) and Blake et al. (1997) for invertebrates, and Gabrielson et al. (2000) for macroalgae. Species were classified into different trophic categories using Fauchald and Jumars (1979) and Kozloff (1983).

Long term monitoring methods have been expanded in individual studies to address specialized research questions. The most common changes, which are documented in detail in individual studies, include:

- Expanded seasonal sampling window (beyond mid-June to early July);
- Additional tidal elevations to address project-specific questions;
- Beaches with other habitat characteristics;
- Locations beyond central and southern Puget Sound;
- Modified sample sizes and/or sieve sizes for comparison to other datasets.

I. LONG TERM AND SEASONAL TRENDS IN CENTRAL AND SOUTHERN PUGET SOUND

Objective

In our report describing 2006 data analyses (Dethier 2007), we discussed a sampling effort in Case Inlet (south Sound) and Edmonds (north Sound) where we examined the degree of seasonal variation in biota compared with interannual variation from a single time period (June). Three beaches at each site were sampled in February, April-May, June, and August 2006. In June 2007 we resampled these 6 beaches to test whether the biota returned to a “June configuration”, i.e. whether the communities undergo a relatively predictable annual cycle bringing them back to a similar composition each June.

Samples were collected at the same locations that were sampled throughout 2006. Stakes marking the transects had been removed in August 2006, so precise tidal levels were estimated using tide tables. In addition, we sampled 3 beaches at Possession Point, a long term monitoring site where we have collected samples in June annually from 1998 to 2007. Long-term patterns in species richness are examined for each of these sites.

Results and Discussion

Seasonal Patterns

Appendix 1 lists the organisms that were identified and enumerated at the Case and Edmonds sites during all sampling events. Figure 2 shows a multidimensional scaling (MDS) plot comparing the biota of the Edmonds and Case beaches sampled seasonally in 2006 and again in June 2007. The clearest pattern, seen repeatedly in the past, is that the biotic communities at the 2 areas are very different (points spread clearly apart on the graph). More interestingly, at neither Case nor Edmonds was there was a tendency for the June 2007 samples to 'return' to looking like the June 2006 samples; rather, the biota at all beaches showed constant small changes through time. On the Case beaches (the points to the right in Fig. 1), the points tend to cluster by beach rather than by month, and each beach 'wanders' through time. The richest beach, Case 16, showed the least change through time, but even there the June 2006 and June 2007 biota are not very similar. Both Case 15 and Case 17 showed very large differences between their June 2006 and 2007 biotic communities. In June 2007 these two beaches (but not Case 16) experienced large drops in abundance of ulvoids, hermit crabs, *Littorina*, and capitellid polychaetes. All three beaches showed increases in barnacles, gammarid amphipods, and limpets relative to June 2006. No consistent changes in substrates were seen. In contrast, at Edmonds there is a gradual and consistent shift through time in all 3 beaches, starting at the top of the graph with the Feb. 2006 points and moving steadily to the bottom to the June 2007 points. Here it is possible to see that the winter and spring (Feb. and May) biota differ from the summer (June and Aug.) biota, as noted in Dethier (2007). The Edmonds beaches appear to have become more diverse through time (see below). The overall difference between these two sites suggests both greater among-beach variation and greater instability at Case; we hypothesize that the greater variation in physical conditions (temperature, salinity, and sand movement) contributes to both the unpredictable changes in the biota, and the overall low diversity.

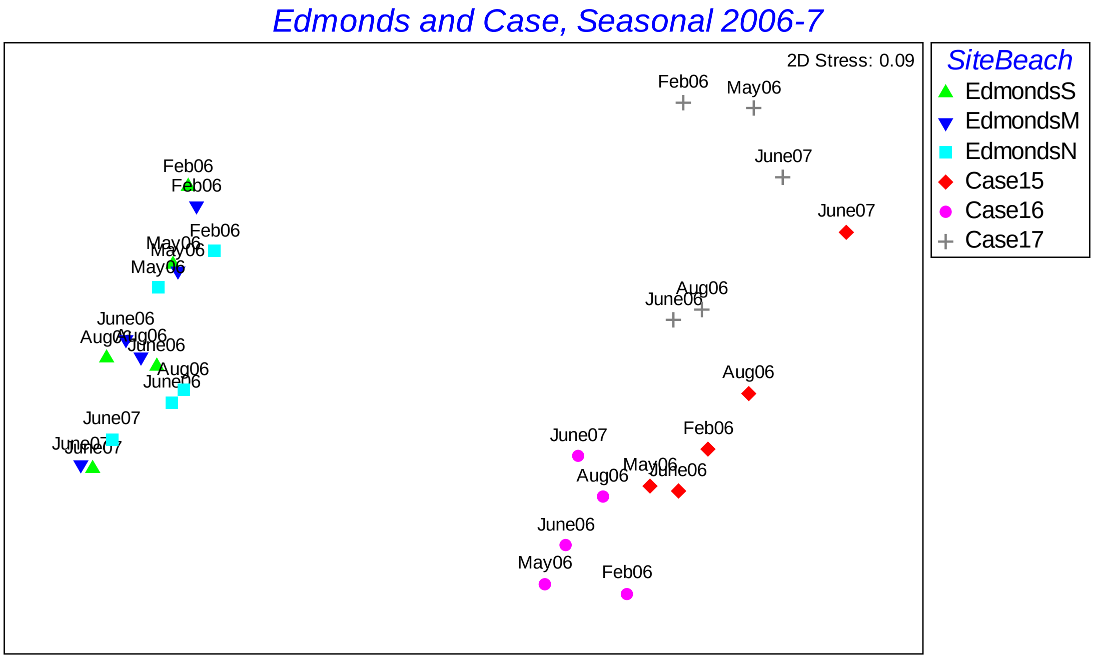
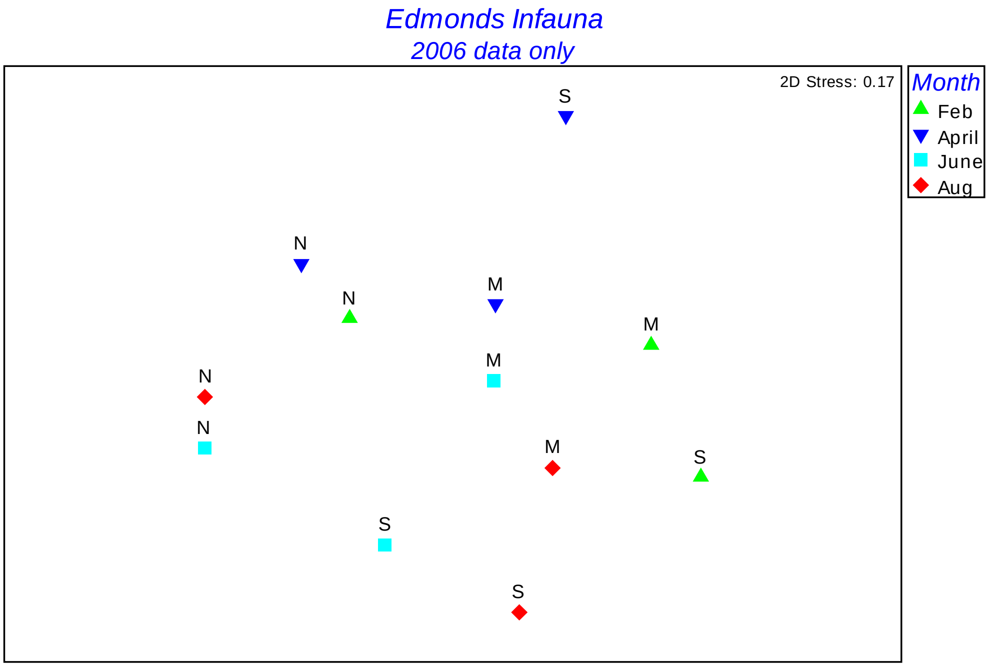


Figure 2. MDS plot showing the biota at Edmonds and Case beaches from Feb. 2006 to June 2007.

To further investigate these seasonal patterns, we subdivided the 2006 biotic data into surface organisms. The MDS plots in Figure 3 (contrasting the upper and lower panel) clearly show that most of the seasonal change at the Edmonds beaches visible in Figure 2 are driven by changes in the surface organisms, not the infauna. Points from a given month cluster in the surface data, but not for the infauna. ANOSIM analyses of differences among months were highly significant for quadrat data ($R = 0.901$, $p = 0.001$) but only marginally for cores ($R = 0.296$, $p = 0.042$). Species differing among months in the quadrat data were mostly algae, which tended to be more abundant in the spring and summer months. In winter, more limpets, *Nucella* snails, hippolytid shrimp, and barnacles were observed. Differences among months in the infaunal data were largely subtle differences in abundances of a variety of worms, which were not consistent in their season of greatest abundance. Infauna from the cores also differed among beaches (see clustering by beach label in the upper panel, especially for N and M), but there was no clustering by beach for the surface biota.



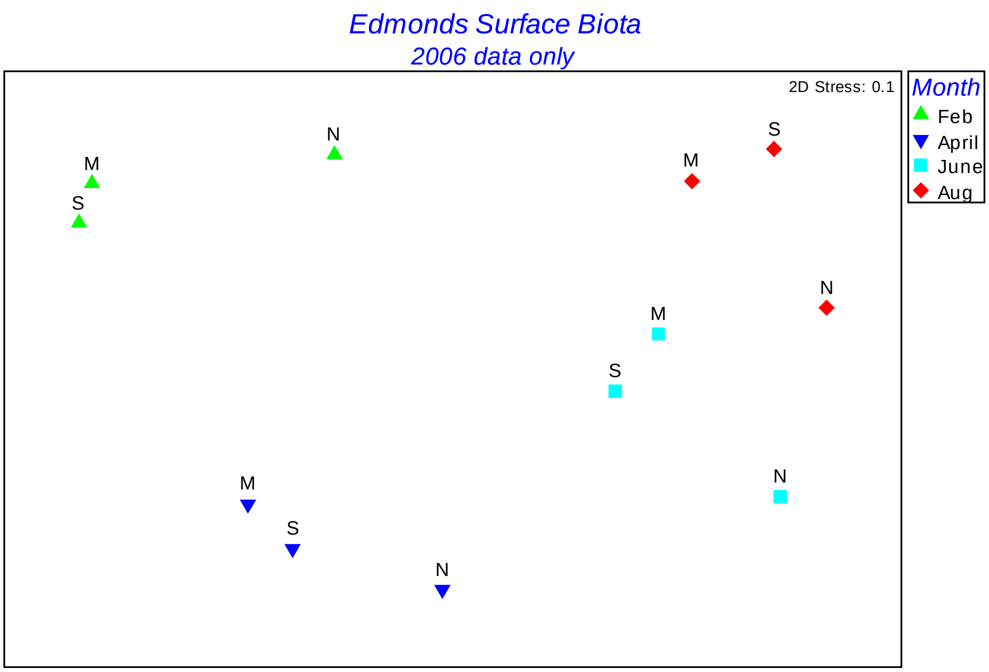


Figure 3. MDS plots of Edmonds biota subdivided into Core-species (top panel) and Quadrat-species (bottom panel). "April" in this Figure is the same as "May" in Figure 2 (sampling was right at the end of April).

Figure 4 shows the same contrast for biota sampled at Case Inlet in the different seasons. In contrast with at Edmonds, the Case biota showed little consistency among beaches within a month (as also seen in Figure 2), i.e. there was greater variation among beaches than among months; this can be seen especially in Fig. 4 lower panel, where the points are coded by beach number rather than by month. The fact that these Case "replicates" are poorly matched has been noted previously. For the infaunal data there were no differences among months (ANOSIM Months R = 0.130, p = 0.21) but there were differences among beaches (Beaches R = 0.731, p = 0.002). The same pattern held for the surface biota (Months R = 0, p = 0.46; Beaches R = 0.78, p = 0.001).

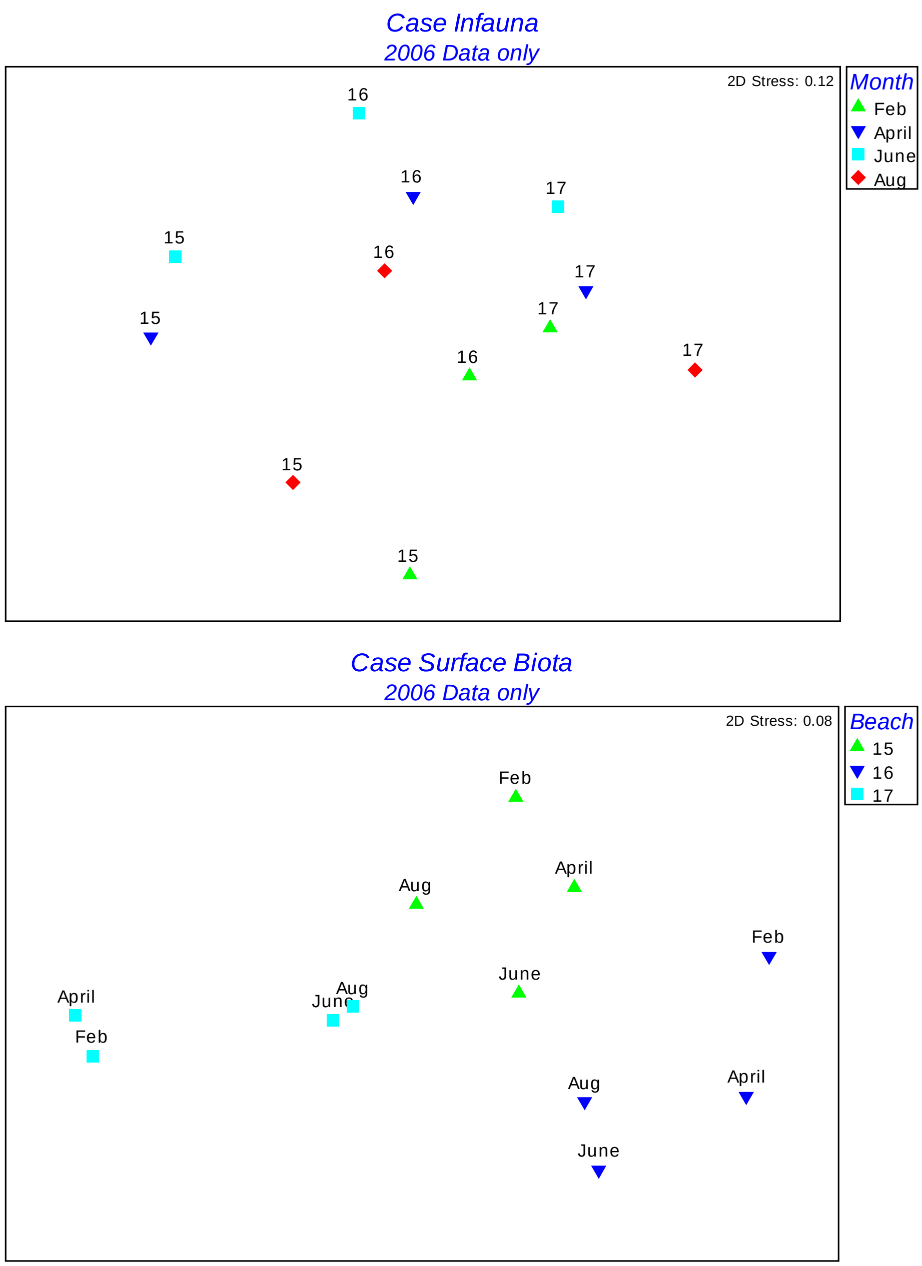


Figure 4. MDS plots of Case biota across seasons.

Thus at Edmonds, it is clear that the seasonality noted previously is driven largely by changes in abundances of surface biota. This is not surprising, since surface organisms are much more vulnerable to seasonal changes in wave energy and sand scour than are the buried infauna. In addition, many algae on these beaches are seasonal annuals that appear in late winter and get more abundant through the spring, driving much of the variation in the quadrat data. The overall lower diversity at Case and the large beach-to-beach variation obscures any seasonal pattern there. In particular, the low algal diversity and abundance at the Case beaches makes it less likely to observe seasonal changes in the quadrat data.

Species Richness Patterns

Figure 5 shows the species richness at Case and Edmonds over 9 years (not sampled every year). Both sets of beaches, especially Edmonds, appear to have increasing richness, but this ‘trend’ is driven mainly by the relatively low richness in 1999 samples. It is possible that this was a poor year at some sites (e.g. from some high physical stress), but it is also possible that in these early samples we were not yet as effective at distinguishing taxa (both epibiota and infauna) that we now differentiate. However, this was not true at Possession (see below), so we suspect that taxonomic uncertainties are not the key factor. A plot of species richness through time at other sites (Dethier 2007) suggested that richness was lower in 1999 than in any subsequent years at some sites (Normandy, West, Edmonds) but not at others (Possession, Carkeek, Brown, and Budd).

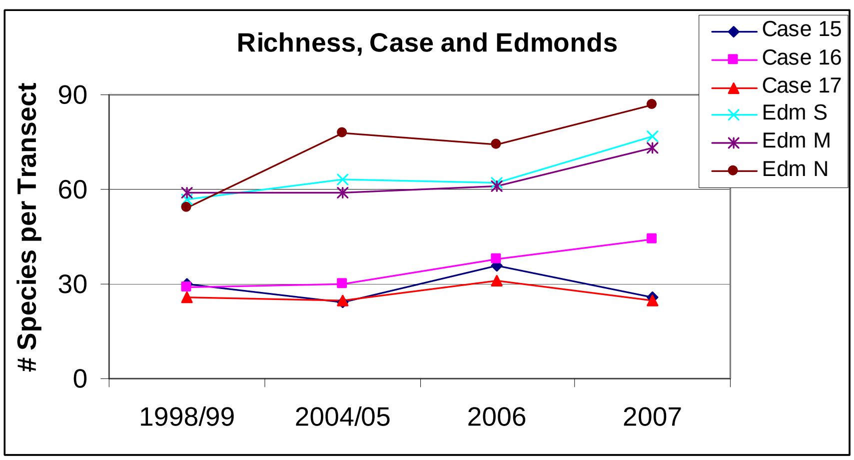


Figure 5. Species richness at Case and Edmonds beaches through time.

Further analyses of the richness patterns at the Edmonds beaches between 1999 and 2007 show that most of the increase in richness has been in the infaunal species. Figure 6 illustrates these two years with the richness broken down into Quadrat species (surface flora and fauna) and Core species (infauna). While for all sites and both types of species there were increases from 1999 to 2007, these increases were consistently larger for the infaunal richness. MDS analyses of the whole biota from these two years show that the surface species had a 72% similarity between years, while the infauna had only a 48% similarity (encompassing both species and relative abundances). The infauna found only in 2007 are mostly common or straightforward-to-identify taxa, suggesting that they are likely to have been noted in 1999 if they were actually present. Many other species were found in both years, but were more abundant in 2007. Only a few species were found only in 1999. Thus the data suggest that the richness increase through time at Edmonds is real, not an artifact.

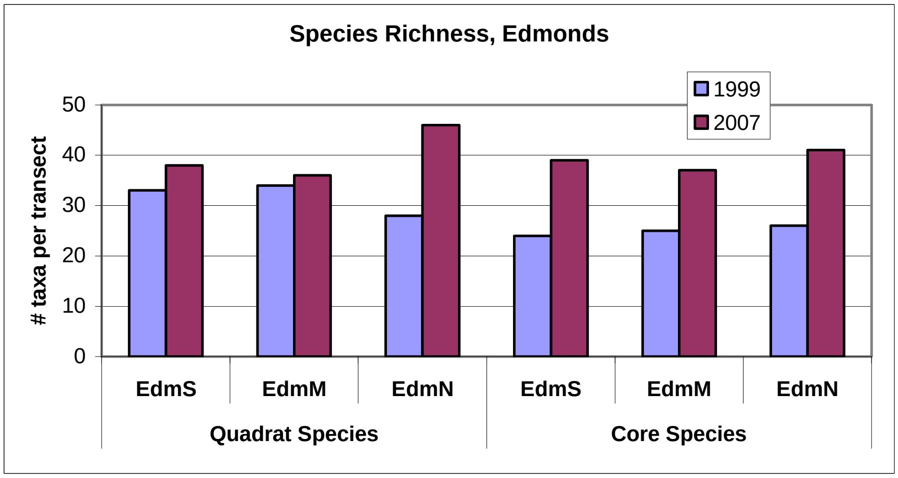


Figure 6. Number of species of surface and infaunal organisms found at each of the Edmonds transects in 1999 and 2007.

Figure 7 illustrates biotic similarity at the 6 most species-rich beaches that we have sampled through time, at Edmonds and Possession. The sites are overall somewhat different in biota (Possession points mostly left and top, Edmonds at right and bottom). However, the biotic communities have clearly changed through time in parallel at the two sites; the years (colors) are clearly visible as clusters. In this case, the transition from 2004 to 2006 to 2007 does not suggest unidirectional change; rather, 2004 is intermediate in its biotic community between 2006 and 2007. The 2007 changes appear to have been driven by a large recruitment of barnacles (as also observed in the Brightwater study, unpubl. data); 2007 samples had many more barnacles and their predators (*Onchidoris*, flatworms) as well as *Lacuna*, juvenile *Tresus*, and *Armandia* polychaetes than 2006.

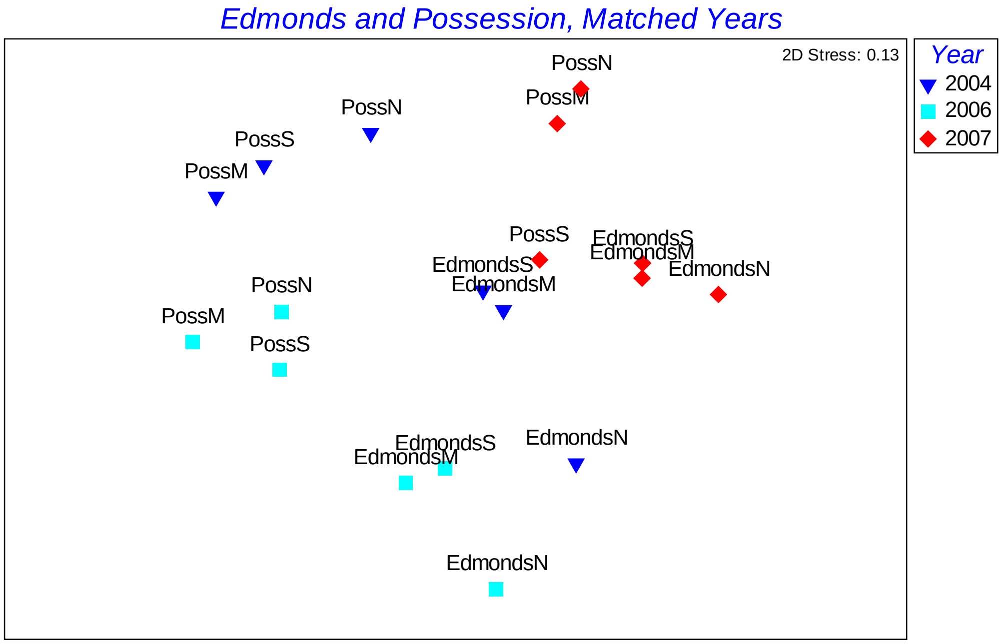


Figure 7. MDS plot of the beaches at Edmonds and Possession in the 3 years when both areas were sampled.

At the Possession beaches we now have an unbroken 9 year sampling record, allowing us to look at long term changes in parameters such as species richness. The pattern at Possession is intriguing (Fig. 8); there is a strikingly regular alternation among years in high vs. lower richness, with the species list varying by 10 or more among adjacent years. Unfortunately, we do not have such continuous data from other sites to see if a similar pattern occurs, although it would be harder to see at less-rich beaches.

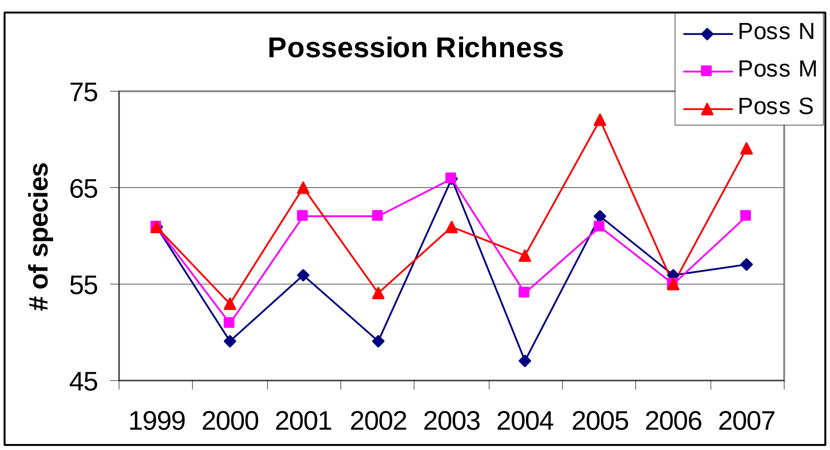


Figure 8. Species richness at the 3 Possession beaches.

Because barnacle cover seems to be associated with higher among-year richness, at least at the Brightwater sampling sites, we plotted the cover of barnacles over these same years, for both Possession and Edmonds (with patchier data from Edmonds). Figure 9 shows that although barnacle cover varies hugely among years, and quite consistently among all 6 of these northern beaches, it does not correlate with the pattern in species richness. For example, 2000, 2002, and 2007 were all high-barnacle-cover years, but richness was low in 2000 and 2002 and high in 2007. Figure 10 shows this lack of relationship as a scattergram; clearly there is no correlation, for these sites, between barnacle cover and overall species richness.

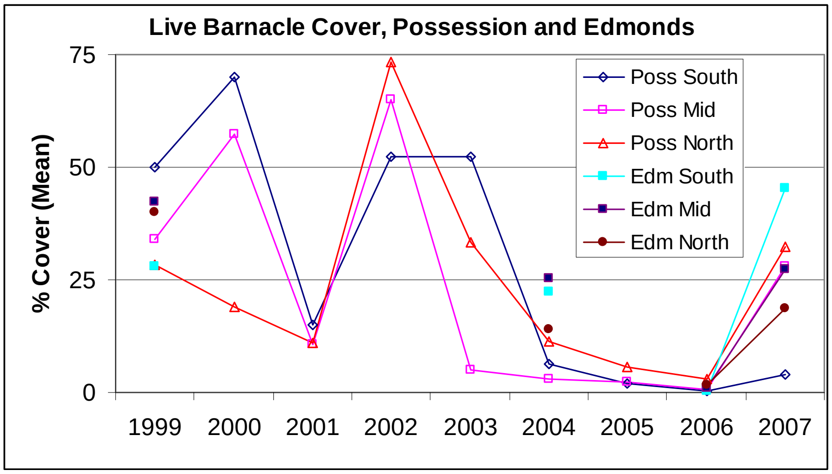


Figure 9. Variation in percent cover of barnacles through time at Possession and Edmonds.

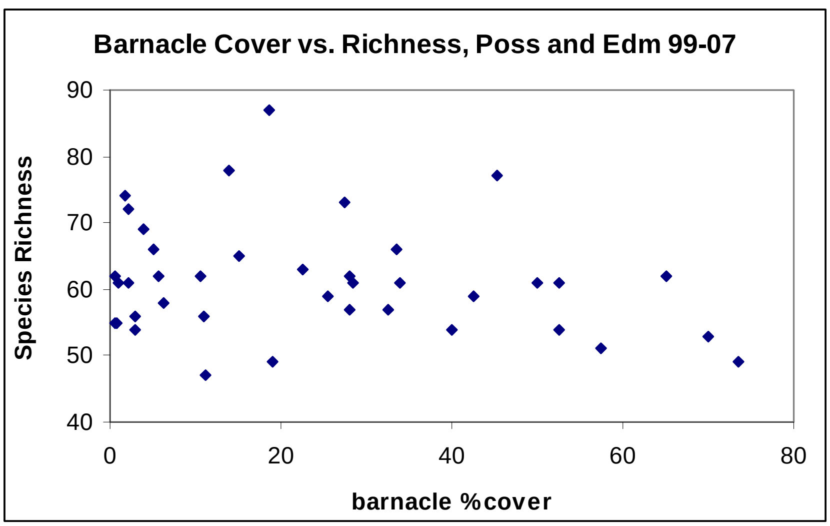


Figure 10. Scattergram of the relationship between barnacle cover (mean per transect) and species richness (total per transect)

Figure 11 illustrates the biotic communities at Possession only, over the 9 year sampling record. Overall, the 3 beaches per year tend to clump together, with greater among-beach similarity in some years (e.g. 1999) than others (e.g. 2000). The year when we mistakenly sampled too low on the beach (2005) stands out clearly. There is no general pattern of the communities trending in one direction through time. Rather, this appears to be simple interannual variability (e.g. driven by variation in recruitment), not long term change in a particular direction (e.g. domination by different organisms).

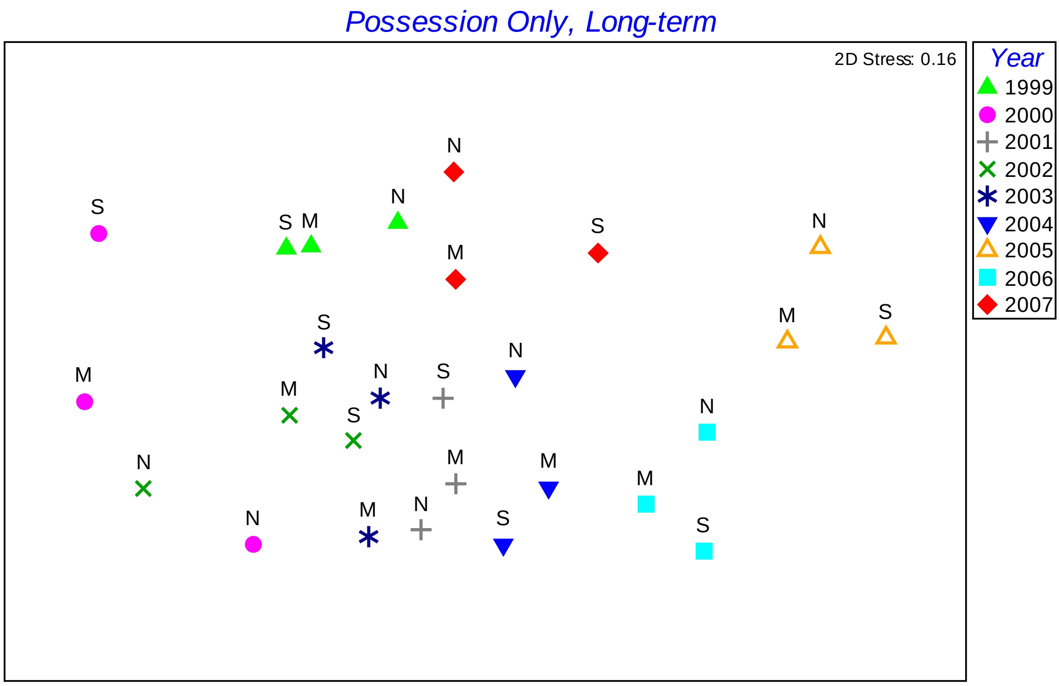
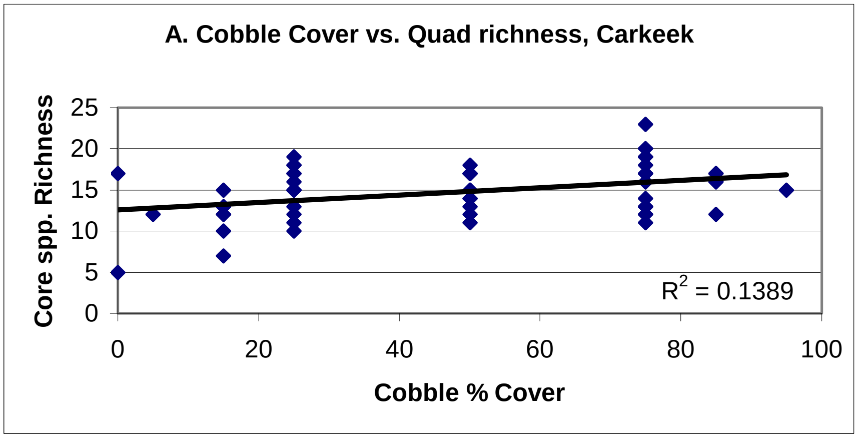


Figure 11. MDS plot of biotic communities at Possession only, from 1999 to 2007.

The high species richness at Edmonds and Possession and the large percentage of surface cobble at those sites led to the question of whether there is a causal relationship between these two parameters. This is a difficult question to analyze, given all the factors that co-vary with cobble vs. sand cover among all our sites (e.g. temperature and salinity differences south vs. north). Thus we looked at this question in detail at our Carkeek beaches, which vary (within a site) more in the type of surface substrate than any of our other commonly sampled sites. We analyzed sample-level data (rather than the usual mean among 10 samples per transect) and tested for relationships between substrate types and species richness using all the years of data where sand and cobble were recorded (sand since 2001, cobble since 2005). Figure 12A shows that there is a surprisingly weak positive relationship between the amount of cobble cover and the richness of epibiota species, even though the range of cobble cover values is very high. Figure 12B shows a stronger relationship between the amount of sand and the richness of epibiota; as noted in previous reports, surface sand has a significant negative impact on surface flora and fauna, probably from a combination of scour and burial – but not simply because more sand means fewer cobbles, as this would have shown up as a positive relationship in Figure 12A.



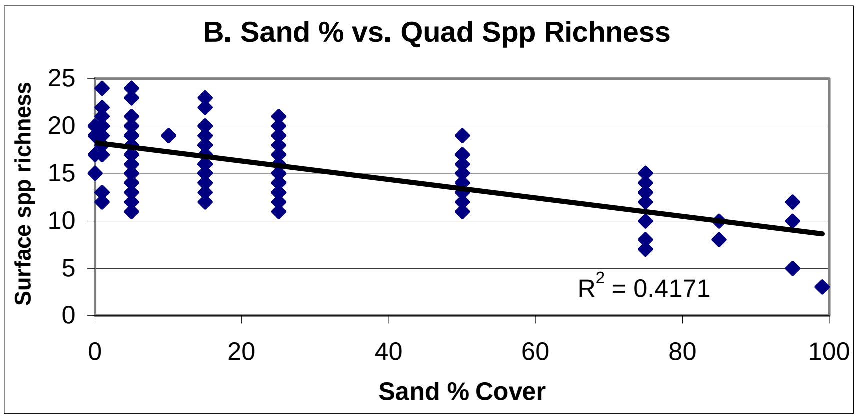


Figure 12. Regression of surface cobble and surface sand abundance vs. species richness of epibiota, sample-level data (not means)

Figure 13 shows the same correlations for species richness of infauna found in individual cores. Despite our expectation that the 'armoring' effect of cobbles on the surface might increase substrate stability and thus diversity for infauna, no such effect was seen (Fig. 11A). There was, however, a weak negative effect of the amount of surface sand on infaunal diversity. The causes of this relationship are unclear; it could relate to infauna (especially less mobile species) getting buried or smothered by a rapid influx of sand, or the sand may be an indicator that the substrate was generally unstable at that sample location, reducing infaunal diversity.

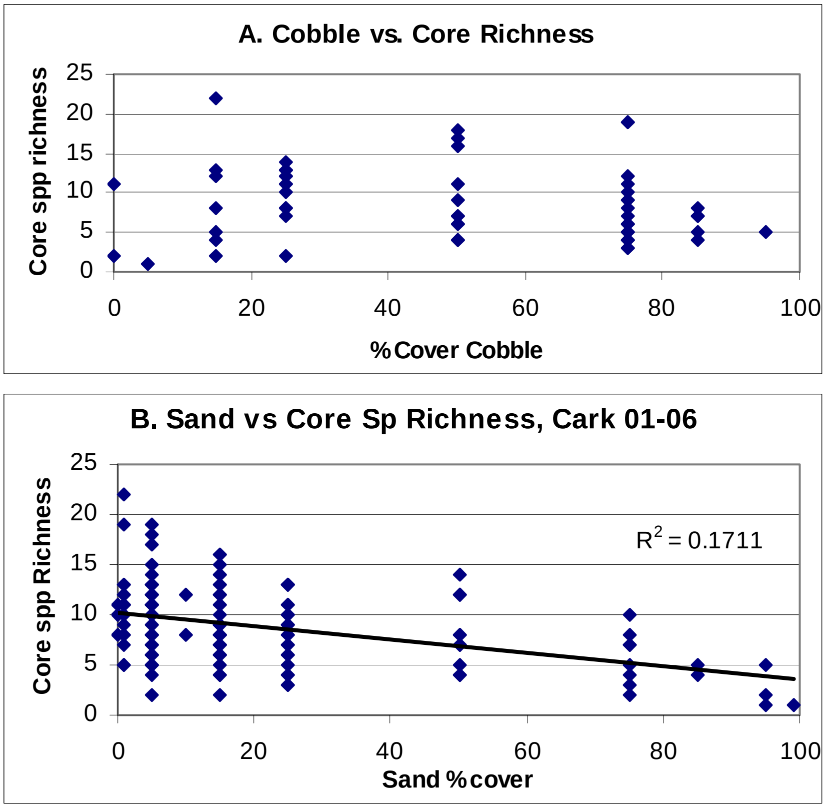


Figure 13. Percent cover of Sand and Cobble vs. species richness of infaunal organisms in cores, using sample-level data (not means) from Carkeek, 2001-2006.

In total, these analyses suggest that while cobble and sand cover correlate with the broad north-south gradient in species richness (Dethier and Schoch 2005), these parameters are unlikely to be critical determinants of this pattern.

II. WOODARD BAY MONITORING PROJECT

Objective

This localized project was designed to monitor for changes in shoreline communities resulting from removal of a bulkhead at a protected beach in south Sound. The site was monitored in August 2005 and August 2007; the bulkhead removal and shoreline restoration work was done in Fall 2005. Transects were monitored at 2 tidal heights (MLLW and +1.5m) at each of 3 locations (described in Dethier 2006). One pair of transects was established on the beach below the restoration area, and the others on beaches to either side. Although changes to the shoreline (either physical changes such as in grain size, or biological changes) are likely to be slow following this kind of restoration, it is helpful to document the biota periodically; the challenge will be distinguishing interannual variation from change caused by beach restoration, since only one year of "before restoration" data are available.

Results and Discussion

Appendix 2 lists the organisms that were identified and enumerated at Woodard during all sampling events. Figure 14 illustrates an MDS plot for the biota at the 3 Woodard beaches (at two tidal heights) and at 3 beaches in Case Inlet sampled in the same two years, for comparison. The biota at the Case beaches, which are pebble-sand, are clearly dissimilar from the biota in the muddy Woodard beaches. At each site, variation within a beach between years is similar in scale. At Woodard, biota at the low and high intertidal transects are clearly different, as described in our initial report (Dethier 2006).

Biota at Woodard and Case Beaches, 2005 and 2007
Woodard B is by seawall removal area

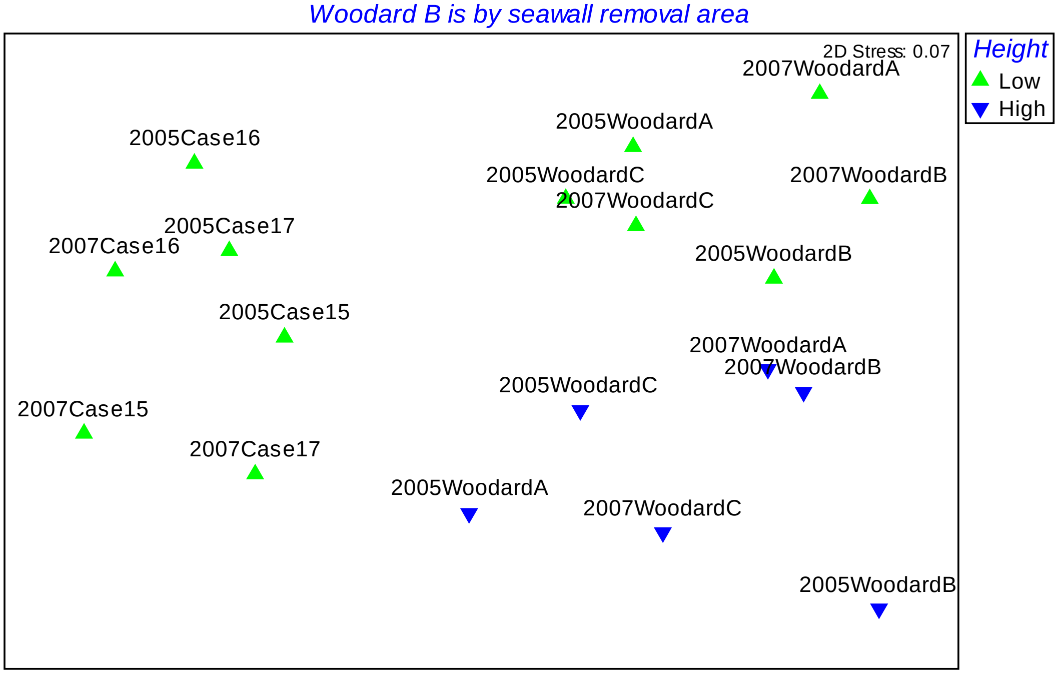


Figure 14. MDS plot showing the biota at 3 beaches in Case Inlet and 3 beaches in Woodard Bay, in both 2005 and 2007. Woodard B is in front of the seawall removal area. No high zone sampling was done in Case.

Figure 15 illustrates the biota in Woodard Bay only, to more clearly distinguish patterns there. Again, Low and High zones separate very clearly. Neither points representing years within a beach nor beaches within a year clustered closely, i.e. there is variation in biota both between years and beaches, and all beaches did not change in the same manner from one year to the other. The only pattern that might possibly relate to removal of the seawall (near beach B) is that the biota in B at both tidal heights became more similar to the biota in beach A in 2007 relative to in 2005. Since all beaches changed between years, however, it is impossible to ascribe any cause and effect to this pattern at this time.

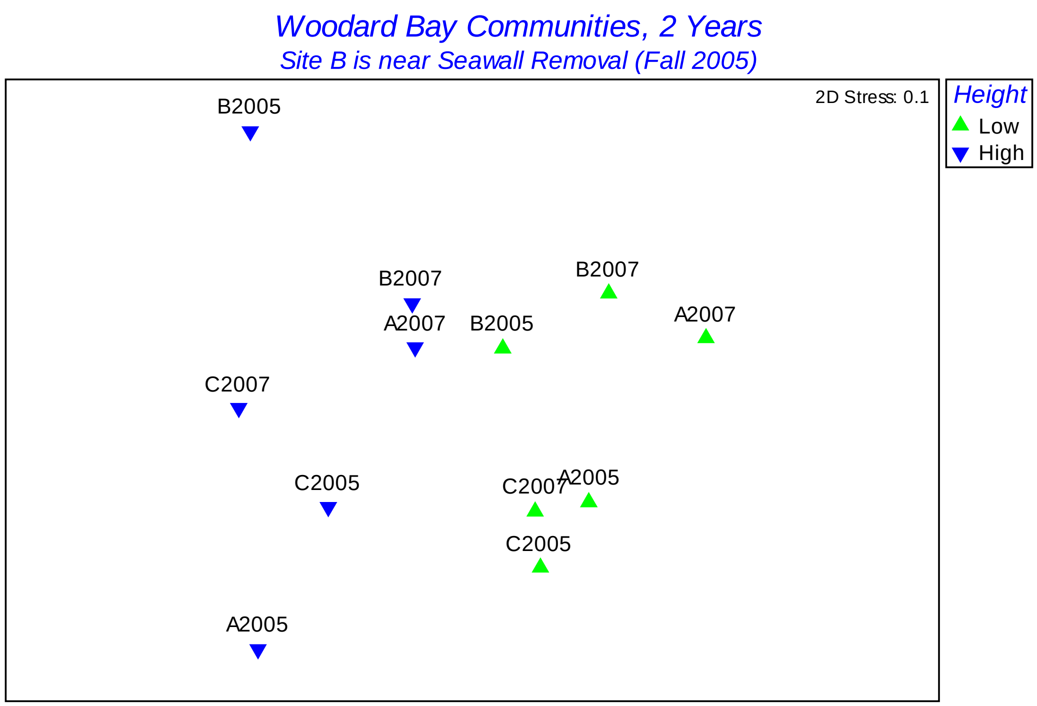


Figure 15. MDS plot showing the biota at 3 beaches in Woodard Bay, in both 2005 and 2007.

Figure 16 illustrates species richness found at the Woodard transects in the two sampled years. The most striking pattern is that species richness increased at all three beaches in the low zone from 2005 to 2007. Examination of the low-zone species lists shows that 5 taxa were found only in 2007, and were found then at all 3 beaches; these were several amphipods in the genus *Monocorophium*, the introduced snail *Nassarius*, juvenile cockles *Clinocardium*, the predatory polychaete *Glycera*, and hippolytid shrimp (not seen at beach C). These differences could be related to a variety of factors (sampling at slightly different levels, warmer or cooler physical conditions, major recruitment events for these species, or substrate changes). The only species that declined substantially in 2007 was the opisthobranch *Haminoea*, although it was still found at all beaches.

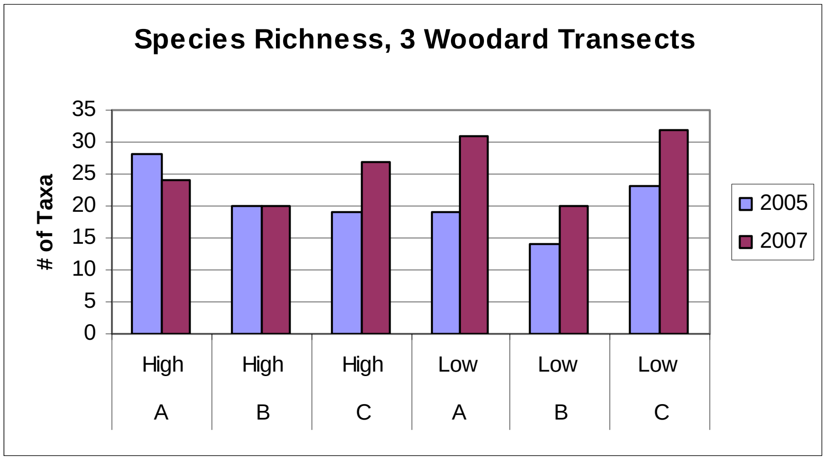


Figure 16. Number of taxa per transect in Woodard Bay found at the 3 transects at each level in the two years.

CONCLUSIONS AND RECOMMENDATIONS

- Seasonal changes exist in the biota of the pebble-sand beaches of Puget Sound, mostly in the surface flora and fauna, but summer samples in different years can be as different from each other as samples in different seasons. Thus constraining sampling to June eliminates one variable (seasonal change) and allows us to focus on the other major variable (interannual change). Long-term consistency in season of sampling is important for detecting other types of change such as human-induced ones, because it allows us to reduce (but not eliminate) confounding factors.
- Species richness remains a reasonable indicator of some biotic differences, both among sites (e.g. the big differences between Case and Possession) and among years. Long term patterns in richness are intriguing but not yet understood, e.g. the annual alternation of higher and lower richness at Possession, and the gradual increase in richness through time at Edmonds. The negative effect of surface sand on richness continues to be documented; our newest analyses show that this effect is particularly strong on surface flora and fauna, but also exists for infauna.
- Continuing to sample Possession Point annually will probably prove valuable in terms of seeing longterm effects. Monitoring of other Puget Sound beaches should be spread out in space and time, allowing more effort to be put into shorter-term focus studies.
- The effects of seawall removal on beach biota at a site in Woodard Bay are not yet obvious; this is not surprising after only 1.5 years. The monitoring of these beaches should continue, although it is possible that the scale of this physical change is small enough, and at a sufficient distance from the beach transects sampled, that no impact will be visible. Monitoring every 2 years, or possibly

longer, is probably sufficient. On the next monitoring date it might be advisable to find some group to re-quantify grain sizes, assuming that data on this parameter were taken before restoration.

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APPENDIX 1. Species found at Case and Edmonds Sites (mean per zone of percent cover for sessile organisms or count for mobile organisms).

Site Name	Case15					Case16					Case17				
Year	2006	2006	2006	2006	2007	2006	2006	2006	2006	2007	2006	2006	2006	2006	2007
Month/Day	2/26	4/30	6/10	8/8	6/13	2/26	4/30	6/10	8/8	6/13	2/26	4/30	6/10	8/8	6/13
Acrosiphonia spp.	0	0	0	0	0	0	6.2	1.1	0	0.9	0	0	0	0	0
Alia spp.	33.2	14.7	4.5	5.3	0	6.5	7	2.8	1.7	4.9	0	0	0	0	0
Allorchestes angusta	0	0	0	0	0.4	0	0	0.2	0	0	0	0	0	0	0
Ampharete labrops	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0
Amphiodia spp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anthopleura artemisia	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0
Anthopleura elegantissima	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anthopleura spp.	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0
Armandia brevis	0.7	0.1	0.5	0	0	0	0	1.1	0	0.9	0.1	0	0	0	0
Asabellides sibirica	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0
Axiothella rubrocincta	0	0.2	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Branched red blades	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bryozoa (miscellaneous)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calliopius spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calliostoma sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cancer sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cancer sp. Juvenile	0	0	0	0	0	0	0	0	0	0	0.1	0	0.1	0	0
Capitella capitata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caulacanthus sp.	0.3	0	0.6	0.6	1.1	2.6	0.1	3.7	8.6	0.9	0	0	0	0	0
Caulleriella ?pacifica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ceramium sp.	0	0	0	0	0	0	0.1	0.9	0	0.2	0	0	0	0	0
Chondracanthus canaliculatus	0.3	0.1	0	0	0	18.8	4.4	0	2.7	2.8	0	0	0	0	0
Chondracanthus exasperata	0	0	0	0	0	0	0	4	0	0	0	0	0.1	0	0
Cirratulus multioculatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clinocardium nuttallii	0	0	0	0	0.1	0.1	0	0	0	0	0.1	0.2	0	0	0
Clinocardium nuttallii juveniles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cobble percentage	21	13	17	20	17	30.5	39	34	42.5	36.5	11	13	24	18	14
Colpomenia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cottidae (sculpins)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crepidula dorsata	0.3	0.1	0	0.1	0.1	1.5	0.5	0.3	0.4	0.8	0.2	0.1	0.3	0	0
Crepidula fornicata	0	0	0.1	0	0	0	0	0.1	0	0	0	0.1	0	0	0
Cryptosiphonia woodii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dead barnacles (Class Cirripedia)	7	4.6	5.6	6	4.6	3.8	3.8	4.2	4.1	4.2	6	3.6	4.2	7.2	3.7
Decamastus gracilis	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0
Dendraster excentricus	0	0	0	0	0	0	0.4	0	0	0	2.7	1.3	0	0	0
Dendraster juv. in core	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0.5	0.3
Desmarestia spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diatoms, chain-forming	1.7	3.6	0	0	0	48	3.7	0	0	0.1	0	0	0.1	0.1	0

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Site Name	Case15					Case16					Case17				
Year	2006	2006	2006	2006	2007	2006	2006	2006	2006	2007	2006	2006	2006	2006	2007
Month/Day	2/26	4/30	6/10	8/8	6/13	2/26	4/30	6/10	8/8	6/13	2/26	4/30	6/10	8/8	6/13
Dorvillea japonica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dorvillea longicornis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Edwardsia sipunculoides	0	0	0	0	0	0	0	0	0	0	0.5	1.3	1.4	1.4	1.6
Eobrolgus chumashi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eteone longa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eteone tuberculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euclymene spp.	0.1	0	0	0	0	0.2	0.6	0.6	0.3	0	0.5	0.5	0.6	0.1	0
Eulalia viridis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Evasterias troschelii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family Hippolytidae	0.05	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0
Flatworm (unident.)	0	0	0	0	0	3.5	4.9	0	0	5.6	0	0	0	0	0
Fleshy crust	2.6	3.6	3.8	1.8	3.4	19	16	16	11	3.4	0.7	1	1.8	0.8	1
Fucus gardneri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gammarid amphipods	2	0	0.3	25.5	55	0.2	0	0.5	4.1	27.5	0	0.1	0	3.7	7
Gelidium spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glycera americana	0	0.1	0.1	0.2	0	0	0	0	0.1	0	0	0	0	0	0
Glycinde picta	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0
Glycinde polygnatha	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Gnorimosphaeroma oregonense	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gracilaria pacifica	0	0	0	0	0	0	0.9	0	0	0	0	0.1	0	0	0
Grandidierella japonica	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0
Grateloupia sp.	0	0	0	0	0	0	0	6.6	0	0.1	0	0	0	0	0
Gunnel (unident.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Halcampa decemtentaculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harmothoe imbricata	0	0.1	0	0	0	0	0.1	0	0	0	0	0.3	0	0	0
Hemigrapsus nudus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemigrapsus oregonensis	9.1	2.4	13.6	6.3	7.4	14	13.2	32	21.5	8.7	0.4	0.7	11.2	8.3	1.6
Hemipodus borealis	1.8	3.6	3.1	2.7	1.8	1.1	1.1	1.6	0.8	2.5	1.2	2.2	1.9	0.8	2.5
Hermissenda crassicornis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hyale frequens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kefersteinia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lacuna vincta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laminaria saccharina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leitoscoloplos pugettensis	0	0.3	0.5	0	0	0	0	0	0	0.2	0	0.1	0	0	0
Lepidasthenia berkeleyae	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidochitona dentiens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leptochelia dubia	0	0	0	0	0	0	0	0.1	0	0.1	0	0	0	0	0
Leptosynapta clarki	0	0	0	0	0.1	0.3	0.6	0.3	0.1	0.2	0.8	1.2	1.1	1.2	0.4

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Month/Day	2/26	4/30	6/10	8/8	6/13	2/26	4/30	6/10	8/8	6/13	2/26	4/30	6/10	8/8	6/13
Lirularia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Littorina scutulata	0	1.6	2.1	2.7	212.5	0	0.5	0.1	0	1.1	44	40.4	18.8	9.3	50.5
Live barnacles (Class Cirripedia)	6.6	6	12	16	19	4.2	4	7.8	8.1	30.5	2.2	1.4	11	10	16
Lophopanopeus bellus bellus	0	0	0.1	0	0.1	0.1	1.9	0.8	2.8	0.2	0	0	0.1	0	0
Lottid limpets	3.4	1.7	0.5	4.1	85	2.7	3.6	5.3	13.8	58.5	9.3	7.5	7.8	9.3	34.5
Lucina tenuisculpta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lumbrineris zonata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lyonsia californica	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0
Macoma inquinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Macoma inquinata juveniles	0	0	0	0	0	0	0.1	0.1	0	0	0	0	0	0	0
Majid (spider) crab	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0
Majid juvenile crab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Malacoceros glutaeus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Malmgreniella nigralba	0	0	0	0.1	0	0	0	0	0	0	0	0	0.3	0.4	0
Margarites sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mastocarpus sp.	0	0	0	0	0	0	0.6	0.1	0.2	0.2	0.1	0	0.5	0.1	0.2
Mazzaella heterocarpa/oregona	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mazzaella sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mazzaella splendens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mediomastus californiensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metridium sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micropodarke dubia	0	0.2	0.1	0	0	0	0.4	0.1	0	0	0	0	0	0	0
Monocorophium spp.	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0.2	0
Mooresamytha bioculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mopalia lignosa	0.1	0	0.1	0	0	0	0	0	0	0.3	0	0	0.1	0	0
Mopalia muscosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mopalia sp.	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0
Mysella tumida	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0.1	0
Mytilus trossulus	0	0.1	0	0	1.4	0	0	0	0	0.6	0.1	0	0	0.1	0.4
Nassarius sp.	0	1.3	0	0	0	0	0	0	0	0	0	0	0	0	0
Nemertean (unident.)	0	0.3	0.2	0	0	0.1	0.6	0.4	0.3	0.8	0.5	0.8	0.9	0.1	0.3
Neoamphitrite robusta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Neotrypaea californiensis	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Nephtys caeca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nephtys caecoides	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
Nephtys ferruginea	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0
Nereis procera	0.1	0.2	0.1	0.1	0.2	0	0	0	0	0.2	0	0	0	0	0
Nereis vexillosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Site Name	Case15					Case16					Case17				
Year	2006	2006	2006	2006	2007	2006	2006	2006	2006	2007	2006	2006	2006	2006	2007
Month/Day	2/26	4/30	6/10	8/8	6/13	2/26	4/30	6/10	8/8	6/13	2/26	4/30	6/10	8/8	6/13
Nicomache personata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Notomastus lineatus	0.1	0	0.1	0	0.1	0	0	0.2	0	0	0.1	0	0	0.1	0.1
Notomastus tenuis	9.8	21.8	24.1	13.6	11.3	11.3	20	32.5	18.1	32	10.9	12.2	22.1	10.3	11.3
Nucella lamellosa	0	0	0	0	0	0	0.1	0	0.1	0.2	0	0	0	0	0
Odonthalia floccosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odostomia sp. (unident.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Onchidoris bilamellata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Onuphis elegans	0	0	0	0	0.1	0	0	0	0	0.1	0	0	0	0	0
Ostrea lurida	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0
Owenia fusiformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pagurus spp.	2.6	6.3	18.7	9.3	4.2	1.5	9.3	7.4	9.1	15.4	0	0.4	4.1	6.3	0
Petalonia fascia	0	0.2	0	0	0	0	0.3	0	0	0.7	0	0	0.1	0	0
Petrolisthes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pholoe minuta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
?Pholoides asperus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phoronopsis harmeri	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0
Phyllodoce maculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Pinnixia faba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pinnixia schmitti/occidentalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pisaster ochraceus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Platynereis bicanaliculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Podarke pugettensis	0	0	0.1	0	0	0	0.1	0	0	0	0	0	0	0	0
Podarkeopsis glabrus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pododesmus cepio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polinices lewisii	0	0	0	0.1	0	0	0	0	0	0	0	0.1	0	0	0
Polycirrus n. sp. (L. Harris)	0	0	0.1	0.1	0	0.1	0.1	0.4	0.2	0	0	0	0	0	0
Polydora ?websteri	0.1	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0
Polydora cardalia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polydora columbiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polynoid (unident., in quadrat)	0	0.2	0	0	0	0	0.6	0.5	0	0.3	0	0	0	0	0
Polysiphonia sp. (unident.)	0	0	0	0	0	0.5	0	0	0	0.4	0.8	0	0.4	0	0
Pontogeneia ivanovi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porphyra sp.	0	1.1	0	0	0	0	4.8	0	0	0.2	0	0.4	0	0	0
Potamilla sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Prionitis sp. (unident.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prionospio multibranchiata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prionospio steenstrupi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Protothaca staminea	0	0	0.1	0	0	0	0.2	0.3	0.2	0	0	0	0	0	0.1

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Site Name	Case15					Case16					Case17				
Year	2006	2006	2006	2006	2007	2006	2006	2006	2006	2007	2006	2006	2006	2006	2007
Month/Day	2/26	4/30	6/10	8/8	6/13	2/26	4/30	6/10	8/8	6/13	2/26	4/30	6/10	8/8	6/13
Protothaca staminea juv.	0.4	0.2	0.1	0.1	0.2	0	0	0	0	0.3	0	0.1	0	0	0.2
Pseudopythina rugifera	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Pugettia gracilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Punctaria expansa	0	0	0	0	0	0	0	0	0	0	0	0.9	0	0	0
Sabellid (unident.)	0.3	0	0	0	0	0	0	0.1	0	0	1.6	0.1	0.1	0	0
Samytha californica	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0
Sand percentage	49	31.5	39	42.5	50	9.2	5	12	14	13	90	78.5	72.4	70.5	55
Sarcodiotheca sp. (unid.)	0	0	0	0	0	0.2	0	0	0.5	1	0	0	0	0	0
Sargassum muticum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Saxidomus giganteus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Saxidomus giganteus juv.	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Scleroplax granulata	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Scoloplos acmeceps	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scytosiphon simplicissimus	0	0.5	0	0	0	0	4.8	0	0	0.3	0	0	0	0	0.1
Serpulid sp. (unident.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Soranthera ulvoidea	0	0	0.1	0	0	0	0	0.1	0	0	0	0	0	0	0
Sphaeromid isopods	0.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spio filicornis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spiochaetopterus tube	0.3	1	1	1	0.2	0.3	0.2	0.1	0.2	0	0.9	1	1.4	1.4	2.1
Spiophanes berkeleyorum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sponge, unidentified	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stichaeidae (gunnels, pricklebacks)	0	0.4	0.1	0	0	0	0.3	0	0	0.1	0	0	0	0	0
Stronglyocentrotus droebachiensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Syllids (incl. stewarti, heterochaeta)	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0
Tellina modesta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellina nuculoides	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tharyx parvus	0	0	0	0	0	0	0	0.1	0	0	0	0	0.1	0	0
Tonicella lineata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tresus capax	0.1	0	0	0	0	0	0	0	0	0.1	0	0.1	0.4	0.1	0.1
Tresus capax juveniles	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0
Turbonilla sp. (unident.)	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0.1
Ulvoids (unident.)	1.6	20	22.5	5.7	0.1	18.5	84.9	82	45.5	75.9	5.8	1	8.7	12.2	1.3
Urticina sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Venerupis philippinarum (juv.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0

APPENDIX 1. Species found at Case and Edmonds Sites (mean per zone of percent cover for sessile organisms or count for mobile organisms).

Site Name	EdmondsM					EdmondsN					EdmondsS				
Year	2006	2006	2006	2006	2007	2006	2006	2006	2006	2007	2006	2006	2006	2006	2007
Month/Day	2/24	5/1	6/16	8/9	6/18	2/24	5/1	6/16	8/9	6/18	2/24	5/1	6/16	8/9	6/18
Acrosiphonia spp.	0	0.2	0.4	0	0.5	0	0	3.2	0.1	0.6	0	0.3	1.1	0	1.1
Alia spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Allorchestes angusta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ampharete labrops	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Amphiodia spp	0	0	0	0	0	0.5	0.8	0.2	0.3	0.6	0.1	0.1	0	0	0
Anthopleura artemisia	0.1	0	0.1	0	0.6	0	0	0	0	0.1	0.1	0	0	0	0
Anthopleura elegantissima	0.1	0.2	0.8	0.3	0	0.3	0.6	1.9	1.6	0.5	1	0.4	1	2.1	0.6
Anthopleura spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Armandia brevis	2.6	0.3	0.1	1.8	6.6	0.9	1	0.1	0.5	9.3	1.9	0	0.1	1.8	5.7
Asabellides sibirica	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0
Axiothella rubrocincta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Branched red blades	0	0	0	0	0	0	0	2.7	0	0	0	0	0	0	0
Bryozoa (miscellaneous)	0	0	0	0	0	0.2	1	2.5	3.3	1	0.1	0	0	0.1	0
Calliopius spp.	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0
Calliostoma sp.	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0
Cancer sp.	0	0	0.2	0	0	0	0	0.1	0	0	0	0.1	0.1	0.2	0.1
Cancer sp. Juvenile	0	0	0.4	0	0	0	0	0.1	0.4	0	0	0	0	0.2	0
Capitella capitata	0	0.2	0.6	0.1	0.8	0	0	0.5	0	0.6	0	0	1.4	0.5	0.7
Caulacanthus sp.	0	0	0	0	0	0	0	0.2	2.2	0.1	0	0	0	0	0
Caulleriella ?pacifica	0	0	0	0	0.2	0	0.1	0	0	0.1	0	0	0	0	0.1
Ceramium sp.	0	0	0	0.7	4.2	0	0	0	1.5	0.4	0	0	0	0.7	1.3
Chondracanthus canaliculatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chondracanthus exasperata	0	1	0	0	0	0	0	0	0	0	0	0.5	0	0	0
Cirratulus multioculatus	0.2	0.6	1.3	1.2	1.4	0.7	0	0.3	0.3	0	0	0	0.1	0.1	0.1
Clinocardium nuttallii	0	0	0.1	0.1	0	0	0	0	0	0	0.2	0.1	0	0	0.1
Clinocardium nuttallii juveniles	0	0	0	0	0.7	0	0	0	0	0.2	0.1	0	0	0	0.5
Cobble percentage	77.5	73	64.5	70	38.5	71	75.5	74	68	51.5	71	73	75.5	72.5	47.5
Colpomenia sp.	0	0	0	0	0	0	0	0.1	0	0.2	0	0	0	0	0
Cottidae (sculpins)	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Crepidula dorsata	0	1.3	0	0.1	0	0	0.1	0.2	0	0.1	0	0.3	0.2	0	0
Crepidula fornicata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cryptosiphonia woodii	0	0	0	0.1	0.1	0.1	0.2	1.6	0.3	1	0	1.5	0.2	0.1	0.5
Dead barnacles (Class Cirripedia)	27.5	10	11	8	4.6	20.5	8	9	4.6	24.5	12	7	9	4.2	10.7
Decamastus gracilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dendraster excentricus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dendraster juv. in core	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Desmarestia spp.	0	0	0	0	0	0	0	0	0	0	0	0.5	0.1	0	0
Diatoms, chain-forming	1.9	27	0.2	1.7	1.7	0	16	0	1.2	1.2	5	20	0.6	0.5	2.1

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Site Name	EdmondsM					EdmondsN					EdmondsS				
Year	2006	2006	2006	2006	2007	2006	2006	2006	2006	2007	2006	2006	2006	2006	2007
Month/Day	2/24	5/1	6/16	8/9	6/18	2/24	5/1	6/16	8/9	6/18	2/24	5/1	6/16	8/9	6/18
Dorvillea japonica	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0
Dorvillea longicornis	0	0	0	0	0.2	0	0.2	0	0	0.7	0	0	0	0	0
Edwardsia sipunculoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eobrolgus chumashi	0	0	0	0	0.2	0	0	0	0	0	0	0	0.1	0	0
Eteone longa	0	0	0	0	0	0	0	0	0.1	0.1	0	0	0	0.1	0.1
Eteone tuberculata	0	0	0	0	0	0.1	0	0	0	0	0.1	0	0	0	0
Euclymene spp.	0	0.2	0	0.2	0.2	0.6	1.5	1.5	1.2	1	0.3	0.2	0.8	0.9	0.1
Eulalia viridis	0.1	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0
Evasterias troschelii	0	0	0	0	0	0	0	0.1	0	0	0	0.1	0	0	0
Family Hippolytidae	1.8	0.6	0	0	0.15	0.25	0.1	0	0	0	1.8	0.85	0.1	0.15	0.1
Flatworm (unident.)	0	0.2	0	0.1	10.7	0	0.1	0	0	4.5	0	0	0	0	5.8
Fleshy crust	5.3	5.8	5	15	1.4	16.5	14.5	27	41.5	6.6	4.8	12	12	22	2.6
Fucus gardneri	1	1.6	3.5	3	3.3	5.6	10	5.8	8.6	0.5	0.1	0.5	0	0.6	4.2
Gammarid amphipods	0	0	0.6	0.2	0	0.3	2.7	1.7	1.3	0	0	0.1	0	1.2	0
Gelidium spp.	0	0	0	0.1	0	0	0	0.2	0.1	0.2	0.1	0	0	0	0.2
Glycera americana	0.1	0.1	0.4	0.3	0.4	0.2	0.6	0.5	0.6	0.5	0.1	0.1	0.1	0.3	0.3
Glycinde picta	0.1	0	0	0.3	1	0	0.1	0	0	1.9	0	0.1	0	0.2	1.4
Glycinde polygnatha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gnorimosphaeroma oregonense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gracilaria pacifica	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0
Grandidierella japonica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grateloupia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnel (unident.)	0	0	0	0.4	0	0	0.1	0	0	0	0	0	0	0.3	0
Halcampa decemtentaculata	0	0	0	0	0	0.2	0.1	0.1	0.4	0.2	0	0	0	0	0
Harmothoe imbricata	0	0	0	0	0.1	0	0	0	0	0.4	0	0	0.1	0	0.2
Hemigrapsus nudus	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0
Hemigrapsus oregonensis	0.5	0.1	0	0	0	0.2	0.1	0.1	0	0	0	0	0	0	0
Hemipodus borealis	0.1	0.2	0.1	0.1	0.4	0.9	0.3	0.5	0.3	0.6	0.1	0.2	0.1	0	0
Hermissenda crassicornis	0	0.2	0.3	0	0.6	0	0	0.1	0	0.3	0	0.2	0.1	0	0.9
Hyale frequens	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0
Kefersteinia sp.	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0
Lacuna vincta	0	0	0.7	10.8	27.5	0.2	0.1	0.3	0.1	19	0	0	1.7	11.6	30.5
Laminaria saccharina	0	0	0	0	0	0	0.3	0	0	0	0	2	0	0	0
Leitoscoloplos pugettensis	0.1	0.1	0.2	0.1	0.2	0	0	0	0	0.4	0	0	0.3	0	0.1
Lepidasthenia berkeleyae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidochitona dentiens	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0
Leptochelia dubia	0	0.3	0.2	0	0.5	0	0	0.2	0	0.9	0.1	0.4	0.3	0	0.6
Leptosynapta clarki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Site Name	EdmondsM					EdmondsN					EdmondsS				
Year	2006	2006	2006	2006	2007	2006	2006	2006	2006	2007	2006	2006	2006	2006	2007
Month/Day	2/24	5/1	6/16	8/9	6/18	2/24	5/1	6/16	8/9	6/18	2/24	5/1	6/16	8/9	6/18
Lirularia sp.	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
Littorina scutulata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Live barnacles (Class Cirripedia)	3.4	1.4	0.9	2.4	27.5	5.8	1.8	1.8	1.8	18.7	4	2.2	0.5	0.9	45.2
Lophopanopeus bellus bellus	0.2	0.7	0	0	0	0.5	0.8	0.3	0.1	0	0.1	0.1	0.2	0	0.2
Lottid limpets	25.5	16	5.5	9.3	7.5	36	11.6	10.9	6.3	16.2	22.5	32.5	9.7	10.3	7
Lucina tenuisculpta	0.1	0	0.3	0.1	0.7	0.2	0.4	0	0.2	0.7	0.2	0.4	0.2	0.1	1.3
Lumbrineris zonata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Lyonsia californica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Macoma inquinata	1	0.6	1	1	2.3	1.1	0.8	1.7	1.4	0.4	0.9	0.8	1.5	1.4	0.1
Macoma inquinata juveniles	3.1	2.1	0.8	1.9	1.8	1.3	1.9	2.4	3.3	3.6	1.2	0.4	0.5	1.9	1.7
Majid (spider) crab	0	0	0	0	0	0.4	0	0.1	0	0	0.3	0	0.3	0.4	0
Majid juvenile crab	0	0	0	0	0	0	0	0	0.6	0	0	0	0	0.1	0
Malacoceros glutaeus	0	0	0.3	0	0	0.1	0	0.1	0	0.1	0	0	0	0	0
Malmgreniella nigralba	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0
Margarites sp.	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0
Mastocarpus sp.	1.6	2.2	4.2	6.2	6	7	4.6	0	9	8	1.7	1.8	3.8	5.2	6
Mazzaella heterocarpa/oregona	0	0	0.2	2.4	0.1	0	1	0.9	2.4	1.3	0	0	1	0.3	1.6
Mazzaella sp.	0	0	0	0	0	0	1.5	0	0	0	0.5	0	0	0	0
Mazzaella splendens	0.2	1.6	0.5	0	0.5	0.3	2	2.2	0.1	2.2	0	4.1	1.6	0	0.1
Mediomastus californiensis	6.6	11.5	14.1	10.2	21.7	13.5	21.5	34.4	23.4	20.2	6.5	13.4	19.1	10.5	11.8
Metridium sp.	0	0.3	0	0	0	0	0	0	0	0	0.2	0	0	0.2	0.1
Micropodarke dubia	0	0.6	0.2	0	0	0	1.4	0	0	0	0	0.6	0	0	0
Monocorophium spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mooresamytha bioculata	0	0	0	0	0	0.1	0	0	0	1.1	0	0	0	0	0.1
Mopalia lignosa	0.5	0.7	0.8	1.3	0.4	1.2	0.3	0.4	1	0.5	0.9	0.6	1.3	1	0.5
Mopalia muscosa	0.2	0.1	0.3	0.2	0	0.2	0	0.2	0.4	0.3	0.1	0	0	0.8	0
Mopalia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mysella tumida	0.2	0	0.1	0	0.1	0	0	0.2	0.3	0.5	0	0.5	0.3	0	0
Mytilus trossulus	0	0	0	0	0.1	0	0	0	0	0.9	0	0	0	0	0.8
Nassarius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nemertean (unident.)	0.6	0.8	0.7	0.4	2.7	0.6	0.4	0.3	0.2	1.6	0.4	0.2	0.6	0.4	2.1
Neoamphitrite robusta	0	0	0	0	0	0	0.1	0	0.2	0	0	0	0	0	0
Neotrypaea californiensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nephtys caeca	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0
Nephtys caecoides	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0.1
Nephtys ferruginea	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nereis procera	0.1	0	0.1	0.1	1.7	0	0.1	0.3	0.2	0.8	0.4	0.4	0.2	0.4	1.6
Nereis vexillosa	0	0	0	0	0.1	0	0	0.1	0.1	0.3	0	0	0.1	0.1	0

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Site Name	EdmondsM					EdmondsN					EdmondsS				
Year	2006	2006	2006	2006	2007	2006	2006	2006	2006	2007	2006	2006	2006	2006	2007
Month/Day	2/24	5/1	6/16	8/9	6/18	2/24	5/1	6/16	8/9	6/18	2/24	5/1	6/16	8/9	6/18
Nicomache personata	0	0.1	0	0	0	0	0.4	0.1	0.1	0	0	0	0	0	0
Notomastus lineatus	0	0	0	0	0	0.1	0.1	0	0.2	0	0	0	0.1	0.3	0
Notomastus tenuis	0.6	0.4	0.1	0.6	0.5	2.1	0.9	5.5	8	5.9	0.2	0.7	0.5	0.1	1.8
Nucella lamellosa	12.4	3.8	1.3	1.5	3.1	5.2	3.1	0.7	1.4	2.9	6.8	1.2	1.7	3.4	2.3
Odonthalia floccosa	0	0	0	0	0.5	0	1.3	0	0.1	0.4	0	0	0	0	0
Odostomia sp. (unident.)	0	0	0.1	0	0.1	0	0	0	0	0.2	0	0	0	0	0
Onchidoris bilamellata	0.3	0	0	0	8.1	0	0	0	0	1.5	0	0	0	0	14.6
Onuphis elegans	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ostrea lurida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Owenia fusiformis	1.5	1.6	0.7	0.9	2.3	5.2	2.8	1.3	2.4	4.3	3.2	4.6	1.4	0.9	0.5
Pagurus spp.	2.8	3.7	2.1	1.2	2	5	4	1.9	5.8	3.6	3.1	3.6	7.2	1.6	3
Petalonia fascia	0	1.2	0.5	0	0.3	0	2.9	0.1	0.1	0	0	2.8	1.2	0.1	0.6
Petrolisthes sp.	0	0.1	0	0	0	0.1	0	0.1	0	0	0	0	0	0	0
Pholoe minuta	0.1	0.1	0.1	0.1	0.2	0.1	0.5	0.4	0.4	0.3	0	0	0	0.2	0
?Pholoides asperus	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0
Phoronopsis harmeri	0.4	0.8	0.9	1.2	1.4	0.7	0.8	1.2	0.5	2.2	1.8	4.9	1.9	1.9	1.4
Phyllodoce maculata	0.1	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0.1
Pinnixia faba	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0
Pinnixia schmitti/occidentalis	0	0	0	0.2	0	0.2	0.5	0.2	0.3	0.3	0.2	0	0	0	0.1
Pisaster ochraceus	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0
Platynereis bicanaliculata	2.8	1.5	1.1	0.1	0	0.8	0.8	0.3	0.4	0.2	1.1	2.7	0.6	0	0
Podarke pugettensis	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0
Podarkeopsis glabrus	0	0	0	0	0.3	0	0	0	0	0	0.2	0	0	0	0.1
Pododesmus cepio	4.1	2.1	1	1.9	0.5	8.7	9.2	2.4	3.5	1	1.6	1.5	1.7	0.1	0.3
Polinices lewisii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polycirrus n. sp. (L. Harris)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polydora ?websteri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polydora cardalia	0	0	0	0	0.4	0	0	0	0	0.4	0	0	0	0	0.1
Polydora columbiana	0	0	0	0	0.1	0	0	0	0	0.4	0	0	0	0	1.2
Polynoid (unident., in quadrat)	0	0	0	0	0.7	0	0.1	0	0.1	0.4	0.1	0.1	0.1	0.2	0.9
Polysiphonia sp. (unident.)	5.2	0	1.9	1.2	2.5	6	0	5.2	3.3	1.1	1.7	0.2	0.4	0.9	1.9
Pontogeneia ivanovi	0	0	0.2	0	0.2	0	0	0	0.1	0.8	0	0	0	0	0
Porphyra sp.	0	0.4	2.9	0	2.3	0	0.1	2	0.2	0.7	0	0.7	2.3	0	3
Potamilla sp.	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0
Prionitis sp. (unident.)	0	0	0	0	0	0.1	0	0	0.1	0.5	0	0	0.1	0	0
Prionospio multibranchiata	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0
Prionospio steenstrupi	0.1	0.1	0.1	0	0	0.7	0.7	0.3	0.1	0	0	0	0.1	0	0
Protothaca staminea	0	0	0.2	0.4	0.4	0.3	0	0.3	0.1	0	0	0.1	0.4	0	0.1

APPENDIX 1. Species found at Case and Edmonds Sites (mean per zone of percent cover for sessile organisms or count for mobile organisms).

Site Name	EdmondsM					EdmondsN					EdmondsS				
Year	2006	2006	2006	2006	2007	2006	2006	2006	2006	2007	2006	2006	2006	2006	2007
Month/Day	2/24	5/1	6/16	8/9	6/18	2/24	5/1	6/16	8/9	6/18	2/24	5/1	6/16	8/9	6/18
Protothaca staminea juv.	0.4	0.4	0.3	0.6	0.1	0.2	0.3	0.9	0.6	1.2	0.8	0.1	0	0.6	1
Pseudopythina rugifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pugettia gracilis	0	0	0	0.5	0.8	0.2	0.1	0	0	0.2	0	0.1	0	0	0.6
Punctaria expansa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sabellid (unident.)	1.4	1	0.3	0.6	0.5	0.2	0.1	0.3	0.3	0.1	0.3	1.1	0.2	0.1	0.4
Samytha californica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sand percentage	3.8	9	11.6	10.1	12	13	12	8.6	9	11	13.6	12	14	18.5	10.6
Sarcodiotheca sp. (unid.)	0.1	0.5	0.5	0.2	0.2	0.2	0.4	0.1	0.4	0.2	0	0.3	0.6	0.4	0.6
Sargassum muticum	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0.1	0
Saxidomus giganteus	0.1	0.1	0	0	0.2	0.2	0.1	0.1	0.1	0	0	0.1	0	0	0.1
Saxidomus giganteus juv.	0.4	0.2	0.2	0.1	0.5	0.2	0.1	0.3	0	1.4	0	0.1	0.2	0.1	1.1
Scleroplax granulata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scoloplos acmeceps	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2
Scytosiphon simplicissimus	0	0.3	0.1	0	0	0	0.9	0.6	0	0.5	0	0.4	0.4	0	0
Serpulid sp. (unident.)	0	0	0	0.2	0	0	0.1	0	0	0	0	0	0	0	0
Soranthera ulvoidea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sphaeromid isopods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spio filicornis	0	0	0	0.3	1	0	0	0.1	0.2	9.4	0	0	0	0	1.9
Spiochaetopterus tube	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spiophanes berkeleyorum	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0
Sponge, unidentified	0	0	0	0.5	0	0	0	0.1	0.1	0	0	0	0	0	0
Stichaeidae (gunnels, pricklebacks)	0	0.1	0.2	0	0.2	0	0	0.2	0	0	0	0	0	0	0.1
Stronglyocentrotus droebachiensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2
Syllids (incl. stewarti, heterochaeta)	0	0	0	0	0	0	0	0	0.3	0.1	0	0	0.1	0	0
Tellina modesta	0.1	0.1	0.3	0.2	0	0	0	0	0.1	0.4	0.2	0	0.4	0.4	0.2
Tellina nuculoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tharyx parvus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tonicella lineata	0	0	0	0	0.1	0	0	0	0	0.1	0	0	0	0	0
Tresus capax	0.1	0.8	0.1	1.5	0.8	0	0.2	0	0.3	0.1	0.4	0.3	0.6	1.8	0.2
Tresus capax juveniles	0.1	0	0	0	5.2	0	0	0	0	11.7	0	0	0	0	8.3
Turbonilla sp. (unident.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ulvoids (unident.)	3.4	16	79.5	88.4	91.2	6	21	88	84	43	1.8	20.5	89	93.6	85
Urticina sp.	0	0	0	0	0	0.3	0	0	0	0.2	0	0	0	0	0
Venerupis philippinarum (juv.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX 2. Species found at Woodard Bay Sites (mean per zone of percent cover for sessile organisms or count for mobile organisms).

sitecode	WoodardA				WoodardB				WoodardC			
date	8/3 - 8/4, 2005		8/27/2007		8/3 - 8/4, 2005		8/27/2007		8/3 - 8/4, 2005		8/27/2007	
zone	0	4.9	0	4.9	0	4.9	0	4.9	0	4.9	0	4.9
Alia spp.	0	0	0.4	0	0	0	0	0	0	0	0	0
Allorchestes angusta	0	0	0	0	0	0.1	0	0	0	0	0	0
Americorophium salmonis	0	0	0.2	0.2	0	0	0	0.4	0	0	0	0
Anisogammarus pugettensis	0	0	0.1	0	0	0	0	0	0	0	0	0
Aphelochaeta multifilis	0	0	0	0	0	0	0	0	0.1	0	0	0
Armandia brevis	0	0	0.1	0	0	0	0	0	0	0	0	0
Cancer sp.	0	0	0.1	0	0	0	0	0	0	0	0	0
Cancer sp. Juvenile	0	0.1	0.2	0	0	0	0	0	0.2	0	0	0
Capitella capitata	0	0	0	0.1	0	0	0	0	0	0	0	0.7
Clinocardium nuttallii	0	0	0	0	0	0	0	0	0.3	0	0	0
Clinocardium nuttallii juveniles	0	0	0.6	0	0	0	0.3	0	0	0	0.5	0.2
Cobble percentage	0	1.1	0	0	0	0	0	0	0.1	1.5	0	0
Crepidula dorsata	0.5	0	0	0	0	0	0	0	0	0	0	0
Crepidula fornicata	0.2	0.1	0	0	0	0	0	0	0.6	0	0.1	0
Dead barnacles (Class Cirripedia)	1.3	1.8	0.1	0.6	0.4	0.5	1.1	0.5	2.2	1.6	4.4	1.2
Dendraster excentricus	0	0	0	0	0	0.1	0	0	0	0	0	0
Diatoms, chain-forming	0	0.1	0	0	0	0	0	0	0.1	0	0	0
Eulalia spp.	0	0	0.1	0	0	0	0	0	0	0	0	0
Family Hippolytidae	0	0	0.2	0	0	0	0.6	0	0	0	0	0
Flatworm (unident.)	0	0.4	0	0	0	0	0	0	0.1	0	0	0
Gammarid amphipods	5.5	3.5	8.3	3.5	7.8	0.1	1.2	7	9.2	5.4	4.6	1.4
Glycera americana	0	0	0.3	0	0	0	0.1	0.1	0	0	0.1	0
Glycinde picta	0.2	0	0.5	0.6	0.4	0.2	0.6	0.2	0.1	0	0.1	0
Grandidierella japonica	0	0	0.5	0.1	0	0	0.1	0.3	0	0	0	0
Haminoea vesicula	0	0.2	0.8	7.8	1.3	0.6	0.1	8	5.9	0	0.7	0
Harmothoe imbricata	0.1	0	0.1	0	0	0	0.2	0	0.1	0	0.1	0
Hemigrapsus oregonensis	0.2	0.5	0.3	0	0	0	0	0	0.1	0.3	0	0
Hemipodus borealis	0.1	0	0	0.7	0.2	0.3	0	0.6	0	2.8	0.2	3.6
Jassa sp.	0	0	0.1	0	0	0	0	0	0	0	0	0
Leitoscoloplos pugettensis	0	0	0	0	0	0	0	0	0.2	0	0.3	0
Leptosynapta clarki	0	0	0	0	0	0	0	0	0	0	0	0.1
Littorina scutulata	0	15.4	0	0	0	0.1	0.1	0	0	0.7	0	0.2
Live barnacles (Class Cirripedia)	1.8	5.8	0.1	1.5	0.4	0.2	0.8	0.5	2.6	4	4.4	1.2
Lottid limpets	0	3	0	0	0	0	0	0	0	0.6	0	0.6
Lyonsia californica	0	0	0	0	0	0	0.1	0	0	0	0	0
Macoma balthica (juv.)	0	0	0	0.1	0	0	0	0.3	0	0	0	0.2
Macoma inquinata	0.1	0.2	0	0	0	0	0	0	0	0.1	0	0
Macoma inquinata juveniles	0	0	0	0	0	0	0	0	0	0	0.1	0.1
Macoma nasuta	0	0.3	0	0.2	0.1	0	0	0	0	0	0	0.1
Macoma nasuta juv.	0.5	0.2	0.7	1.4	0.9	3	1.6	0.8	0.6	0.3	0.5	0.4
Mediomastus californiensis	0	0	0	0	0	0	0	0	0	0	0	0.1
Monocorophium spp.	0	0	2.6	0.5	0	0	0.1	1	0	0	0.7	0.3
Mya arenaria juveniles	0	0.1	0	0.1	0	0	0	0.5	0	0	0	0.2
Mysella tumida	0	0	0	0	0	0	0.1	0	0	0	0	0
Mytilus trossulus	0	0.3	0	0	0.1	0	0	0	0	0.1	0.2	0.2
Nassarius sp.	0	0	0.2	0	0	0	0.3	0	0	0	2.4	0

APPENDIX 2. Species found at Woodard Bay Sites (mean per zone of percent cover for sessile organisms or count for mobile organisms).

sitecode	WoodardA				WoodardB				WoodardC			
date	8/3 - 8/4, 2005		8/27/2007		8/3 - 8/4, 2005		8/27/2007		8/3 - 8/4, 2005		8/27/2007	
zone	0	4.9	0	4.9	0	4.9	0	4.9	0	4.9	0	4.9
Nemertean (unident.)	0.2	0.1	0	0.2	0	0	0	0.1	0	0	0.1	0
Nephtys caeca	0	0	0	0	0.1	0	0	0	0	0	0	0
Nephtys caecoides	0.1	0	0.2	0	0	0	0	0	0	0	0	0
Nephtys ferruginea	0	0	0	0	0	0.1	0	0	0	0	0	0
Nereis procera	0	0	0	0.1	0	0	0	0	0	0	0.2	0
Notomastus tenuis	0	0.3	0	0.7	0.1	1.6	0	0.7	1	0.4	0.6	1.7
Pagurus spp.	0.2	0.7	0	0	0	0	0.1	0	0.8	0	1	0
Paraprionospio pinnata	0	0	0.1	0	0	0	0	0	0	0	0	0
Phoronopsis harmeri	0	0	0	0	0	0.2	0	0.1	0	1	0.4	0.3
Pinnixia schmitti/occidentalis	0	0	0.1	0	0	0	0	0	0	0	0.2	0
Platynereis bicanaliculata	0	0	0	0	0	0	0	0	0	0	0.1	0
Polinices lewisii	0	0.1	0	0.1	0	0.1	0	0	0	0	0	0.1
Polydora armata	0	0	0	0	0	0	0	0	0	0.1	0	0
Polydora brachycephala	0	0.2	0	0	0	0	0	0	0	0.1	0	0.2
Polydora proboscidea	0	0.1	0	0	0	0.1	0	0	0	0	0	0
Polynoid (unident., in quadrat)	0.1	0	0.2	0	0	0	0	0	0.1	0	0.9	0
Prionospio multibranchiata	0	0	0	0	0	0	0	0	0	0	0.1	0
Protothaca staminea	0	0.4	0	0	0	0.1	0	0	0	0	0	0
Protothaca staminea juv.	0	0.1	0	0	0	0.9	0	0.1	0.1	0	0	0.1
Pseudopolydora kempi japonica	0	0	0	0.1	0	0	0	0.1	0	0.1	0.1	0.2
Sand percentage	98.6	94.6	97.8	96.8	99	99	95	94.6	98.6	94.2	90.8	92.6
Saxidomus giganteus juv.	0.4	0	0	0	0	0	0	0	0	0	0	0
Scleroplax granulata	0	0.2	1.3	0.1	0	0	0	0	0.1	0.6	0	0.3
Scololepis foliosa	0	0	0	0	0	0	0	0	0	0.4	0	0.3
Sphaeromid isopods	0	0	0	0	0	0.1	0	0	0	0	1.5	0
Spiochaetopterus tube	1.5	0.1	0.9	1.1	1.2	0.2	2	0.8	3	0.9	3.4	0.6
Spiophanes berkeleyorum	0.1	0	0.5	0.1	0.1	0	0.5	0	0.2	0	0.1	0
Traskorchestia spp.	0	0	0.2	0	0	0	0	0	0	0	0.1	0
Tresus capax	0	0	0	0.1	0	0	0	0	0	0	0.1	0
Ulvoids (unident.)	26.3	2.7	6.2	2.6	8	0.6	4.7	0.9	53.4	6.4	12.1	2.4
Venerupis philippinarum	0	0.5	0	0	0	0	0	0	0	0	0	0