

**Seasonal Abalone Fishing Pressure Trends in Gerstle Cove, Salt Point State Park,
CA.**

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Abstract *Haliotis rufescens*, the red abalone, is now the only legally fished abalone species found in U.S. waters. *H. rufescens* occurs from mid-Oregon to Baja California, but is available only to sport fishermen north of San Francisco Bay. Once an extremely prevalent species, it has become the focus of new California Fish and Game regulations due to the recent collapse of the southern California fishery. This study investigates seasonal fishing trends among abalone divers at N. California's most popular and accessible location, Gerstle Cove Campground, located 20 miles north of Jenner, California. "Creel" or catch surveys were conducted among abalone divers returning from the water to the main parking lot during the 3-4 hours surrounding the low tide, two weekends per month. The surveys span the entire season, from April 1-November 30, excluding the months of July and August. As the season progresses fishing pressure is expected to steadily decline. This decline was thought to be mirrored by a decline in productivity as well. There is no such correlation in evidence for the site as a whole. Two dive locations did show a correlation in productivity declines for shore divers and shore pickers. These findings suggests that population densities are able to sustain fishing pressure well in many locations but that in the most used areas communities are being thinned enough to show significant productivity decline.

Introduction

The red abalone, *Haliotis rufescens*, is now the only abalone, of 5 indigenous species, that may be legally fished off the California coast. Abalones are large, herbivorous marine mollusks that may reach shell lengths of over 11". Most prevalent in protected areas with large kelp canopies, *H. rufescens* occurs along the entire western U.S. coast, south to the Baja peninsula. Occupying rocky cracks and crevices from the inter-tidal zone to depths in excess of 60', they graze almost entirely on kelp. Reproduction occurs via broadcasting sperm and eggs into the open water (CDFG, 2002). Because broadcast breeding is indirect and reliant upon other individuals in the relative vicinity, abalone populations are very density dependent. Several studies have shown that recruitment occurs only occasionally due to the extreme environment in which the larval abalones must live (Tegner et al. 1989; Karpov et al. 1998).

Prized for their rich, flavorful meat and highly iridescent shells, abalones have been the target of both sport and commercial fishermen since the early part of the 20th century. Because abalone grow slowly and are dependent upon relatively high population densities to successfully reproduce, they are very susceptible to exploitation. Historically, commercial fishing of abalone has never been allowed north of San Francisco Bay, and sport-fishermen have always been required to free-dive for them. Much of the coast south of the Bay however served as a very productive commercial fishery, where both sport and commercial abalone fishermen were allowed the use of underwater breathing apparatus. Due to years of large commercial harvests the southern populations of *H. rufescens* recently collapsed under heavy commercial fishing pressure (Karpov et al, 2000). In 1997 all sport and commercial fishing south of San Francisco Bay was banned (CDFG, 2002).

In an effort to avoid such a collapse in the stable northern California populations, the California Department of Fish and Game (CDFG) has progressively stiffened sport-fishing regulations each year since 1997. The CDFG recently posted a finalized version of an Abalone Resource Management Plan (ARMP), which will be presented to the Department of Fish and Wildlife in December 2002 for approval. This plan outlines the current status and pressures facing each indigenous abalone species and presents a multi-

species management approach to rejuvenating abalone fisheries along the California coast (CDFG and Karpov, Tegner, Rogers-Bennett, et al.; 2001).

In the year 2000 some of the first preliminary regulation changes were put into effect. The most noticeable change was a catch limit decrease from 4 to 3 and the imposition of a 100-abalone yearly catch limit. In an effort to improve seasonal abalone catch estimates abalone divers became required to purchase an “ab-tag”, sticker and punch card, with their fishing license. Punch cards were to be returned to the CDFG no later than Dec. 30, one month after the close of abalone season. Due to catch estimates, based upon punch-card returns, the seasonal limit for 2002 was further reduced to 24 abalone per year (CDFG,2002). Punch cards issued during the 2002 season have been updated as well. Fishermen can now specify one of 51 dive locations in which their catches took place. Persons who fail to return punch cards may be fined.

Catch estimates made with the 2002 cards will make up the CDFG first full season, site-specific survey of abalone fishing pressure on the northern California coast. In California the abalone fishing season runs from April 1-November 30, excluding July. In the past, short-term surveys conducted by CDFG volunteers at popular locations were referenced to investigate probable fishing pressure trends. These surveys focused primarily on the weekends when the highest pressure could be expected (such as opening or Memorial Day weekends), and have never been conducted on a regular basis throughout an entire season. As a result there is no record of seasonal pressure or productivity changes at even the most popular abalone fishing locations.

This paper aims to provide a season-long, site-specific survey of fishing pressure and preference, trends at Gerstle Cove. Gerstle Cove provides abalone divers with easy access to the water from a large parking lot and is the most frequented area by abalone divers in Sonoma County (Kashiwada, 2002). The main question I set out to address was how fishing pressure trends relate to productivity trends. Because abalone populations are sensitive to population density fluctuations, finding a correlation between pressure and resulting productivity, or vice versa, could greatly aid in the management of popular fishing locations such as Gerstle Cove. The first and most general question I wished to investigate was: *Will fishing pressure (catch/person/hour) decrease steadily or suddenly as the season draws on, and will there be a corresponding decline in productivity?* More

specifically: *Will a highly used area reflect a greater loss of productivity than one frequented less often? Do different modes of fishing (shore picking, shore diving or boat diving) show different responses?* Observing consistent and reliable decreases in both productivity and pressure for different fishing modes would allow managers to estimate how different communities around a popular location could withstand variable fishing pressures from season to season.

Materials and Methods

Sample collection: Creel survey forms designed and provided by Jerry Kashiwada, a CDFG marine biologist, were used to survey abalone divers at Gerstle Cove, CA (see survey key below). Gerstle Cove, within Salt Point State Park, is the most popular abalone fishing site in Sonoma County (Kashiwada, CDFG, personal communication). Located 28 miles north of Bodega Bay, on Hwy 1, Salt Point State Park is the most convenient dive site for fishermen from the Bay Area and central valley. The site was chosen both because of its popularity and because the main lot provides a manageably sized focus area in which surveys can be easily conducted. Abalone fishermen were approached upon return to their vehicles from the water and asked to take part in the survey and have their catch measured. Besides April, during which surveys were conducted on only one weekend, and excluding August, surveys were conducted two weekends per month throughout the abalone-fishing season. In total surveys were conducted on 18 days.

Abalone fishermen are split into two categories, divers and shore-pickers. Divers swim from either a boat or the shore and then free-dive to the bottom, wear the abalones are pried off of rocks. Shore-pickers wade through the tide pools and find abalones in cracks and crevices. Because both fishing styles benefit from the water being at its lowest point, survey times were based upon low tide times. Unless low tide occurred near sunset or before sunrise I stationed myself in the parking lot during the 3-4 hours surrounding low tide.

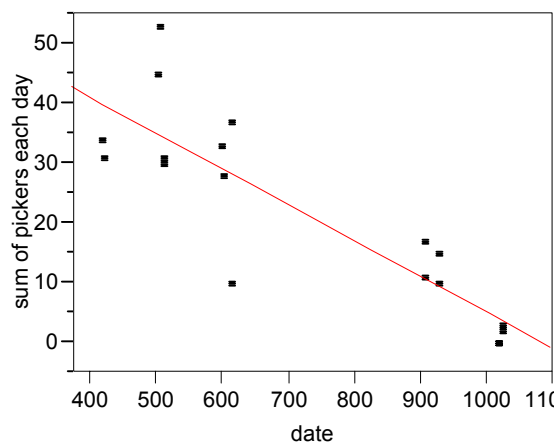
Statistical Techniques: Each day's total number of pickers, abalone taken, abalone returned, and picker hours were grouped by mode, dive location and date. These data were then entered into the JMPIN Statistics program in several summary tables

grouped by date, mode and dive location (JMPIN Statistics. 4.0.4 (Academic), John Sall. 1998-2001. Duxbury Press. SAS Institute). To check for linear trends, sums of each of the variables were plotted against the date. Lines were fitted to each plot in order to obtain R^2 values as a measure of each lines goodness of fit. Several pairing combinations were analyzed in order to determine ratios of mode/county, mode/location, the average rates of productivity and returns for each mode, average group sizes, and average catch and release per person per hour also by mode and location. Possible correlations between trends were checked using pair wise correlations between R^2 values and non-parametric correlations were tested using Spearman's Rho analyses of the paired trends. A site survey of pressure in each distinct area around the parking lot as well as the average productivity of the site and the distribution of use by mode was also compiled.

Results

Analysis of the summed values of mean productivity (defined as catch/person/hour) plotted by date show a pronounced, if not smooth decline towards the end of the season . Fitting a line to the plot, as Figure 1 illustrates, reveals a significant trend downwards. This trend justifies the initial assumption that over all pressure would fall off as the season progressed.

Figure 1:

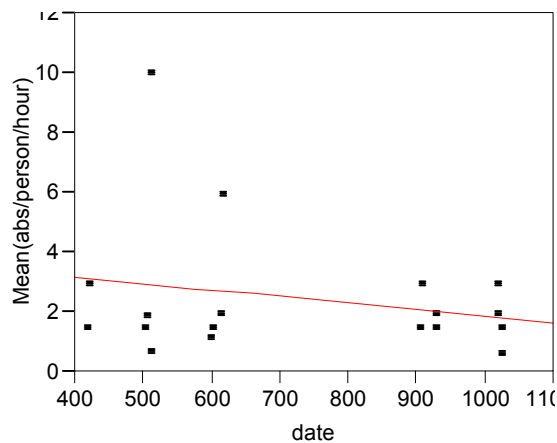


— Linear Fit
sum of pickers each day = 65.154361 - 0.0598867 date
 $R^2 = 0.75161$
Mean of Response = 21.6667
Observations = 18

Estimate = 65.154
t-Ratio = 9.95

Catch totals (as would be expected), show a significant decreasing trend throughout the season as well, with a seasonal average of 53.56 abalone being taken per day. However, there was no trend found when analyzing the mean productivity of the site as a whole. Figure 2 shows the randomness of productivity for the site as a whole. This finding goes against the initial assumption that there would be a correlation between fishing pressure and site productivity.

Figure 2:

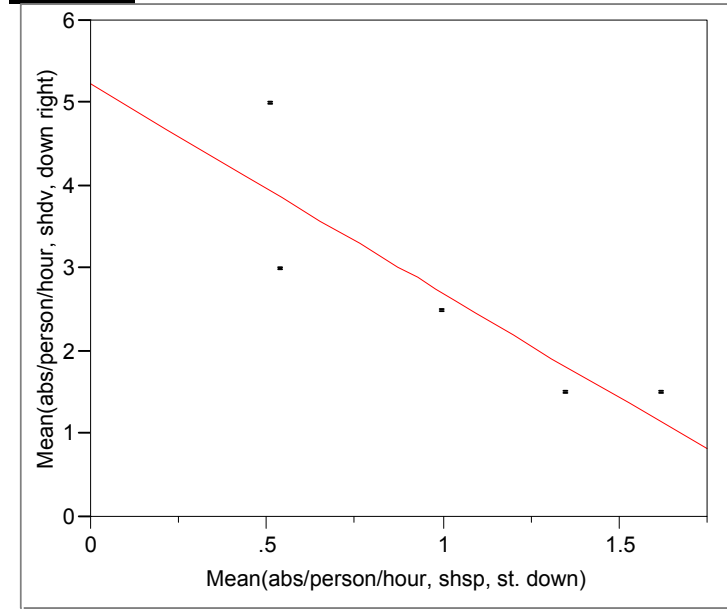


— Linear Fit
Mean(abalone/person/hour) = 4.0293008 - 0.0021513 date
R² = 0.050928
Mean of Response = 2.46713
Observations = 18
t-Ratio = 2.28

Of the pairings noted in the methods section the strongest productivity trend was seen within the two most used locations, noted as “st. down” and “down right” (see Appended Site Survey Map, appendix, pg 10). The correlation occurs for productivity declines for shore pickers, “st. down” (the second most used location for shore pickers) and shore divers, “down right” (the most used location by shore divers). Both of these locations show a productivity decline throughout the season and were plotted against each other to check for a correlation. Figure 3 shows the resulting plot of productivity throughout the year in each of these locations. This correlation suggests that there is in fact support for the second hypothesis that pressure does impact productivity at popular dive sites. Throughout the rest of the site there were no correlations found between sites. Overall

the season saw a total of 390 fishermen who accounted for approximately 367.0267 fishing hours and took 964 abalone. The specific dive locations are illustrated on the appended Site Survey Map, appendix, pg. 10.

Figure 3:



— Linear Fit
 $\text{Mean}(\text{abs}/\text{person}/\text{hour}, \text{shdv}, \text{down right}) = 5.2367895 - 2.522575 \text{ Mean}(\text{abs}/\text{person}/\text{hour}, \text{shsp}, \text{st. down})$
 $R^2 = 0.737162$
 $t\text{-Ratio} = 5.49$
 Pairwise Correlation = -0.8528, count 5
 Non-Parametric Correlation: Spearman's Rho = -0.9747

Discussion

Although the significant decline in pressure throughout the season agrees with our stated hypothesis the failure to detect a consistent change in catch per hour went against my expectations. This suggests that the abalone population density throughout the site may not be greatly reduced during the fishing season. As was mentioned above there was a correlation found between two locations, which each played host to a greater percentage of abalone fishermen than most others. This correlation gives credibility to my assumption that certain sites, if not the site as a whole, would experience a decline in productivity. Because other dive locations did not share this trend there are several assumptions that can be made in explanation. Many of these locations simply did not experience the degree of pressure that the “st. down” and “down right” locations experienced. These two locations both endured strong pressure from both shore divers

and shore pickers, in combination these two sites were the most used of any location accessible from the main parking lot. At lower fishing pressures, or perhaps in areas less accessible (currents, exposure, bottom strata, etc.) the fishing pressure may not be sufficient to noticeably decrease fishing productivity. In this survey, no data concerning weather conditions, water temperature or visibility was collected. In future surveys these data may prove invaluable when trying to account for random productivity throughout the season. Other possible complicating variables include holiday scheduling and weather conditions around the Bay Area and Central Valley, where the majority of divers live.

Rangers and lifeguards stationed at Gerstle Cove should be encouraged to conduct creel surveys throughout the year in order to gain a more thorough understanding of fishing impacts on this population of abalone. This site offers researchers an ideal location to investigate the limits of a red abalone fishery given that there is a year-round staff that patrols the site. Because the site also offers a wide range of fishing locations ranging from easily accessible and unexposed to highly exposed and accessible only by water I would recommend a more in depth investigation of productivity and use compared with accessibility. Of course because this survey may serve only as a pilot study of this location there would need to be several more seasons worth of surveying done to determine whether or not the noted trends are significant and predictable.

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Appendix:

Survey Key:

- 1) Sample Group; alphabetical code of group being interviewed. Groups of divers rather than individuals is preferred and grouped by county of origin, common mode and location fished.
- 2) County of Origin; numerical county code or alphabetical state abbreviation.
- 3) Mode; Prefix: BT= Boat SH= Shore Suffix: SP= Shore Picker DV= Diver
- 4) Total Pickers; Grouped by single county and mode.
- 5) Abalone Taken; Number of abalone taken and kept by group.
- 6) Abalone Returned; Number of abalone picked up and put back by the group.
- 7) Total Picker Hours; how many hours were spent actually looking for abalone, entered as a total group time, (e.g. 3 pickers fished for one hour = 3hours total).
- 8) Cuts; Abalone are inspected looking for cuts on the epipodium-foot, margins and any cuts not readily seen. Light cut = multiple abrasions or bar cuts to the epipodium and up to 1/8th inch deep cuts on the foot. Medium cuts = up to 1/2 inch deep in the foot resulting in bleeding; multiple light cuts to the foot are listed as medium. Heavy cuts = deeper than 1/2 inch or multiple medium cuts; also broken shell or punctures to gonads, gills, or cephalic area.
- 9) Total Abs Examined; Number of abalone examined for cuts (Number may differ from number measured for lengths).
- 10) Location; CDF&G Block No., 1'x1' Box, and Grid No. (See attached maps)
- 11) Time Group Interviewed
- 12) Length Frequency; Abalone are measured using a brand less, probably homemade, gauge at their longest shell length to the nearest mm. Boxes are for even lengths only so odd lengths are denoted by a horizontal line between boxes while even lengths are denoted by vertical hash marks within the boxes.
- 13) Notes; Fishermen are asked whether they encountered any abalone with signs of Withering Syndrome. If no incidence a note of (NoWS enc.) is entered, if none of the taken abalone exhibit signs of Withering Syndrome then (NoWS obs.) is entered. Any other notes of interest are entered in this box as well.

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