WSG Project Number: **R/F-150**
Project Title: Understanding Dispersal and Recruitment Dynamics of a Key Marine Invertebrate Species (*Haliotis kamschatkana*) Using Molecular Techniques for Larval Identification

Project period: 2/1/2004 – 1/31/2008

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PROJECT COMPLETION SUMMARY REPORT

OBJECTIVES and METHODS

Understanding larval dispersal dynamics is imperative for interpretation of stock structure and population dynamics, and for proper management of marine species, especially declining species like the pinto abalone. However, information on dispersal and recruitment of broadcast spawning species is limited. Our objectives:
A. Develop larval Pinto abalone tagging methods using the mtDNA cytochrome oxidase gene, and assess its utility for high throughput detection of target species presence in seawater samples.
B. Characterize larval dispersal patterns under experimental mesocosm conditions and via tagged larval field experiments.
C. Calculate juvenile abalone abundances at index sites, and evaluate based on predictions from larval dispersal predictions.
D. Use our new tools for tracking invertebrate larvae to provide a basis for sound management and enhancement of Pinto abalone by determining larval dispersal and juvenile recruitment patterns.

RATIONALE

This study provided critical tools and information for the restoration and management of a species that may soon be designated as a threatened or endangered marine invertebrate species. Little information exists on marine invertebrate larval dispersal, especially in complex estuarine systems such as Washington's greater Puget Sound and Straits. Nevertheless, understanding dispersal patterns in declining marine species is of paramount importance for restoration efforts. We developed a new tool for analysis of water samples to enable direct detection of abalone larvae in both mesocosm and field studies. Future investigations of larval dispersal will provide direct empirical data on larval behavior in the field and will aid in testing the effectiveness of restoration efforts.

MAJOR FINDINGS

A. We developed a qPCR primer-probe set that exclusively amplifies abalone DNA from seawater samples; the assay we developed is both accurate (no significant differences between direct counts and blind qPCR estimates) and precise (95% of within-run

replicate coefficients of variation were below 2%). This work has been published in the peer-reviewed literature.
B. Samples taken in mesocosm experiments show both tolerances and behaviors of pinto abalone larvae subjected to thermal and salinity gradients. Pinto abalone exhibited positive thermotaxis in 9-18 ºC thermoclines, and positive halotaxis in 26 to 31 psu haloclines relative to non-stratified controls. Within the biologically meaningful ranges tested, salinity had a much greater effect than temperature on survival; we observed >50 percent mortality at or below 23 psu.
C. Over the last two years, we conducted seven exhaustive surveys of 60 juvenile abalone recruitment modules deployed in 2004 at three sites and two depths (3.4 and 6.6 m MLLW). The extremely low incidence of juvenile abalone observations (n=3) is a strong indication of contemporary low recruitment.
D. We have accumulated data on the settlement competency period for larval pinto abalone from three separate spawning events, and observed that at 14 °C, settlement begins around day 6, peaks at approximately day 9, and can extend to day 11.
E. With our collaborators, we have documented significant declines in adult abalone throughout the San Juan Islands. This manuscript is in review.

4. SIGNIFICANCE OF RESULTS

The qPCR assay for quantifying pinto abalone larvae in plankton samples has helped advance similar molecular techniques (5 citations of the work), and the method has been applied directly to burrowing shrimp (*Neotrypea californiensis*) and Olympia oysters (*Ostrea conchaphila*).

The new information on larval pinto abalone behavior will impact our understanding of larval movements and settlement in different environments. Rather than modeling abalone larvae as passive particles that simply flow with water masses, the models can be refined to reflect vertical movement along temperature and/or salinity gradients, yielding much greater resolution and realistic models. Our work on the larval settlement period sheds light on the distance larvae can disperse from their natal sites. The work on swimming behaviors will be submitted in 2008 for publication.

Despite our extensive surveys for juvenile pinto abalone, almost none were found. This finding was corroborated by adjacent index station surveys conducted by Washington State Department of Fish and Wildlife in 2003-2006. The apparent lack of juveniles may signify reproductive, larval, or juvenile failure; for successful restoration of the depleted adult populations it will be important to clarify which of these failures is occurring.

The project supported two graduate students (MS) and fostered collaborations with the Washington Department of Fish and Wildlife, NOAA, and the Puget Sound Restoration Fund. Outreach activities include presentations to resource managers, scientists, and an interpretive poster placed in Western Washington dive shops, marinas, and on state ferries.