Abalone

Seven species of abalones are found in California. Abalones attach with a large foot to rocky substrate, and feed primarily on drift algae. Five species of abalones (black, green, pink, red, and white) were popular sport and commercial species until southern California populations experienced severe declines during the 1960s, 1970s, 1980s and 1990s. A valuable red abalone recreational fishery still remains in northern California. These declines likely resulted from a combination of overharvest, disease, and a long-term warming trend leading to poor recruitment coincident with enhanced storm activity, reduced kelp abundance, and increased competition with sea urchins (Leet et al. 1992; Engle 1994). One species, the white abalone, has been listed as endangered under the general Endangered Species Act (ESA) and another, the black abalone, is a candidate species for such listing.

Black abalone (*Haliotis cracherodii*)

Status of the Population:

Black abalone populations in southern California have suffered catastrophic declines since the mid-1980s that have resulted in a nearly complete disappearance of black abalone along mainland shores south of Point Conception (Miller and Lawrence-Miller 1993), as well as at many of the Channel Islands (Lafferty and Kuris 1993; Richards and Davis 1993). Mortality was associated with "withering syndrome" (WS), in which the foot shrinks and weakened individuals lose their grip on rock surfaces (Antonio et al. 2000; Friedman et al. 1997; Gardner et al.,1995). Withering syndrome has been observed in abalone north of Point Conception in recent years; however the disease is not widespread (Altstatt et al. 1996). Because of low recruitment, slow growth, and already reduced reproductive populations, black abalone are currently proposed for Federal listing under the ESA.

Green abalone (*Haliotis fulgens*)

Status of the Population:

Green abalone supported an important fishery in California, with landings peaking in 1971 and rapidly declining thereafter (Leet et al. 1992). They were most common along the far southern mainland coast and at the southern Channel Islands, and were present at the northern Channel Islands, but are now rarely encountered. The green abalone commercial and sport fisheries are currently closed. Populations appear to be extremely low.

Pink abalone (*Haliotis corrugata*)

Status of the Population:

In the early 1950s, pink abalone comprised the largest segment (about 75 percent) of the abalone fishery and were a significant component of the total abalone landings. Commercial landings originated at the eastern northern Channel Islands (Anacapa and Santa Cruz), and the southern Channel Islands (San Nicolas, Catalina Island, Santa Barbara, and San Clemente). Because pink abalone are more fragile than other abalone and grow more slowly, the level of take could not continue (Leet et al. 2001). On Department research cruises to San Clemente, Catalina Island, and Santa Barbara Islands in 1996 and 1997, the number of abalones sighted per unit of time was used to quantify stocks, and a factor was applied to estimate the number of commercially legal pink abalone that could be collected per hour. Estimates ranged from about one to 1.5 abalone per hour (Leet et al. 2001). Similar cruises conducted in 1999 estimated only 0.28 commercially legal pink abalone per hour (Leet et al. 2001). At Catalina Island, no commercial-sized pink abalone were found (Leet et al. 2001).

Red abalone (*Haliotis rufescens*)

Status of the Population:

Red abalone was previously an important fishery in California, with landings peaking in 1967 and steadily declining thereafter (Leet et al. 1992). In central and southern California, red abalone had declined the least of all five species by the time the fishery was closed in 1997 (Leet et al. 2001). Combined landings of red abalone declined during the period from 1969 to1982 stabilizing at 1/10 their historic average during the 14-year period before the 1997 closure (Leet et al. 2001). Detailed examination of catch by area and fishery independent assessments revealed that the stability in landings masked ongoing reductions of local populations, as successive areas declined by over two orders of magnitude. From 1952 to1968 most red abalone were caught in central California, followed by southern mainland, Santa Cruz, Santa Rosa and San Miguel Islands (Leet et al. 2001). Catches declined first along the central coast under the combined effects of expanding sea otters and fishing pressure. Outside the sea otter range catches declined more slowly along the southern mainland than at Santa Rosa, Santa Cruz, and San Nicolas Islands. From 1983 to1996, catches decreased off these three islands to three percent for Santa Rosa and less than one percent for Santa Cruz and San Nicolas, of their respective peak catches by the 1997 closure (Leet et al. 2001). San Miguel Island and the north coast were the exceptions to this pattern. Catches from San Miguel Island, the farthest and most northern of the Channel Islands, and the north coast comprised 71 of the 87 tons landed in 1996 prior to the fishery closure in 1997 (Leet et al. 2001).

A successful red abalone sport-only fishery continues to the north of San Francisco County, where SCUBA has always been prohibited and commercial take was only allowed for a three year period during World War II. Beginning in the 1960s, breath hold diving effort has increased in relation to shore picking (Leet et al. 2001). In 1960, an estimated 11,000 diver-days were expended to take 118,000 pounds of red and black abalone, compared with 29,000 diver-days to take 192,000 pounds in 1972 (Leet et al. 2001). By 1985 to 1989, average diver-days and shore picker-days per year were focused on red abalone in central and northern California. Estimated landings of red abalone in central and northern California for combined divers and shore pickers reached a high of 3,472,000 pounds in 1986 and had decreased to 1,161,000 pounds by 1989 (Leet et al. 2001). In 1998 an abalone stamp was first sold to generate revenues for stock assessments. In 1998 and 1999 an average 33,000 stamps were sold showing effort levels are comparable to those estimated for the 1985 to 1989 period (Leet et al. 2001).

White abalone (*Haliotis sorenseni*)

Status of the Population:

The white abalone fishery developed late due to their deep habitats, with the first reported commercial landings in1968. However, this species was popular for their tender meat. Abundances were highest at the southern and northeastern Channel Islands. Peak landings occurred in 1972 and decreased thereafter (Leet et al. 1992). Average density during periods of peak take in the 1970s was one abalone per square meter. Density has dramatically decreased since to 0.002 per square meter (Carlton et al. 1999). Surveys in the Channel Islands area found that density may have further decreased to 0.0001 per square meter (Davis et al. 1998). Since females must be within a few meters of a male during spawning for fertilization to occur, present population densities in the area may preclude successful spawning. The entire white abalone fishery has been closed since 1993, though densities have continued to fall (Carlton et al. 1999; Davis et al. 1998). Sub-threshold breeding density and continued predation (by fish, octopus, sea stars and other species) suggest that recovery without significant human intervention is unlikely. Submersible surveys were carried out to further evaluate population status and to explore possibilities for collection of specimens for a captive breeding program. The rarity of this species prompted the National Marine Fisheries Service (NMFS) to list it as a candidate species under the federal ESA in 1997. This action required a status review, which concluded that overexploitation was the major cause of the decline. Subsequently, in May 2001 the white abalone became the first marine invertebrate to receive Federal protection as an endangered species.

All Abalone Species

Home Range/Migratory Patterns:

All abalones are benthic rock dwellers, moving relatively short distances throughout their lives. Some species may migrate from deep to shallow depths in search for food. Others may spend years on the same home location. Each species of abalone has a different depth and latitudinal distribution. Three species (red, black, and pinto) occur throughout California. Pink, green, and white abalone occur in southern California and into Mexico. Flat abalone occur from central California northward. The depth distributions are: black, intertidal; red, intertidal to 80 feet; green, subtidal to about 20 feet; pink, subtidal to 120 feet, white, subtidal to depth of 200 feet; flat sub tidal to 70 feet, and pinto, subtidal to 70 feet.

Current Regulations:

No commercial take is allowed.

Recreational take is prohibited south of a line drawn due west from the center of the mouth of San Francisco Bay. Only red abalone may be taken north of that line. Red abalone must be seven inches or greater along the longest shell diameter. No more than three red abalone may be possessed at any time and no more than 24 may be taken in any calendar year. No scuba or surface-supplied air may be used in taking abalone.

How MPAs May Help:

There is empirical evidence that the establishment of marine reserves benefits fished invertebrates such as abalones (Dugan and Davis, 1993). It is clear that populations protected from fishing will achieve larger sizes, live longer, and produce more offspring over their lifetime than counterparts in fished areas. Size is critical for abalone reproduction and the largest abalone have many more (4-8 times) eggs than intermediate size animals (Tegner 1989). Increased densities observed in protected areas are important for reproductive success. Abalones that are close together have an 80 percent chance of successful fertilization, but this value rapidly declines if individuals are farther apart. Abalone farther than 4 meters from their nearest neighbor have little chance of successful fertilization because of dilution of the eggs and sperms (Babcock and Keesing 1999).

Abalone stocks that have produced sustained yields over time have been ones in which a part of the population was protected, either in actual or de facto reserves where fishermen did not have access to the resources (Karpov et al. 1998, Walters and McGuire 1996). In California, pink abalone inside the Anacapa Island reserve at Landing Cove were larger in size and as a consequence had increased spawning

potential, compared with a fished site (Admiral's Reef) and an unprotected reserve (Cathedral Cove) (Rogers-Bennett et al. In press).

Pinto abalone (*H. kamtschatkana*) inside a reserve in British Columbia had larger individuals (greater than 130 millimeters) and higher abundances compared with unprotected closed areas (Wallace 1999). Despite the total closure of the abalone fishery in British Columbia enacted in 1990, only the closed area neighboring a prison with a 24-hour armed guard had more and larger abalone, suggesting widespread illegal fishing (Wallace 1999). Likewise, the potential reproductive output, estimated by multiplying the number of abalone by the mean fecundity of the site, was also greatest in the heavily protected closed area. Abalone populations in British Columbia have not rebounded despite the fishery closure suggesting the need for restoration (Campbell 2000) and better compliance with the provincial closure.

Abalone have provided some of the best examples of how important interactions between members of the marine community may be facilitated by no-take reserves. Researchers have determined a link between the presence of adult red sea urchins and juvenile abalone. Juvenile abalone find shelter under the spines of adult sea urchins and use this as protection from predation and wave sheer. More juvenile red and the rare flat abalone were found inside red sea urchin reserves compared to areas where red sea urchins had been fished in northern California (Rogers-Bennett and Pearse 2001). This interaction was first described in central and southern California red abalone (Tegner and Dayton 1977). Similar results have been found in Japan (Kojima 1981) and South Africa (Day and Branch 2002). In South Africa, experimental removals of sea urchins dramatically decreased local densities of juvenile abalone (Day 1998).

It has been suggested that just the moratorium on the take of abalones south of San Francisco Bay alone is sufficient to lead to recovery of California abalone resources because now most of California is an "abalone reserve". The closure is a first step toward recovery, but it has not brought individuals closer together to facilitate reproduction and it has not provided any actual increased protection to the remaining stocks. The southern California abalone closure, established in 1977, prohibited abalone take along parts of the Los Angeles and Orange County coasts, but was not successful in recovering stocks (Tegner 1993). It was too far from existing stocks for recolonization to take place and did not afford sufficient protection from poaching to be effective.

Additionally, for high value species like abalone that need aggregations of adults to successfully recruit, protection is facilitated by establishment of no-take reserves. In such areas there is no question about whether a species is allowed to be taken, and possession of any species is a violation. Such protected areas will be necessary

before aggregating of the remaining stocks, and translocations operations can be conducted.