

## **Effect of Green Macroalgal Blooms on the Survival, Growth, and Behavior of Cockles in Pacific NW Estuaries**

**Nathaniel S. Lewis and Theodore H. DeWitt**

Nutrient over-enrichment of estuaries is a pervasive issue worldwide that often results in blooms of green macroalgae (GMA; *Ulva* spp.), which can have disruptive and deleterious effects to estuarine flora and fauna. However, little is known of the effects of GMA blooms on the production of estuarine ecosystem goods and services, particularly harvested species of shellfish on tide flats which may be covered by thick mats of GMA. We investigated the vulnerability of intertidal cockle (*Clinocardium nuttallii*) populations in Yaquina Bay, OR, to blooms of GMA which occur from May to October, fueled by upwelled, tidally advected nitrogen. Our surveys revealed that cockle abundance declined with GMA biomass after several months exposure to the thick mats, and that cockles also decreased their burial depth in the presence of GMA mats. Cockles experimentally subjected to constant GMA accumulation in field cages exhibited higher mortality, less growth, decreased burial depth, and greater emigration than those exposed to no macroalgae. Laboratory experiments revealed that the mechanical pressure-effect of GMA accumulation (i.e., weighted surface barrier) on the overlying sediment elicited a more rapid unburial response than exposure to low dissolved oxygen (i.e., near-anoxia) or *Ulva* presence. The combination of surficial pressure and *Ulva* presence evoked the most rapid response. Our cumulative findings indicate that cockles alter their burial strategy by unburying and moving laterally across tide flats in response to the accumulation of GMA. Prolonged exposure beneath GMA can lead to reduced growth or death if the cockles are unable to move away from mats. Cockles appear to be capable of withstanding small-scale, short-term GMA accumulation without much direct negative impact due to their mobility. However, movement to the sediment surface or along the seafloor may increase their exposure to predators, a risk that we are quantifying.