Population status of white abalone *Haliotis sorenseni*: the use of remote sensing techniques for recovering the first endangered marine invertebrate

On July 7, 2003 the *R/V David Starr Jordan,* captained by Lt. Cdr. Christopher Moore, left the University of California, San Diego Nimitz Marine Facility for a destination approximately 120 miles off the coast, Cortes Bank. The objectives: 1) survey the Bank for the endangered white abalone, *Haliotis sorenseni*, to improve abundance estimates for the population in the wild; and 2) generate a 3-m resolution bathymetric map of the Bank using multibeam sonar to estimate the amount of potential white abalone habitat on the Bank.

The white abalone was listed as an endangered species on May 29, 2001 (NOAA 2001) effective June 28, 2001, after completing a comprehensive status review of the species (Hobday and Tegner 2000). The decline of white abalone was attributed to over-utilization by commercial and recreational fisheries in the absence of adequate regulatory mechanisms (Hobday and Tegner 2000). The status review identified an urgent need for human intervention in the recovery of white abalone because sub-threshold densities of the animals in nature, resulting in repeated recruitment failure, make it unlikely that the species will recover on its own. In an effort to recover the species, the NOAA Fisheries Southwest Region is currently engaged in assembling a Draft Recovery Plan by December, 2003 with the help of a Recovery Team. The Recovery Team suggested that habitat surveys in areas once known to support large numbers of white abalone was essential to determine: 1) the current status of the population in nature; 2) the amount of potential white abalone habitat in the wild; and 3) identify sites where future enhancement efforts should be focused.

Approximately 80,000 pounds (weight in shell) of white abalone were landed at Tanner and Cortes Bank from 1955-1993 according to California Department of Fish and Game (CDFG) data, making these offshore Banks the most productive white abalone fishing grounds in California after San Clemente Island. These statistics brought scientists, lead by Dr. John Butler (NOAA Southwest Fisheries Science Center-SWFSC) and Dr. Rikk Kvitek (California State University, Monterey Bay-CSUMB), to Tanner Bank in 2002 and Cortes Bank in 2003. The cruise to Tanner Bank revealed a mean density of approximately 30 white abalone per ha, several orders of magnitude lower than the estimated pre-exploited density of 10,000 per ha. One hundred and ninety-four white abalone were positively identified and their GPS coordinates were logged. An area of 107 km^2 was mapped using high-resolution bathymetry and of that 1450 ha was white abalone habitat. This estimate of white abalone habitat was much greater than that previously reported for all of California (752 ha) by Hobday and Tegner (2000). Using densities from ROV surveys and habitat area from high-resolution bathymetry, a population estimate of approximately 30,000 was obtained from the area surveyed on Tanner Bank. “This result greatly changes our understanding of white abalone abundance”, said Butler. “Previous estimates of white abalone abundance were much smaller because the estimates of habitat area were underestimated”. It was concluded that further work with multi-beam sonar and ROV surveys was needed to establish present white abalone abundance and distribution. “This information is critical to developing a sound recovery plan”, said Dr. Melissa Neuman (NOAA Fisheries Southwest Regional Office-SWR), “Without knowing what the population status is now, it will impossible to gauge the success of recovery actions”.

Fastforward one year. The same approach was used to mount a habitat mapping and population assessment effort on Cortes Bank. After six days of searching the Bank, 19 white abalone, 9 pink abalone, one unidentified abalone and 116 shells were identified. The densities of white abalone

observed on Cortes Bank were about 3 per ha at 30-40m depth, 8 per ha at 40-50m depth, and 3 per ha at 50-60m depth. These densities are an order of magnitude lower than the mean density reported for Tanner Bank (30 per ha), but is similar to the value of reported by Hobday et al. 2001 for Tanner and Cortes Banks (7.85 per ha). The total white abalone habitat area has not yet been calculated, but it will be much greater than the 242 ha reported by Hobday et al. (2001). Certain characteristics of white abalone identified on the two Banks were similar. The identified animals were primarily solitary (> 2m apart from each other), confirming the collective opinion of the White Abalone Recovery Team that the densities of white abalone in the wild are too low for successful reproduction. Also, all of the animals identified were large (> 90 mm) suggesting that the last successful recruitment event occurred at least a decade ago.

The techniques employed during these cruises have proved extremely valuable for the recovery and conservation of white abalone and, more generally, for furthering the mission of NOAA Fisheries. "The high data capture rate and 3D imaging capability of multibeam bathymetry sonar make it the ideal tool for identifying and quantifying the preferred level of topographic relief and landscape features within the depth range of the target species", said Kvitek. These features, combined with the near real-time production of high-resolution topographic relief maps for immediate use by the ROV pilots, greatly increases the efficiency of ROV surveys as well as the accuracy of preferred habitat area estimates. Multibeam sonar has an advantage over sidescan sonar for this type of work because depth and topography are critical to identifying the target habitat. For white abalone, multibeam is clearly the tool to use for safe and efficient ROV deployment. The extension of ROV and multibeam sonar remote sensing technology to other areas along the coast of southern CA, the Channel Islands, and Baja California will be crucial for re-establishing white abalone throughout its historical range. In addition, the potential for addressing other federal and state agency initiatives exists. For example, the marriage of ROV and acoustic remote sensing technologies can help to advance ocean exploration through non-destructive sampling techniques, determine critical habitat for endangered and threatened species, aid in establishing marine reserves, and manage fisheries resources.

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