# Assessing the amount of suitable habitat and the population size of black abalone from Half Moon Bay to Point Conception

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## INTRODUCTION

Black abalone (*Haliotis cracherodii*) have experienced mass mortalities along the coast of California since the mid-1980s and are now protected under the USA Endangered Species Act. Mortality is due to poaching and a fatal wasting disease called "withering syndrome" (WS) (Figure 1). Working with MARINe (Multi-Agency Rocky Intertidal Network) and PISCO (Partnership for Interdisciplinary Studies of Coastal Oceans) monitoring groups, we have documented their decline along the California coast. We began monitoring black abalone in 1992 and currently sample abalone populations at 27 sites from Point Conception to Half Moon Bay (Figure 2). Research has shown that for black abalone populations to be ecologically viable there needs to be at least one mature individual per square meter or recruitment of new individuals is completely suppressed (Miner et al. 2006). The last extant, large and healthy populations exist in the Monterey Bay National Marine Sanctuary- *their area of ecological viability*.

**Figure 1. Photograph of a healthy (top) and withered (bottom) black abalone .**

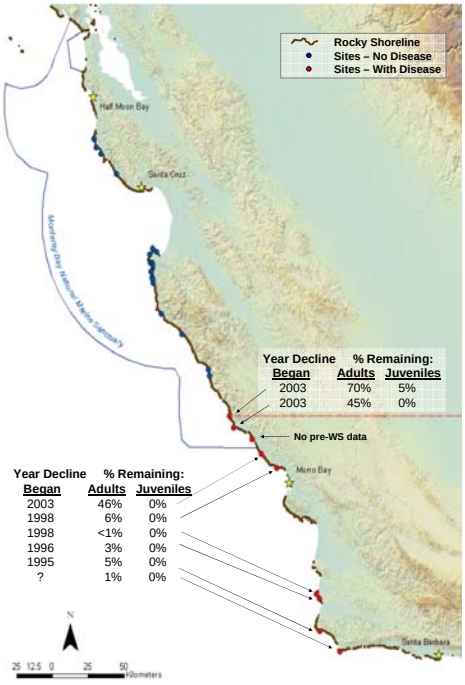


**Figure 2. Map with black abalone sampling locations. No declines due to "withering syndrome" have been documented at sites north of the dashed red line (San Simeon). Percent remaining individuals were calculated by dividing current counts by the mean number of individuals at each site in the years preceding WS decline.**

To assess change in abundance and size structure we initially established plots where abalone occurred in relatively high densities. However, this design may be unsuitable for estimating the entire population size for two reasons. First, abalone may be spatially clustered along the shore in "hot spots" such that our monitoring sites may not be representative of other locations along the coast. In addition, current coastal geology maps allow for discrimination between sand and rock, but not among geomorphologies within rocky shores. Abalone tend to be associated with specific geomorphologies such as deep cracks and crevices dominated by bare rock and crustose coralline algae. Therefore, we designed a study to determine the amount of suitable habitat available for black abalone and to estimate their population size from Half Moon Bay to Point Conception.

**Figure 3. Researchers counting and measuring black abalone.**

## OBJECTIVES

1. **Determine if suitable abalone habitat is spatially clustered.**
2. **Estimate the amount of suitable habitat available for black abalone within our study area.**
3. **Estimate the population size of black abalone from Half Moon Bay to Point Conception.**

## METHODS

We sampled intertidal areas for black abalone (Figure 3) and also characterized the quality of habitat suitable for abalone occupation as: Good Habitat (Figure 7), Moderate Habitat (Figure 8), and Poor Habitat (Figure 9). The sampling design used a gradient of sample areas away from an area of known suitable habitat within the tidal range of black abalone. The center of the gradient was an existing monitoring site (Figure 4).

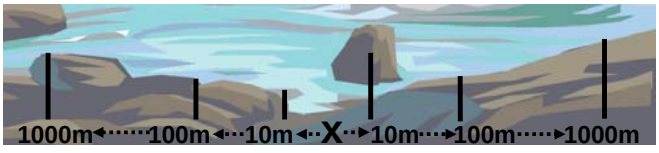


**Figure 4. Diagram of sampling design with bars denoting 10m wide swaths where abalone were sampled. Areas were sampled at shown intervals from an existing abalone monitoring site (X).**

## PRELIMINARY RESULTS

We found that suitable habitat is not spatially clustered. As expected, we found strong correlation between the quality of habitat and the density of abalone (Figure 5). Using GIS layers from the Coastal Impact Assessment Program (MBNMS) we calculated the amount of rocky shoreline within our study area to be roughly 350 km. This information, when combined with our data, allowed us to estimate the amount of suitable abalone habitat available in areas with and without disease (Figure 6).

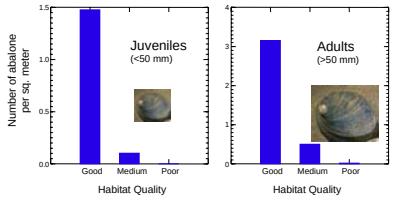


**Figure 5. Density of juvenile and adult black abalone at three levels of habitat quality.**

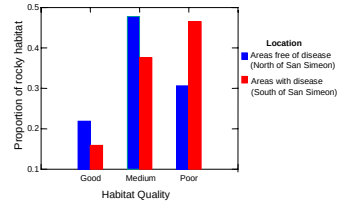


**Figure 6. Estimated proportion of good, medium and poor black abalone habitat inside and outside areas where "withering syndrome" has occurred.**

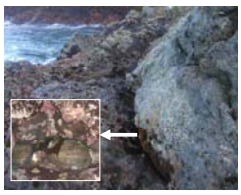

**Figure 7. Predominately GOOD abalone habitat with inset of abalone in deep crack with crustose coralline algae.**

**Figure 8. Predominately MODERATE black abalone habitat with shallow cracks, depressions and mixed algae.**

**Figure 9. Predominately POOR black abalone habitat showing bedrock without cracks and crevices.**

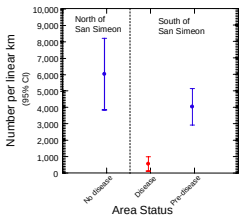


**Figure 10. Estimated number of black abalone north of the "withering syndrome" declines and the number south of San Simeon pre and post WS outbreak.**

Our monitoring has shown that once a population crashes the community structure is altered and the habitat quality changes. For example, cracks that were once dominated by bare rock and crustose coralline algae become filled with sessile invertebrates and sea urchins. While the number of abalone per linear km is dramatically different in areas with and without disease, the numbers of abalone in areas free of disease is similar to pre-disease areas in the south (Figure 10). We also found that in areas with disease there is almost no recruitment (Figure 11). Likewise, in areas with disease, the average density of mature abalone is <1 individual per square meter which is not enough for reproductive success (Figure 12). Pre-disease, the population between Half Moon Bay and Santa Barbara was approximately 1.9 million. Overall, the diseased population declined by 85%. Currently, our best estimate of the black abalone population within our study area is 1.3 million (+/-500,000) of which 92% are in their area of ecological viability. If the disease continues its northward progression, the total population could crash to 300,000 individuals. Our data on recruitment and habitat alteration post-disease suggest that without intervention the recovery of black abalone in areas decimated by "withering syndrome" is unlikely.

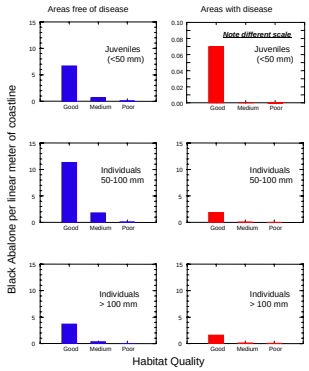


**Figure 11. Estimated number of different size classes of black abalone at three levels of habitat quality inside and outside of areas where "withering syndrome" has affected populations.**

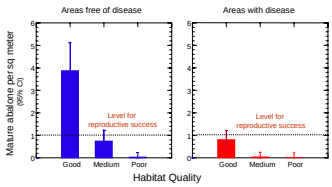


**Figure 12. Density of black abalone in populations inside and outside of diseased areas at three levels of habitat quality.**

## FUTURE WORK

Our next step is to see if we can estimate habitat suitability from aerial surveys. We will test this at sites where we have already done surveys and see how well our estimates match the data we collected. We also plan to do aerial surveys at sites we haven't sampled and then ground truth the data. If the aerial surveys prove to be reliable, logistically feasible and funding is available we will do them on a broader scale. Our findings combined with aerial surveys will be used to better estimate the entire population. In addition, we hope to initiate restoration work that will aid in the recovery of black abalone.

**Citation:** Miner C.M., J.M. Altstatt, P.T. Raimondi, and T.E. Minchinton. 2006. Recruitment failure and shifts in community structure following mass mortality limit recovery prospects of black abalone. *Marine Ecology Progress Series* 327:107-117.

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