Chapter 3. History and Socio-economics of the Fishery

3.1 Overview of the Abalone Fishery

The abalones native to the western coast of North America have been fished and collected from shore since before recorded history. At a time when the sea otter (a natural predator of abalone) ranged the entire coast of California, aboriginal peoples used intertidal species such as abalone for food, decoration, and trade (Cox 1962). By 1850, however, fur hunters had virtually eliminated sea otters along the California coast, removing one of the area's most voracious abalone predators. The resultant expansion of abalone populations likely contributed to the development of commercial fisheries, which thrived on the abundance of abalones.

Closures occurred early in the commercial fisheries, however. The commercial green and black abalone fisheries along the mainland reached their peaks in 1879 (Cox 1962; Cicin-Sain *et al.* 1977), and by 1913 these fisheries were closed (Edwards 1913; Cox 1962). Over the past century, abalone fisheries have been opened and closed numerous times (Appendix A).

During the past several decades, the abalone fishery south of San Francisco has suffered dramatic declines, resulting in a moratorium on take in both the commercial and recreational fishery in 1997. Closure of this major commercial fishery, which landed more than 2,000 metric tons during the 1950s and 1960s, occurred despite fishery management efforts. The collapse of southern California fisheries was, in part, due to increased pressure from a shift in commercial fishing. As the central California fishery was lost to the recovering sea otter population (see Section 2.1.9.1), fishery effort became focused on southern California instead (Wendell personal communication).

While abalone populations have been serially depleted through intense fishing and poor management, outbreaks of withering syndrome (WS), a devastating abalone disease, decadal climatic water temperature changes, and ENSO-related water temperature changes have also caused stock declines.

3.1.1 History of the Abalone Fishery

3.1.1.1 The Commercial Abalone Fishery

Commercial fishery-dependent data were primarily derived from mandatory landing receipts for 1950 to 1996. Between 1942 and 1996, the trends in total commercial landings for all abalone species were marked by four distinct stages (Figure 3-1):

A. 1942 to 1951: The fishery was characterized by increased landings

B. 1952 to 1968: Landings were relatively stable

C. 1969 to 1982: A rapid decline in landings occurred

D. 1983 to 1996: A period of gradual and steady decline occurred

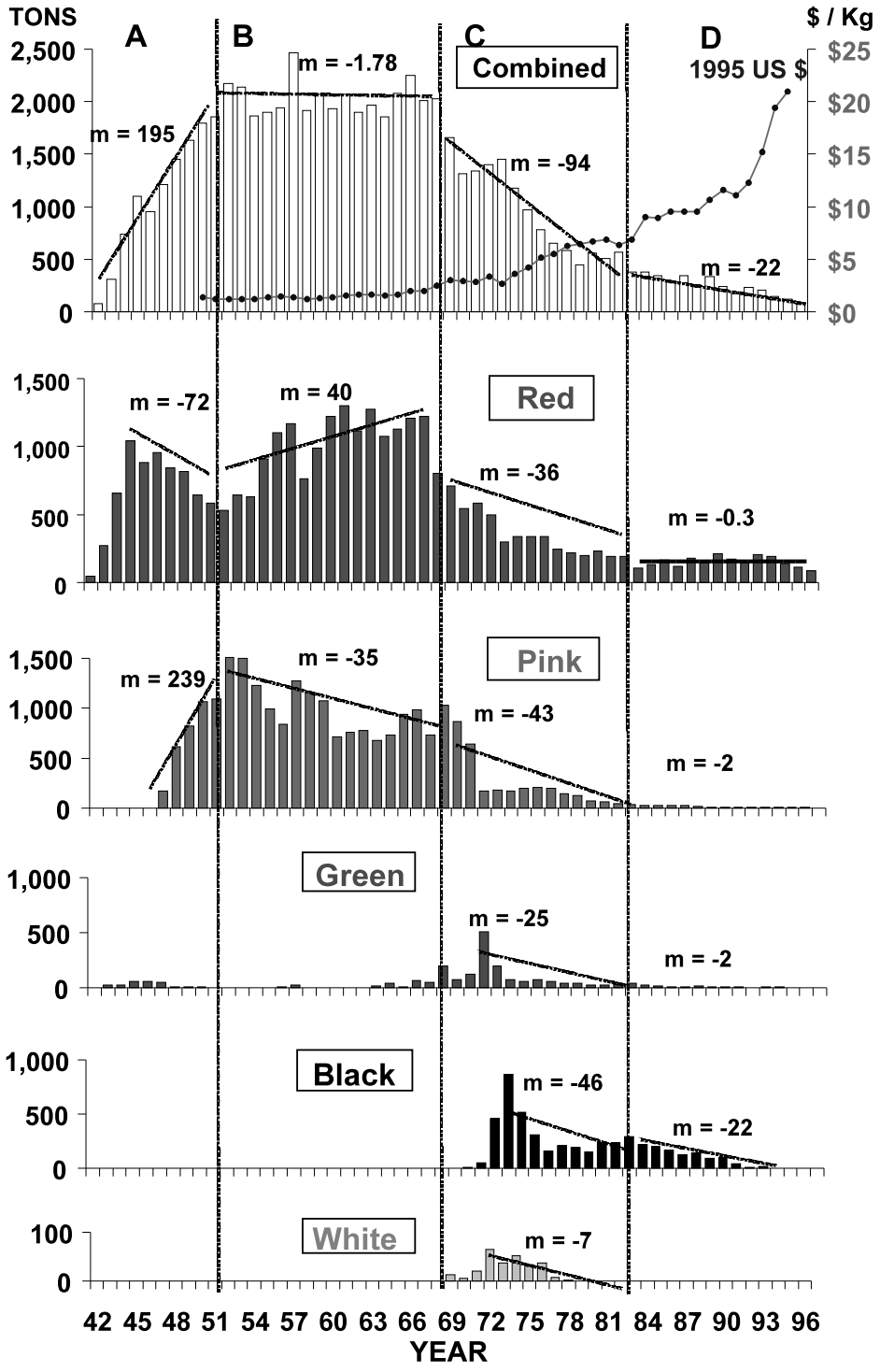

Figure 3-1. Commercial landings (metric tons) of the California abalone fishery (bars), combined (top), and by red, pink, green, black, and white abalones. Landings are divided into periods (A-D) by trends in the total fishery landings, with regression lines (dotted lines) for each period (m=slope, t x year-1). Regressions are provided for individual species where sufficient data exists. The average annual value of all species (US $ per kilogram) is represented by a solid line.

Serial Depletion

The patterns observed in the combined landings mask patterns of the individual species landings. In the California abalone fishery south of San Francisco, apparent stability from 1952 to 1968 was in fact an illusion composed of multiple species landings in multiple fishing areas. When the individual abalone fisheries are divided into components, a pattern of serial decline by species and by area is revealed. Combined landings were bolstered by increases in red abalone landings, which gave the impression of maintained stability in the combined landings during the decline in pink abalone landings. In 1971, there was an abrupt decline in pink abalone landings caused by increases in pink abalone size limits imposed by managers in an effort to protect the population. A spike in green abalone landings in 1971, caused by the lowering of the green abalone size limit, masked the pink abalone landings drop in the combined landings. Around this time, black abalone landings also bolstered the combined landings. Red abalone began to decline during this period (1969-1982), marking the start of intensive commercial fishing of green, black, and white abalones. Landings for these three species rapidly peaked and then declined.

During the last period of the commercial abalone fishery, many commercial divers held both abalone and sea urchin permits. As the availability of abalones decreased, efforts were shifted to the growing sea urchin fishery. Since the abalone fishery was not closed, divers searching for sea urchin continued to land abalone while populations were at extremely reduced levels. Declines in commercial abalone landings were replaced by sea urchin landings, thus maintaining the value of the combined dive fishery at 10 million dollars from 1955 to 1985, while abalones suffered dramatic declines (Dugan and Davis 1993).

Area-specific catch from 1950 for red, pink, and black abalones revealed a spatial trend in catch with higher catches coming from mainland or nearshore islands, shifting over time to more remote areas, with smaller islands declining before larger ones. Two species whose catches did not show a spatial pattern in decline were the green and white abalone, which remained concentrated in a few areas, suggesting they were limited in their spatial distribution prior to exploitation. Declines in catch varied by species and area, but in most cases dropped two orders of magnitude from catches in peak years and areas.

The replacement of one species or sub-species by another, which gives the appearance of stable landings, has occurred in many nearshore marine fisheries, suggesting that the management of species complexes can be problematic (Dugan and Davis 1993; Orensanz *et al*. 1998). Alaskan crustacean fisheries were serially depleted as a succession of species suffered dramatic declines in their landings (Orensanz *et al.* 1998). Similarly, the serial replacement of sub-species has been suggested as a contributor to the collapse of the eastern Atlantic cod fishery (Hutchings and Myers 1994). Replacement of one sub-species of cod by another acted to maintain the illusion of a long period of stability in the cod fishery until a rapid, unforeseen, total collapse occurred when all the sub-species had been fished out.

The regular appearance of red abalone in the commercial landings, as compared to some of the other species, may be a reflection of differences in distribution and vulnerability to take. The more common red abalone has the broadest depth range (Tegner *et al.* 1992; Tutschulte 1976) of any commercially fished abalone.

Pink abalone were the most widely-distributed of the four southern species, and the second most regularly-appearing species in catches. Cox (1962) attributed a portion of the decline in pink abalone during Period B (1952 - 1968) to the combined effects of slow growth and starvation due to reductions in kelp biomass during the 1957-1959 El Niño.

The fisheries for green, black and white abalones, all with narrower depth and geographic distributions, were short lived. Green abalone are a shallow, subtidal species abundant in surf grass beds. This species was rigorously fished during Period C (1969-1982) and thereafter contributed little to the commercial fishery. Black abalone have a wide geographical distribution, but a narrow depth distribution, restricted to the lower and mid-intertidal zone. An added concern for black abalone is the combined effects of fishing and WS (Haaker *et al.* 1992, Alstatt *et al.* 1996). While landing declines occurred prior to the outbreak of this lethal disease, continued take following the outbreak of WS may have further contributed to the potential extinction of this species by removing remaining individuals that may have been resistant to the disease. White abalone have a narrow, deep distribution from 25 to 50 m (82 to 164 ft) on rocky habitat. Davis *et al.*(1998) reported extreme declines in white abalone abundance following commercial and sport exploitation. During extensive surveys in the 1990s at the Channel Islands using deep SCUBA diving and a manned submarine, divers found less than two white abalone per hectare, compared to 2,000 to 10,000 per hectare in the 1970s at comparable depths (Tutschulte 1976). Davis *et al.* (1998) suggest that unless active restoration methods are enacted soon this species may become extinct.

By 1975 there were 383 commercial abalone permits with an annual turnover rate of about 50%. New regulations in 1977 restricted permits to those who held them in 1976, with an additional 5% chosen by lottery from qualified applicants. Minimum landing requirements were instituted as well, with the goal of reducing the number of permitted divers to 200 by the process of attrition. In 1985, legislation mandated a reduction in permits to 100 by attrition (Tegner 1989). At that time, there were 130 permits, a number that remained virtually unchanged until the fishery moratorium in 1997.

Factors Contributing to Management Failure in the Commercial Fishery

A number of factors undermined effective management. Management effort was limited to conventional strategy that primarily focused on size limits to protect stocks (Tegner *et al*. 1992). This strategy was based on egg-per-recruit models that assume several years of spawning success for a significant portion of the abalone population prior to reaching the minimum size for take (Tegner *et al.* 1989), derived from the potential high fecundity of abalone (Giorgi and DeMartini 1977). This management approach did little to ensure the sustainability of abalone resources. Focus on spawning potential ignores the effects of protracted periods of recruitment failure under intense fishing pressure (Sluczanowski 1984). Recruitment of young abalone may not be successful every year (Karpov *et al.* 1998; Rogers-Bennett and Pearse 1998). Karpov *et al.* (1998) reported only one red abalone recruitment event in four years in northern California where animals living in deep water (greater than 8.5 m, or 28 ft) are protected. Likewise, Tegner *et al*. (1989) found a single recruitment peak in a study area on Santa Rosa Island over a five-year period. Another factor may have been the

loss of adult aggregations needed for spawning success (Shepherd and Brown 1993). Low densities can result in fertilization failure in broadcast-spawning invertebrates (Pennington 1985; Levitan *et al.* 1992).

Ultimately, during the final period of decline (1983-1996), reliance on catch-per-unit-of-effort (CPUE) data further delayed closures. CPUE for abalone is a exceedingly poor index of abundance, as has been shown for other spatially-structured fisheries (Orensanz *et al.* 1998). Assumptions for use of CPUE, including the redistribution of the stock and random fishing (Ricker 1975; Gulland 1983), are violated in the abalone fishery as they are in other fisheries for slow-moving, bottom-dwelling invertebrates. CPUE for red and pink abalone increased throughout much of Period D (1983-1996), when red abalone landings remained consistent and pink abalone declined (Figure 3-2). Two factors during this time worked to increase CPUE figures: improvements in locating sites using Loran and Global Positioning Systems (GPS), and increased search time of fishing grounds by abalone and urchin divers in the dual fishery.

Increasing abalone value further delayed conservative management action during the decline (Figure 3-1, Figure 3-2). As the landings declined, the value increased exponentially in response to demands from foreign markets and a growing population of Californians. Increases in value intensified political pressures to continue fishing despite evidence of collapsing stocks. In this case, market forces did not work to stop the fishery as the species declined, and the economics of the dual fishery (abalone and sea urchin) permitted fishing for some abalone species until they neared extinction.

Management also had no mechanism to address factors such as sea otters, pollution, disease, and El Niños (Section 2.1.9.1, Section 2.1.9.2), which contributed to abalone population declines. The degree of relative impacts of each of these factors differed by species and area.

3.1.1.2 The Recreational Abalone Fishery

A final factor in the decline of abalone populations was the added impact of a growing, SCUBA-based recreational fishery in southern California (Karpov and Tegner 1992; Tegner *et al.* 1992). Beginning in the 1970s, this largely unmonitored fishery had a growing impact on abalone stocks on the mainland and in the Channel Islands.

Southern California

Recreational catch and effort have been more difficult to assess than commercial catch and effort due to the lack of a mandatory reporting system. Consequently, historical landings for the southern California recreational abalone fisheries are not well-documented. The commercial passenger diving boat (CPDB) log book system was used in southern California to estimate the number of passengers per dive boat and the total number of abalone landed by each boat. A detailed analysis of CPDB red abalone catch and effort data in southern California is available only for 1978 through 1987 (CDFG 1991, 1993b).

Many of the abalone landings were not identified by species in the log book data. However, those that were identified revealed that green and pink abalones predominated before 1983, with smaller numbers of red, black, and white abalones being taken. From 1986 to 1990 the proportion of pink abalone declined, leaving green

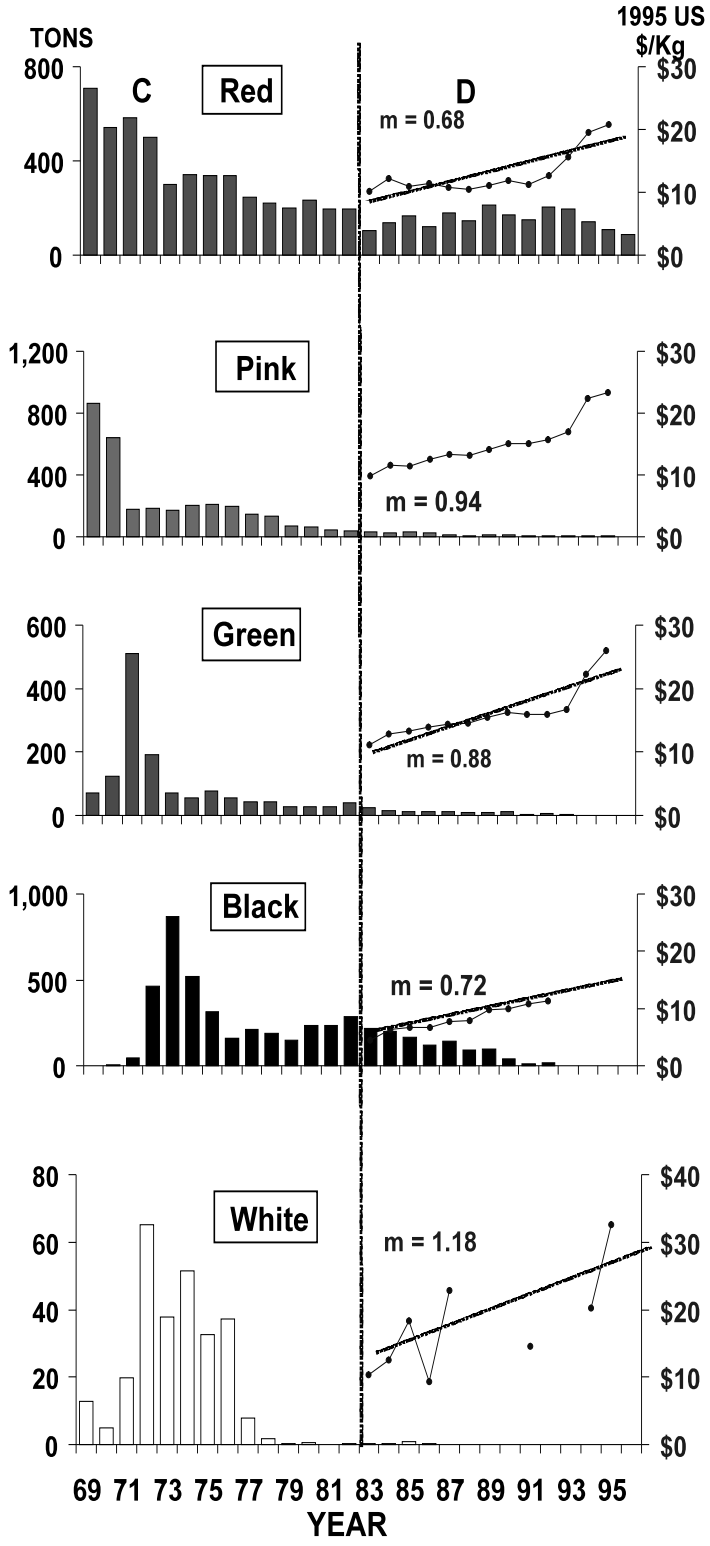

Figure 3-2. Landings for red, pink, green, black, and white abalones (bars): the ex-vessel average value (solid line), with fitted regression lines (dotted line) (m = slope, t x year-1).

abalone as the predominant species. The proportion of red abalone recorded in the logbooks increased, while the black and white abalones disappeared from the logbooks.

This information reflects the nature of the CPDB fishery. The major destination of CPDBs is the Channel Islands. At most of the islands, pink and green abalones occur at depths within the comfort zone of most divers. Red abalone, on the other hand, are commonly found in the cooler waters of relatively remote San Miguel, Santa Rosa and San Nicolas Islands. The opportunity to take red abalone was often dependent upon good weather, which occurs with greater frequency at the islands closer to shore. Thus, there were often more opportunities for divers to take green and pink abalones. The intertidal black abalone, which was common at the Channel Islands, was not usually targeted because it was held in low regard, and was usually inaccessible to boat divers. However, while the fishery was open, shore-pickers harvested black abalone along the southern California coastal mainland. The quantities of black abalone taken by shore-pickers does not appear in any recreational database. White abalone is so rare and occurs so deep that it does not often appear in the recreational catch; however, the data that are available indicates that the recreational fishery landed more than 6,000 white abalone from 1971 to 1979. In the "unidentified abalone" category, landings from the cooler water islands are most likely attributable to red abalone, while unidentified landings from warmer water islands may be attributable to green, pink, and other abalone species.

The steep declines from 1989 to 1990 appear to reflect the reduction in the recreational daily limit from four to two, as well as the shortening of the recreational abalone season from 10 to six months per year. After 1990, the catch increased as divers adjusted to the new regulations. By 1992, red and green abalones made up the largest part of the landings, followed by pink abalone. The number of abalones landed remained at less than ten thousand, which was less than half of the estimated abalone landings prior to the establishment of the 1990 bag limit.

The number of abalone landed per dive boat declined to less than 500 per year after 1990. A slight increase in take occurred in 1989 and was likely an indication of increased effort in anticipation of the regulation changes that were enacted in 1990. The number of boats that landed recreationally-taken abalone varied from 15 to 27, with a low of 11 boats in 1990 when the season and bag limits decreased. The number of CPDBs operating changed little due to the number of alternative target species available to recreational divers.

A reliable measure of the number of sport abalone divers or CPUE for the recreational abalone fishery could not be determined from the CPDB logbook data, because it was not possible to determine if all divers actually targeted abalone, nor could the actual time spent looking for abalone be determined. Additionally, no data is available on the number of shore based or private boat divers.

Northern California

In northern California, creel and telephone surveys have been used to estimate annual recreational harvest level, effort, and CPUE. Combined telephone and field surveys of recreational abalone fishermen were used for selected years between 1977 and 1989 to estimate total catch and effort in northern and central California (Tegner *et*

al. 1992; CDFG 1993b; Karpov personal communication). There was an estimated average take of 685,000 abalone from 235,000 trips (effort days) during 1983 to 1989.

From 1998 to 2000, the average number of abalone fishermen was estimated at 38,000. Preliminary evaluation of the 2000 abalone permit report card program indicates that the abalone take and effort estimates stand at 728,000 abalones taken from 202,000 trips. Sonoma and Mendocino Counties accounted for over 96% of the estimated effort during this time, up from an estimated average of 73% from 1986 to 1989.

Diver and shore-picker catch and effort data from 1995 to 2000 were compared with data from 1989 to 1994 to determine trends in abalone per trip, abalone per hour, returns of undersized abalone per hour, and distance traveled from access point to take point. The result was an indication of site-based (rather than species-based) serial depletion: There was an increased take of abalones from deeper water and from more remote populations at Sonoma County and southern Mendocino County creel survey sites.

3.2 Socio-economic Characteristics of the Fishery

The socio-economic characteristics of the abalone fishery are presented by breaking the fishery into the four major use sectors. The economic value is derived for the two main sectors of the fishery (commercial and recreational) based on the unique characteristics and data that are available to each. Because the data used to calculate the economic value for each sector are different, the values are not comparable between the two.

3.2.1 Commercial Sector

In general, the demand for abalone far exceeds supply (Conte and McBride 1996). Abalone products are marketed as a premium product and command high dollar values in international markets. Japanese Americans dominated the commercial abalone fishery in the early 1900s when abalone were boiled, then dried or canned. Dried abalone sold for approximately $0.20 per pound, and the shells sold for approximately $4 per ton (CDPR 1988). Commercial fishing peaked at an annual harvest of over 2,500 metric tons (t) in 1957. Thereafter about 2,000 t were harvested annually from 1957 to 1969, and commercial abalone landings and abalone abundance continued to decline after 1969. Commercial abalone landings in 1992, 1993, and 1994 were approximately 260, 230, and 140 t, respectively (Conte and McBride 1996).

The 1995 California commercial abalone ex-vessel landings were 118 t valued at $2,515,467 ($2,792,070 in 2000 base year). This is a reduction in total ex-vessel value of the fishery since 1993, when the reported value was $3,154,147 (CDFG 1995b) ($3,601,141 in 2000 base year). Southern California abalone landings represented 73% of the total value in 1995. The remaining 17% came from central California commercial red abalone landings. A more inclusive account of the socio-economic characteristics of the southern and central California abalone commercial fisheries prior to 1997 may be found in the following Department publications: *Final supplemental environmental document: Abalone sport fishing* (CDFG 1993b), *The red abalone (Haliotis rufescens) sport fishery in central and northern California from creel (1975-94),*

aerial (1975-1985), and telephone-based surveys (CDFG 1995a), and *Draft environmental document: Pink, green and white abalone fishery closure* (CDFG 1995b).

3.2.2 Recreational Sector

Since the late 1980s, abalone fishing effort has concentrated in Mendocino and Sonoma counties, which now accounts for 96% of the annual sport effort. This reflects an increase for these counties since 1989 when the average combined annual effort was only 76% (CDFG 2001b). Abalone permit report card returns for the year 2000 show that sport divers residing in Sonoma and Mendocino counties make up 22% of the total abalone trips originating in these two counties. Consequently, 78% of the total abalone trips were made by residents of other counties coming into the local communities and thus bringing an influx of new, or outside, dollars into the local economies.

Travel costs and related expenditures can approximate what abalone sport divers are willing to pay in order to access and enjoy abalone resources. However, this travel-cost approach does not capture or estimate consumer surplus (the value of the activity in excess of the costs to engage in it). Consequently, expenditure information alone may underestimate the true value of the resource to the recreational user. Nonetheless, travel-cost data are often used as a means to estimate the economic value of a resource.

Recreational abalone divers from outside Mendocino and Sonoma counties use a variety of goods and services from local businesses: bed-and-breakfast inns, motels, hotels, lodges, campgrounds, restaurants, dive shops, and boat launches, to name a few. Average direct expenditures by recreational abalone divers for food, lodging, and equipment are calculated at $49 (2000 base year) per trip. These direct expenditures are based on studies by USFWS for average expenditures by recreational pismo clam divers in 1985 (USFWS 1987). Considering that northern California received an estimated 201,614 recreational abalone diving trips in 2000 (CDFG 2001b), these trips may represent as much as $9,879,086 in annual direct expenditures on recreational abalone diving activities (201,614 x $49). Subsequent re-spending by business sectors that cater to the needs of recreational abalone divers results in an economic multiplier effect which, when added to the direct expenditures, yields $17,187,633 (2000 base year) in final output demand for the local economies from recreational abalone fishing.

3.2.3 Non-consumptive Use

While there are undoubtedly socio-economic values related to non-consumptive uses of abalone in California (for example, underwater photography), they have not been quantified and are probably not significant in comparison to the sport and commercial values already discussed. Part of the difficulty in assigning value to these uses is that they are interwoven with the uses of other resources, making it difficult to assign value to any one resource.

3.2.4 Illegal Use: Poaching

Abalone poaching has been a serious concern in California for decades and continues to have a major impact on abalone stocks. Poaching poses a threat to the sustainable management of abalone because it cannot be quantified and has an impact

on both legally-fished and recovering stocks (Daniels and Floren 1998). Also, poaching may accelerate local or total extinction of more severely-depleted populations such as white abalone.

The amount of illegally-taken abalone compared to the legal take is difficult to assess accurately. Department enforcement personnel calculate the percentage of violations during special details, such as abalone checkpoints and other directed details, on an annual basis. However, these contacts are not truly random (checkpoints, for example, are announced in the media ahead of time), thus they cannot be used to accurately estimate illegal take.

Illegal take of abalone is of two general types, sport-related violations and poaching for commercial purposes. The most common sport violations are the taking of over-limits and the under-reporting of catch on the abalone permit report card. The report card is used to record daily diver catch and to provide location of the catch. This information is used to estimate annual recreational catch rates.

The other category of illegal take includes the taking of abalone for commercial purposes, which is currently prohibited in California. This includes poachers who barter or sell their "recreational" catch, and those who engage in large-scale poaching for direct sale to commercial markets. Many of the large-scale poachers are often not observed or contacted in the field. This is due to the unpredictability of how, when and where they conduct their illegal activities.

In 1997, law enforcement officials reported high levels of illegal commercial take prior to the fishery closure (Daniels and Floren 1998). Recent arrests by Department enforcement personnel confirm that illegal commercial activity continues in northern California (Davenport personal communication). The extent of illegal removal of abalone in central and southern California is unknown. As abalone stocks have become depleted, the world price has increased, escalating the impetus to poach (Karpov *et al*. 2000).

The Department expends considerable funding and effort toward enforcement of fishing regulations, including abalone fishing. Department enforcement personnel target high activity periods such as low tides and weekends. Enforcement efforts have been augmented recently by the justice system, which has been levying greater fines and penalties. Improved public education, and the CalTIP (Turn In Poachers) Program, have also acted as deterrents to poaching. In spite of these efforts however, poaching is likely to continue to have an adverse impact on abalone stocks.