Temperature and Salinity of the Yaquina Bay Estuary and the Potential Range of Carcinus maenas

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Introduction

In order to predict the potential niche of the *C. maenas* along a salinity gradient in an estuary, one must know its salinity tolerance and the salinity regime of the estuary. In this chapter we focus on how the salinity might affect the distribution of *C. maenas* in the Yaquina estuary. Naylor (1962) states that adult *C. maenas* can tolerate salinities ranging from 5 to 33 parts per thousand (ppt) . *Carcinus maenas* thrives in salinities above 13 ppt., but when salinity drops below 13 ppt, larval development is greatly limited and may even be interrupted (Dries and Adelung 1982).

The objective of this research is to predict the potential salinity niche of the *C. maenas* within the Yaquina estuary. To accomplish this, we measured salinity at various points along the Yaquina River starting in Toledo, Oregon and working our way to the mouth in Newport, Oregon. Our sampling times were selected to include a wide range of salinities. From these measurements, we located a site at which salinity rarely drops below 5 ppt.

Materials and Methods

We sampled twelve sites along the Yaquina Estuary by driving along the Yaquina Bay Road between Toledo and Newport and along the South Jetty to the mouth. The sites were chosen for their relative accessibility and spacing along the estuary.

A temperature compensated refractometer was used to measure salinity and a standard centigrade thermometer was used to measure water temperature. Water samples were taken 15 cm below the surface with a small plastic disposable pipette. In order to prevent contamination of water samples from the previous site, we rinsed the pipette and the refractometer lens two to three times with water from the sample site. The thermometer was placed in the water for three minutes, then read. Our sampling times include expected

salinity extremes: an out-going tide after a prolonged rainstorm (October 12, 1997) and an incoming tide after six days of dry weather (October 18, 1997).

Results

We have included a map showing the Yaquina River and its estuaries (Figure 1). This map is marked off in river miles, starting with RM 0 at the South Jetty in Newport and ending with RM 12.5 at the Georgia Pacific Plant in Toledo. All of our sites have corresponding river miles (Figures 2 and 3).

A table of the salinities and water temperature for various sites at five sampling dates is presented in Table 1. The first four sampling times were stretched out over longer periods because we sampled organisms for other studies. On Nov. 8, 1997, we took samples at all our sites in a relatively short amount of time. Table 2 and Figure 2 summarize the mean salinity from all of our sampling sites while Figure 3 depicts the salinity gradient in Yaquina Bay for November 8, 1997.

We found that salinity decreased from approximately 25 ppt at the South Jetty (RM 0) to < 1 ppt at the Georgia Pacific Plant in Toledo (RM12.5) (Figures 1, 2 and 3). One exception to the smooth decrease in salinity was the sites located at RM 5.2 (River Bend) and RM 4.2 (Sawyer's Landing). On October 12, 1997 and on November 8, 1997 River Bend exhibited higher salinities than Sawyer's Landing even though River Bend is up river from Sawyer's Landing. River channel topography, current patterns and slough drainage patterns may be responsible for this discrepancy.

Water temperature fluctuated between 11°C and 16° C, although on each sample day the temperature among the sites varied by only 2° C to 3° C.

Discussion

Carcinus maenas can tolerate a wide range of temperatures (5-30°) and salinities (5-33 ppt) (Naylor 1962), making the Yaquina Estuary system a potential target for *C. maenas* invasion. Since water temperature ranged from 11° C to 16° C it does not appear to be a limiting factor, at least in the fall. *Carcinus maenas* could possibly penetrate inland as far as RM 11.5 (River Marker 47) at high tides and subsequent points downstream. Looking at mean salinities , we predict that adult C. maenas could be found from RM 10.8 (Critesers Moorage) all the way to RM 0 (South Jetty). Minimum salinity levels would set the distributional limit for *C. maenas* around Craigie Point at RM 9. The salinity levels at the three sites up the estuary from RM 10.8 are too low to allow adult *C. maenas* to survive. In order to metamorphose and settle, larvae need at least 17-19 ppt (Cohen, Carlton and Fountain 1995), so we predict larvae will not be found above the Oregon Oyster Company farm at RM 8 (Table 2).

It may be possible to use the presence of the shore crabs *Hemigrapsus nudus* and *H. oregonensis* as indicators for the potential salinity niche of *C. maenas*. Both of these native crabs osmoregulate their body fluids down to 6 ppt salinity (Dehnel 1962), just slightly higher than the salinity tolerance of *C. maenas*. We found both species of *Hemigrapsus* throughout the estuary from Hatfield Marine Science Center to the Oregon Oyster Company farm (RM 8). A few small *H. oregonensis* were found as far up river as Craigie Point (RM 9). Craigie Point, with its minimum salinity reading of 4 ppt, is the predicted distributional limit for adult *C. maenas*. The advantage of using the presence of live animals as indicators of a salinity regime is that they integrate salinity history over time. Thus, if an adult *Hemigrapsus* is present at a particular site, that site must exhibit salinities of 6 ppt or greater most of the time.

Possible errors in our measurements affecting salinity levels include freshwater sloughs , depth at which measurements were taken and rainy versus dry periods . Our samples reflect points along the north side of the river (with the exception of Idaho Point). On this side, there are two small sloughs where as on the other side of the river there are four large sloughs. Salinity values in the sloughs could differ notably from our values taken at points within the river. Also, the proximity of some of the sloughs to our sampling sites may have an affect on the salinity level at that site. Since salinity measurements were taken at the surface, they may not be indicative of levels in deeper waters. Precipitation could also have affected our measurements. After rainy

periods (October 12) salinity was lower than after a dry period (October 18). Due to the short duration of this project, the range of salinities we measured is not likely to represent the extremes at these sites.

Studies done in San Francisco Bay, California indicate that when *C. maenas* becomes widely abundant, it may significantly affect other organisms by predation, by being preyed on, by competing for food or space, by digging and disturbing the sediments with its feeding activities (Grosholz and Ruiz 1995). The Yaquina River and its estuary system holds favorable water temperature and salinity regimes for *C. maenas*. It is likely that this species will come to reside in the Yaquina River system as well. This indicates that organisms residing in the estuary could face a disturbance by *C. maenas*.

Conclusion

By looking at the mean salinity from site #1 at Georgia Pacific to site # 12 at the South Jetty in Newport, we see a range of mean salinities from .5 to 29.6 ppt. Based on the fact that *C. maenas* can tolerate salinities between 5 and 33 ppt (Naylor 1962), we can safely predict that the crab will not be found between the Georgia Pacific plant in Toledo and River Marker 47. The mean salinities at these two sites are .33 ppt and 4.5 ppt, respectively. C. maenas prefers and thrives in salinities above 13 ppt, indicating that the species may be found as far inland as Craigie Point. The mean salinity at Craigie Point is 11.3 ppt yet we have recorded the salinity to be as high as 16 ppt and as low as 4 ppt.

In conclusion, *C. maenas* may inhabit a large portion of the Yaquina Estuary. We predict that the potential salinity niche is nine miles long, from the South Jetty to Craigie Point.