Spatial and vertical distribution of the invasive European green crab in a temperate estuarine system

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Introduction

- First observed in Yaquina Bay in 1998, following strong El Niño
  - Reduced upwelling facilitates recruitment
- Population in Yaquina Bay not self-sustainable
  - Requires larval input from California populations
- Negative effects on local ecosystems
  - Measurable morphological changes in snails
  - New England soft-shell clam declined by 50% in 4 years, attributed to the establishment of *C. maenas*
- Suppression of *C. maenas* population by native predators
  - Larger native crab (*C. productus, M. magister*)

Abstract

The European green crab, *Carcinus maenas*, is a generalist predator that has established invasive populations throughout the world, including the west coast of North America. In Oregon, strong cohorts of green crabs recruit only during major El Niño events. The goals of this study are to: 1) compare the abundance and growth of the recent 2014-2015 El Niño cohort to that of the strong 1997-1998 El Niño in Yaquina Bay, Oregon, and 2) explore the spatial and vertical distribution of *C. maenas* and how it relates to that of the native red rock crab, *Cancer productus*. An abundance and size distribution similar to the 1997-98 cohort was observed, indicating favorable current patterns and growing conditions brought on by the strong El Niño. We did not find a correlation between the spatial distribution of *C. productus* and *C. maenas*, however it is possible that the distribution is related to the dynamics of the bay or microhabitat preference. Our data suggests a negative correlation in the vertical tidal distribution of the two species, supporting the hypothesis that *C. productus* sets the vertical lower limit of *C. maenas*. Observations of the interactions of the two species in the same trap support this hypothesis. Future studies should follow the 2015 year class and its effects on the local ecosystems. These data could prove a valuable tool in making predictions on the indirect effects of El Niño or the establishment of a self-sustaining *C. maenas* population in Yaquina Bay.

El Niño Growth

- El Niño provides ideal growing conditions in Yaquina Bay
  - Increasing molt frequency
- El Niño drives the recruitment of *C. maenas* larvae into Yaquina Bay and estuary system
  - Persistent northern currents and reduced upwelling
- Observed size-frequency distribution of 2015 cohort similar to 1998 cohort

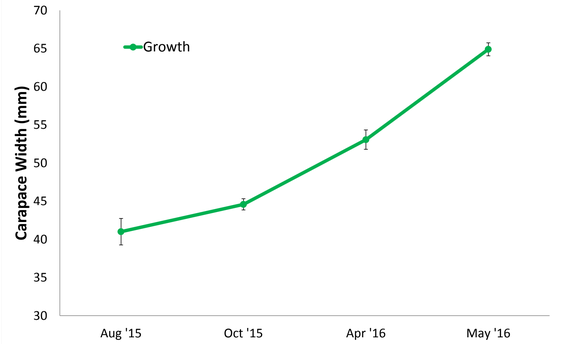

Figure 7: Growth of 2015 year class of *C. maenas* in Yaquina Bay, Oregon. Growth is measured by average carapace width in millimeters per month sampled.

Objectives

- Identify the spatial distribution of *C. maenas* throughout Yaquina Bay and how it relates to the site-specific abundances of *C. productus*
- Make observations of the distribution of *C. maenas* along a vertical gradient in Yaquina Bay and compare with the distribution of *C. productus*
- Document the growth and relative abundances of the *C. maenas* 2015 year class in Yaquina Bay following the strong 2015 ENSO event, make comparisons to the 1997-98 ENSO, and to years of normal atmospheric conditions

Spatial Distribution

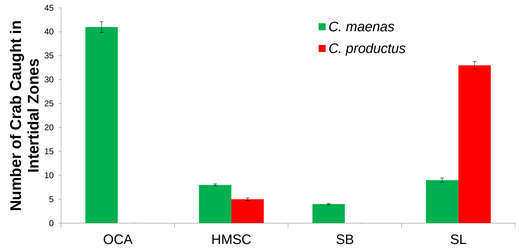

Figure 2: Total amount of *C. maenas* and *C. productus* trapped at 4 sites within Yaquina Bay, Oregon in May 2016.

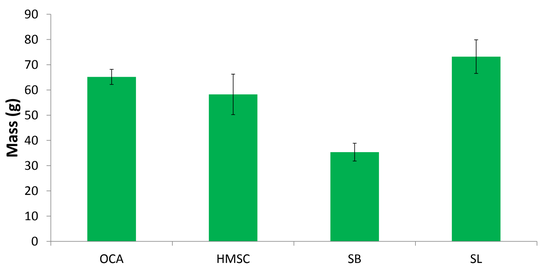

Figure 3: Average mass in grams of *C. maenas* taken from 4 sites within Yaquina Bay, Oregon in May 2016.

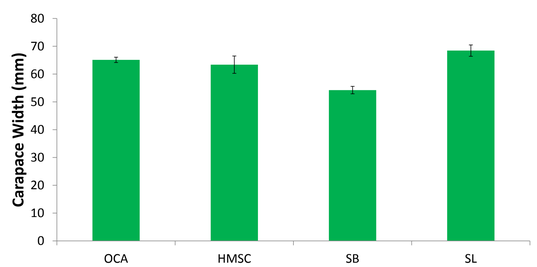

Figure 4: Average carapace width in millimeters of *C. maenas* taken from 4 sites within Yaquina Bay, Oregon in May 2016.

Vertical Distribution

- *Carcinus maenas* more abundant in high intertidal zone
- *Cancer productus* more abundant in subtidal zone
- Data suggests that *C. productus* has an effect on the lower limit of *C. maenas* but does not account for all variation in distribution (p-value < 0.02, MLR)

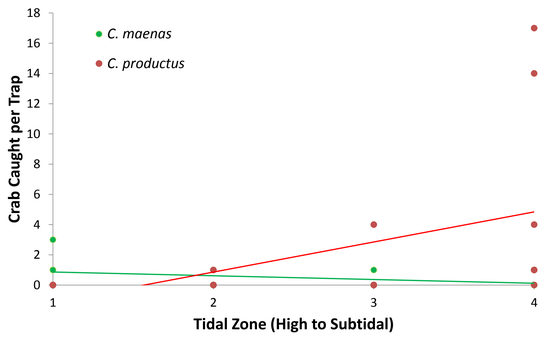

Figure 6: Total numbers of *C. maenas* and *C. productus* caught in traps placed along a vertical tidal gradient in Yaquina Bay, Oregon in May 2016. The high was defined as the point where *Ulva spp.* stopped growing and the low as the point where the trap was half submerged.

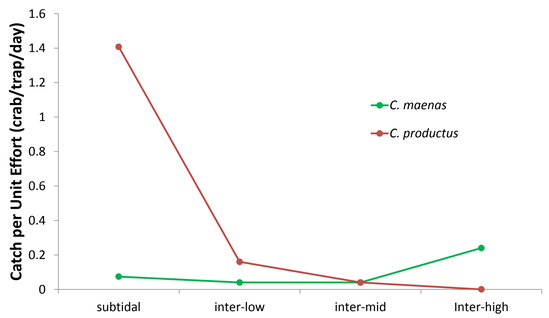

Figure 5: Catch per unit effort of *C. maenas* and *C. productus* calculated from sampling along a vertical tidal gradient in Yaquina Bay, Oregon in May 2016.

Methods

- Utilized Fukui fish traps, with the dimensions 63 x 46 x 23 cm (LWH)
- The sampling for this study took place from 16 May 2016 until 27 May 2016
- All traps checked every 24 hours
- We measured the carapace width (CW) from the tip of the 5th antero-lateral tooth to the corresponding tip on the opposite side of the carapace

- Every green crab was massed
- We performed our analyses using ANOVAs, Tukey analysis tests, and multiple linear regressions on the data

Figure 1 (left): Map showing sampling sites within Yaquina Bay.

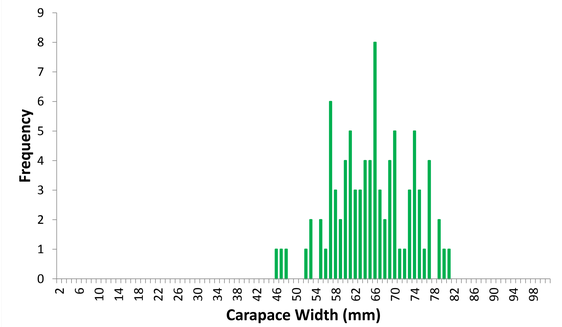

Figure 8: Size frequency distribution of carapace width of *C. maenas* sampled from 4 sites within Yaquina Bay, Oregon in May 2016.

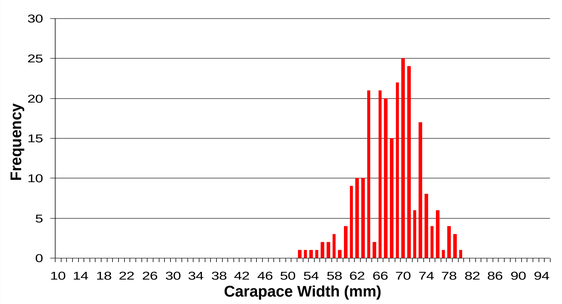

Figure 9: Size frequency distribution of carapace width of *C. maenas* sampled in Yaquina Bay, Oregon in July 1999 (Kalin and Yamada unpublished).

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