Abundance of Sessile and Grazer Species

at Four Intertidal Sites in Yaquina Bay, Oregon

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Introduction

Invasions of exotic species in marine ecosystems have become a wide-spread though poorly documented and understood phenomenon (Carlton 1989, Carlton and Geller 1993). Although some introductions apparently have little effect on the recipient community, introduced species can have dramatic, detrimental effects on the native community. For example, the Asian clam, *Potamocorbula amurensis,* has had a tremendous impact on San Francisco Bay by displacing many infaunal species and by dramatically increasing the filtering rate in the bay, thus reducing the amount of food in the water column (Carlton et al. 1990). The weedy green alga, *Caulerpa,* can rapidly dominate a habitat into which it is introduced (e.g., Davis et al 1997) and the introduction of the European Green Crab, *Carcinus maenas*, into Central California waters has had a strong effect on prey and competitor species (Cohen et al. 1995; Grosholz and Ruiz 1995).

Carcinus maenas only recently appeared in Oregon waters and it is likely that the species will spread up the Oregon coast and establish viable populations. This "invasion-in-progress" offers the opportunity to study where and how the crab spreads and how the crab impacts native communities by performing baseline measures of the communities before the invader becomes established. To develop a monitoring program to follow the community structure over time, we performed a preliminary estimate of the abundance of the potential prey species and species that may provide necessary habitat for the recruitment of *C. maenas*. To do this, participants in the Green Crab course surveyed the numeric and cover abundance of common species of barnacles and gastropods (potential prey) and algae (potential prey or canopy for recruitment).

The objectives of this part of the project were to 1) determine appropriate sites to census, 2) determine typical patterns of abundance at these sites, 3) make recommendations for the most effective methods of censusing to document potential changes and 4) make predictions about the effects of *C. maenas* based on the current observed community structure.

Methods and Materials

The four sites sampled were HMSC, Idaho Point, Natural Gas Site, and Sawyer�s Landing (see map). At all of these sites, the high zone was sampled. At HMSC and Sawyer�s Landing, the mid zone was also sampled but the mid zone of Idaho Point and the Natural Gas site lacked sufficient hard substrata. At all of these sites, the low zone consisted of very fine sediment and was not sampled.

At each site/zone, a transect line placed parallel to the water line, and thus, remaining within the zone. We defined the upper edge of the high zone by the upper edge of the barnacles. At those sites where there was suitable substratum below the high high zone, transects were placed well below high zone transects, on the rocky substratum, yet in areas exposed on a +0.5ft low tide. Zonation was often not distinctive enough to allow for quantifiable definitions of zones; nevertheless, the mid and high transects at the sites in which they were both sampled were quite different.

Random numbers were used to determine the placement of quadrats along the transect, as well as above and below the transect. Quadrats used were 50cm on a side (0.25m^^{2}) and were divided by a grid into 25 cells (each 4% of the total) to facilitate visual estimation of cover (Dethier et al. 1993).

To determine the percent cover of sessile organisms, visual estimates were used. Although there can be differences in the ability of individual observers to perform such estimates, especially in speciose communities, variation within our observers were minimized by two factors: first, the number of species that were estimated was relatively small and the species were distinct and, for the most part, easy for even novices to distinguish. Second, the majority of the estimates were made by a just a few individuals that had previous experience performing visual estimates and that had been trained using software designed to increase the accuracy and speed of visual estimation ("BiasBlaster," contact Gary Allison for a copy). Densities of grazers (limpets and littorines) were determined by simple counts of all organisms in the quadrats. The size of the largest and the smallest of the common animals were measured for each of the quadrats. These data are summarized as the total range in size across a given transect (Table 1).

Results

Percent cover

Total cover was highest at the site closest to the mouth of the bay (HMSC) and declined at more inland sites (Figure 1). Bare space was quite common at all of these sites, with the most inland sites often having greater than 70% bare space. The most abundant space occupiers were the barnacle, *Balanus glandula* (Figure 2A), and the algae, *Fucus* spp. (Figure 2B), *Mastocarpus papillatus*, and *Ulva* spp. (which probably included other ephemeral greens that were difficult to distinguish from *Ulva* in the field).

Grazer densities

Mobile grazers were relatively infrequent at the sites we sampled (Figure 3). The most numerically abundant grazer was *Littorina scutulata* and occurred at some densities at all sites we censused. It occurred at highest densities at Idaho Point and at moderate densities at HMSC and Natural Gas site. The other common grazer was the limpet, *Lottia digitalis*, although it only occurred in any substantial numbers at HMSC and densities were quite variable.

Size

We recorded the size of the smallest and largest individuals of the most common animal species (Table 1). For the barnacles (*B. glandula* and *C. dalli*), there were no obvious differences among sites. However, the grazers and mussels were apparently larger at Idaho Point. Although the densities of limpets (*L. digitalis*) and mussels (*M. trossulus*) were highly variable at that site, the littorines were consistently quite abundant and also quite large, compared to other sites.

	Number of quadrats	*Balanus glandula*	*Chthamalus dalli*	*Littorina scutulata*	*Lottia digitalis*	*Mytilus trossulus*
HIGH zones						
HMSC	20	<1-6mm	N/a	<1-9mm	5-15mm	3-11mm
Idaho Pt.	10	<1-8mm	N/a	6-14mm	17-32mm*	2-33mm*
Nat. Gas site	20	<1-8mm	<1-2mm	1-8mm	N/a	N/a
Sawyer�s Landing	10	<1-5mm	N/a	N/a	N/a	N/a
MID zones						
HMSC	18	<1-10mm	<1-2mm	<1-4mm	1-7mm	N/a
Sawyer�s Landing	10	<1-6	N/a	2-8	N/a	N/a

Table 1 � minimum and maximum size of common animal species measured at different sites. N/a indicates that the species was not present or common enough to be measured. * indicates that these measurements are from a small number of individuals found in only one or two of all the quadrats sampled for that site.

Discussion

Patterns

Although these surveys took only 10-20 quadrats within each area and there was a large variability within each transect, several patterns are apparent. The two dominant species of sessile organisms were the barnacle, *Balanus glandula*, and the brown alga, *Fucus* spp. Because it is fairly abundant at all sites, *B. glandula* is an obvious potential prey species for *C. maenas*. Following the abundance of *B. glandula* will likely be a good indicator of the effect of *C. maenas*. Furthermore, if *Fucus* is a necessary requirement for the recruitment of *C. maenas*, than this survey suggests that locations such as HMSC are the more likely to be invaded.

Although none of the sites had high densities of grazers, Idaho Point stood out as different from the others because it had both more and larger animals. The substratum there is quite muddy, even in the mid zone, and it may be that larger crabs such as *Cancer productus* or *Cancer magister* cannot tolerate the fine sediment; thus, at this site, predation pressure may be lower than at other sites. Introductions of the crab to this site may produce strong effects.

Future sampling

One of the primary objectives of this project was to determine an effective methodology to allow detection of changes due to a *Carcinus maenas* invasion. With that in mind, we offer the following recommendations:

Permanent transects: We recommend the establishment of several permanent transects instead of the haphazard placement of a transect line within a subjectively-defined zone. The latter is preferable when a large, well-defined area is to be subsampled and similar such areas are to be compared. However, in this case, the primary goal of this monitoring effort will be to detect changes within a site over time, not necessarily to compare sites. Because �zones� are difficult to define consistently, sampling that used the haphazard-placement method may place the transects in fundamentally different habitats and thereby increase year-to-year variability due solely to the sampling method. This increase in �noise� will likely reduce our ability to detect real changes that occur due to *C. maenas*. Using permanent transects will eliminate much of that noise by providing a consistently defined area to be sampled year after year. One drawback of permanent transects is that inferences cannot be made beyond the transect (or set of transects) to the whole site. Therefore, the set for this project should represent a range of sites and tidal heights around the expected impact area.

Replication: Given the high variability along all of the transects that were performed, we recommend at least 20 quadrats be taken for each transect. It may be beneficial to perform 40 and reduce the number of species that are actually quantified to just those that are greater than 5% (for the sessile species) or more than some minimum number (for the grazers). Because the variability is high across many of these sites, highly-detailed censuses with a small number of replicates are not likely to yield enough power to detect any differences over time.

Performing percent cover estimates: These estimates require some training before students may perform them with enough repeatability to make the data useful. One aspect of that is species identification; students must be familiar with the species they are going to encounter if they are to effectively distinguish among them. Because these communities have a relatively small number of common species, a short field guide and a quick introduction in the field may be all that is necessary. The list of species found in this study should be sufficient. Another aspect is the speed and accuracy of the actual visual estimates. As explained in the methods section, visual estimation of cover can be a very accurate technique for assessing percent cover and much quicker that other methods, *if* observers are sufficiently trained. Most of the observers that collected the data in this report had some previous field experience and had worked with the training program, BiasBlaster, to develop their skills. We recommend that all observers be adequately trained before data collection. In a large group situation, such as the class situation we had, it may work best to have just a few students perform these censuses.

Sizes: we measured the smallest and largest animals in each quadrat which yields data about the extremes of the populations but not necessarily the average population size. Although this method is a quick way of assessing something about size in the population, such measures are can be misleading about the population if there are outliers or skewed size distributions. We suggest that it may be more informative to measure a random subsample of the population within a quadrat.