B. Project Summary

Intellectual Merit

Low dissolved oxygen (hypoxia) is one of the most pronounced, pervasive, and significant disturbances in marine ecosystems. Yet, our understanding of the ecological impacts of hypoxia in pelagic food webs is incomplete because of our limited knowledge on how organism responses to hypoxia affect critical ecosystem processes. In pelagic food webs, distribution shifts of mesozooplankton and their predators may affect predator-prey overlap and dictate energy flow up food webs. Similarly, hypoxia may induce shifts in zooplankton community compositions towards species that impede energy flow to planktivorous fish. However, compensatory responses by species and communities might negate these effects, maintaining trophic coupling and sustaining productivity of upper trophic level species. We propose to answer the question "***Does hypoxia affect energy flow from mesozooplankton to pelagic fish?***" We approach this question with a nested framework of hypotheses that considers two sets of processes alternatively responsible for either changes or maintenance of pelagic ecosystem energy flows. We propose to take advantage of the unique opportunity afforded by the Hood Canal, WA ecosystem to address these questions. Unlike most hypoxia-impacted estuaries, hypoxic regions of Hood Canal are in close proximity to sites that are not affected, permitting us to decouple effects of hypoxia from other confounding factors. Hood Canal also supports a diverse mesozooplankton community that is more representative of coastal and oceanic food webs than those present in other estuarine ecosystems where hypoxia has been studied. By combining acoustics and direct sampling of mesozooplankton with bioenergetic modeling of energy flow, we will link observed distributional and compositional shifts in mesozooplankton and fish to pelagic food web energy flux. Thus, this work will deepen our understanding of how hypoxia affects pelagic ecosystems by measuring its effect on the critical and potentially sensitive zooplankton-to-fish food web linkage while quantifying the relative importance processes that are responsible.

Broader Impacts

Improved understanding of how hypoxia impacts marine ecosystems will benefit the practical application of ecosystem-based management in coastal and estuarine ecosystems. Effective application of ecosystem-based management requires that the impacts of human activities are well understood and that ecological effects can be tracked using indicators. Our work contributes to both of these needs. First, by describing the magnitude and mechanisms by which hypoxia affects energy flow to upper trophic level organisms, we can better evaluate the full extent of ecological effects of hypoxia on marine ecosystems. Improved evaluation is critical because current emphasis is often placed on visible effects of hypoxia such as fish kills, but these events may constitute rare occurrences and therefore have less significant ecological effects than those that we propose to quantify. By documenting effects and identifying key processes, we contribute to improved performance measures that can detect ecological effects of hypoxia and better evaluate the success of corrective actions. This information is critical for any agency that manages a marine ecosystem and we will share our findings on local and national levels with Federal, State, Tribal, and County biologists. To increase exposure of science to underrepresented groups, we will provide Native American youth with opportunities to participate in field collections and laboratory processing through summer internships. We will collaborate with the NSF-funded Pacific Northwest Louis Stokes Alliance for Minority Participation and Tribes from the Hood Canal region to recruit and mentor students for potential careers in marine science. This project will support several undergraduate researchers, two Ph.D. students, a post-doc, and two early-career scientists.