

Chapter 7. Abalone Management

7.1 Fishery Management Plan

The management component of the ARMP focuses on the northern California red abalone recreational fishery (Figure 1-1). The concepts described in the plan will be applied to recovered abalone fisheries in the central and southern regions of California outside of the Central California Sea Otter Range. The ARMP recognizes that abalone populations subject to sea otter predation will not support fisheries.

This plan incorporates the basic protective management measures that have been successfully used in northern California, and establishes an adaptive framework for making management decisions in response to changes in stock conditions and fishery patterns. The management plan portion of the ARMP is presented in two phases: an interim plan, which is precautionary and uses available funding and data collection methods, and a long-term plan, which will allow more refined and responsive management, but requires more data. The interim plan will become effective upon plan approval. The long-term plan will continue to be developed, and a timeline for its completion and implementation is presented.

7.1.1 Management Measures

The management measures described here will serve as the basic management program for the current northern California recreational fishery. It will also serve as the basic management program for any future commercial or recreational abalone resource that has recovered.

7.1.1.1 Species-specific Considerations for Management

Management of multiple species of abalone must incorporate species-specific elements in fishery regulation. Size limits, take limits, and management zones, for example, will be based on the biology and status of each species. The use of species-specific elements in fishery regulations is critical and applies to both the interim and long-term management plans. Since 1997, the northern California recreational abalone fishery has been based on red abalone, the only species with abundances that can support a fishery.

7.1.1.2 Gear Restrictions

The prohibition of the use of SCUBA gear and surface-supplied air while taking abalone in northern California established a depth refuge for a part of the red abalone population, because free divers generally do not dive deeper than 28 ft (8.5 m) (Karpov *et al.* 1998).

The required use of a specialized abalone iron to remove abalone reduces damage to the vulnerable foot, thus providing some level of protection. The required possession and use of a caliper-type measuring gauge reduces incidental foot-cutting mortality by ensuring that only legal-sized abalone are removed and kept. These gear restrictions have been mandated in northern California since 1975, and were required in southern California from 1975 until the closure of the fisheries in 1997.

7.1.1.3 Marine Protected Areas

Fish and Game Code §5522(b)(1) provides for a network of no-take abalone reserves, where appropriate. The establishment of marine protected areas (MPAs) to benefit abalone and other resident species may provide an effective way to protect and preserve reproductive populations. Abalone populations in northern California are thought to be protected by a deep water (deeper than 8.4 m, about 28 ft.) *de facto* depth refuge which remains unregulated (Section 2.2.1.1 Northern California Stocks).

Currently, there are five marine protected areas in Humboldt, Mendocino and Sonoma counties (Punta Gorda State Marine Reserve, Gerstle Cove State Marine Conservation Area, Point Cabrillo State Marine Conservation Area, Del Mar Landing State Marine Park, and Bodega State Marine Reserve) that specifically prohibit abalone fishing. Two areas, (Point Cabrillo State Marine Conservation Area in Mendocino County and Bodega State Marine Reserve in Sonoma County) are used as control sites to monitor the effects of the fishery. The remaining areas are inadequate as control sites either because they contain little abalone habitat (such as Punta Gorda State Marine Reserve) or are too small (such as Gerstle Cove State Marine Conservation Area, with less than 0.3 miles coastline).

New MPAs should be established to address the shortcomings of the current MPAs. These shortcomings include lack of consideration for the concept of deep water refuge, and an insufficient range of habitats, which should include shallow and intertidal areas that are currently not well represented. Protecting a wide range of habitats, particularly intertidal areas, could prevent degradation of habitat due to trampling impacts associated with rock picking for abalone (Murray and Denis 1997, Keough and Quinn 1998, Smith 2002). Study areas are needed to increase knowledge of abalone population dynamics, especially:

- Movement between intertidal, shallow, and deep water populations
- Information on source/sink areas and their key features
- The mechanism for replenishment of fished areas
- Information on adult/juvenile abundance relationships

Any newly established protected sites should span a variety of habitat types and depths, because different life history stages may have very different habitat requirements, which could change over time. Establishing a network of MPAs that protect a wide variety of habitats from abalone fishing will give researchers an opportunity to study the spatial dynamics of the abalone fishery, and will help to ensure that productive populations are maintained.

Under the Marine Life Protection Act (FGC §2852), the Fish and Game Commission has developed three designations for the establishment of MPAs to protect and conserve marine life and limit human activities. MPAs appropriate for abalone could fall into any of the three designations: state marine reserves, state marine parks, or state marine conservation areas.

Criteria for MPA development should include or consider, but not be limited to:

- Suitable rocky habitat containing abundant kelp and/or foliose algae
- Presence of sufficient populations to facilitate reproduction. The reproductive biology of abalone suggests that fertilization success is reliant on close proximity, thus high densities of breeding animals could promote reproduction.

- Suitable nursery areas. Nursery grounds have been identified for juvenile abalone: crustose coralline rock habitats in shallow waters which include microhabitats of moveable rock, rock crevices, urchin spine canopy, and kelp holdfasts. Protection of areas with this cryptic habitat may promote juvenile growth and survival until emergence at 50 to 100 mm (approx. 2 to 4 in.) in shell diameter. Areas where invasive surveys find high densities of small abalone (less than 50 mm, or about 2 in.) can be classified as potential nursery areas.
- Oceanographic regimes. The protected lees of major headlands may act as collection points for water and larvae. These areas (for example, the northwest portion of Drakes Bay) may promote the settlement of planktonic larvae, and act as natural nurseries (Ebert *et.al.* 1988).
- Size. Existing MPAs do not provide enough area for large numbers of abalone, nor are they ideal for research regarding population dynamics.
- Accessibility. MPAs need to be accessible to researchers, enforcement personnel, and others with a legitimate interest in resource protection.

Proposed MPA sites should satisfy at least four of the previous criteria.

7.1.1.4 Size Limits

Since 1901, size limits have been a primary tool used to manage abalone. Size limits allow abalone the opportunity to reproduce before becoming vulnerable to the fishery (see Section 2.1.6, Age and Growth, for more information regarding time required to reach minimum legal size).

The minimum legal size for recreationally-taken red abalone is currently 178 mm (7 in.). Fishery models have been used to explore a range of size limits for red abalone. Tegner *et al.* (1989) used yield-per-recruit and egg-per-recruit models to evaluate red abalone size limits, and found that the current recreational size limit is reasonable and conservative.

7.1.1.5 Seasonal Closures

Seasonal closures may be used to protect events such as reproductive periods, or reduce fishing effort and take. The red abalone fishery is closed December through March, and for the month of July. The July closure eliminates effort at a time when take may be high due to calm ocean conditions.

7.1.1.6 Catch Limits

Daily (Bag) Limit

Daily limits are a preferred method of controlling catch in recreational fisheries because they facilitate enforcement efforts. Daily limits prevent concentration of effort and help to distribute the catch throughout the fishing season. Daily limits are also effective in regulating the total fishery catch and a key method of adjusting the total catch to match the total allowable catch (TAC). The current bag limit is three abalone per day.

Annual Limits

Annual limits control total yearly catch by individual fishermen and are another method of adjusting the total fishery catch to match the TAC. If a reduction in total

catch is necessary, however, a reduced annual limit is not as effective as a reduction in daily limit. A reduction in annual limits does not proportionally reduce catch because the annual limit has typically been higher than the average individual catch. Wardens also believe annual limit violations are more difficult to detect than bag limit violations. The annual limit is currently 24 abalone per fisherman.

7.1.1.7 Abalone Take Reporting System

A reporting system for recreational take provides information on individual daily and annual take and the location and date of fishing. In the interim plan, abalone permit report cards are used to report take. In the long-term plan, report cards may be replaced by an abalone tag system (Section 7.1.3.2 New Management Tools).

Abalone permit report cards, commonly known as “punch cards”, were implemented in 2000 to provide information about the recreational fishery and to control annual take. The punch card, which is filled out whenever abalone are taken, provides information about the number, time, date, and location of all abalone taken by fishermen. Until 2002, take was recorded by county. In 2002, 51 discrete sites were added to punch cards to provide specific landing location data.

Punch cards must be returned to the Department by 30 December each year. Data from punch cards are used to identify effort distribution and shifts resulting from local depletion.

7.1.2 Interim Management Plan

The interim management plan is currently used for the recreational red abalone fishery in northern California. This plan uses the available limited resources and data, and must be precautionary. The interim management plan will be used for the northern fishery until the long-term management plan (Section 7.2.1 Northern Management) is developed and implemented.

The interim management plan establishes a fishery-wide adjustable TAC, and a procedure for detecting and closing depleted sites or the entire fishery. The interim plan also provides a method for evaluating the fishery through the use of index sites.

7.1.2.1 Criteria for Evaluating Stock

The interim management plan is based on the best available fishery-dependent and fishery-independent information. A set of stock condition criteria guides the management decision-making process. The criteria include estimates of recruitment, density, catch-per-unit-of-effort (CPUE), and distribution of landings. The target levels for these criteria may be adjusted as better data become available. Criteria are measured at index sites throughout the fishery area (Section 7.1.2.2 Total Allowable Catch).

Criterion 1: Recruitment

Gauging the size frequency of abalone populations may indicate whether large reproductive events have occurred. Size frequency is measured in three size ranges:

1. Less than 100 mm (4 in.)
2. 100 to 177 mm (4 to 7 in.)
3. Greater than 177 mm (7 in.)

Two types of surveys are used to obtain size frequencies and assess recruitment: invasive and emergent. Invasive surveys are used to evaluate juvenile abalone (less than 100 mm) recruitment, but these surveys can be disruptive to the substrate as rocks are overturned and cracks and crevices are examined for small abalone.

Emergent surveys target abalone that are exposed (Tegner *et al.* 1989), and evaluate recruitment of pre-fishery-sized abalone (from 100 to 177 mm) as well as fishery recruitment-sized abalone (greater than 177 mm). Although better population size distribution estimates can be obtained from invasive surveys, they cover much less area than emergent surveys. Therefore, in the data-limited interim plan, emergent surveys are used to assess recruitment densities using size distributions of abalone greater than 100 mm.

A data time series has been collected from Van Damme State Marine Conservation Area that spans a period of strong recruitment. Beginning in 1989, a strong fishery recruitment pulse was detected at Van Damme (Figure 2-1). This recruitment pulse increased the fishable population, which has sustained the local resource over the last decade (Karpov *et al.* 1998). The 1992 fishery recruitment densities from Van Damme were used as the baseline recruitment criterion in the ARMP, because that year's survey provided the most abalone in the size ranges effectively sampled by emergent surveys. Based on the overall 1992 average densities of emergent sub-legal abalone, a density of 4,500 ab/ha in the 100 to 177 mm size range is used to indicate successful recruitment.

Although this density level is higher than typical years, it adds a precautionary measure for increasing or decreasing the TAC. The TAC should not be increased unless there is evidence that a sizeable number of young abalone are present to replace increased catches. Conversely, the TAC might not need to be decreased if there is a sizeable number of abalone present. Because there is uncertainty over what typical levels of recruitment are, this criterion is limited in its use and is applied only in conjunction with the density criterion. No management decisions are based solely on the recruitment criterion. For abalone species that eventually recover and are considered for a fishery, this recruitment measurement will serve as the target until specific data are collected to adjust the appropriate level for each species.

Criterion 2: Density

The interim plan uses two density levels: sustainable fishery and minimum viable population (MVP). The sustainable fishery density is based on estimated densities necessary for a healthy fishery. The MVP level is the threshold below which the population declines.

The sustainable fishery density was estimated from Department surveys conducted between 1999 and 2000 at three fished sites: Van Damme, Fort Ross, and Salt Point State Marine Conservation Areas. An evaluation of deep-water (more than 8.4 m, or 28 ft) density data is used to assess refuge populations (Section 7.1.1.2 Gear Restrictions), while the variation in density across all depths provides an estimate of overall population levels. An average of 6,600 ab/ha was found across all depths, while in refuge (deep) depths, abalone averaged 3,300 ab/ha (Table 7-1). These average densities are used as the best estimate of sustainable densities supporting the ongoing fishery. Surveys conducted in 2003 and 2005 to determine abalone population status confirm these density levels are realistic estimates of abalone densities that can

Table 7-1. Abalone survey summaries, 1999, 2000, 2003 and 2005				
Site	Sustainable density surveys		Population status surveys	
	1999-2000 deep density (Abalone/ha)	1999-2000 combined density (Abalone/ha)	2003, 2005 deep density (Abalone/ha)	2003, 2005 combined density (Abalone/ha)
Van Damme	1,400	7,600	5,100	10,700
Salt Point	5,200	8,300	2,800	8,900
Fort Ross	3,200	4,300		
Arena Cove			3,700	5,700
Caspar Cove			5,000	7,500
Averages	3,300	6,600	4,200	8,200

support a fishery (Table 7-1). Van Damme and Salt Point were included in the recent surveys in addition to two new sites at Arena Cove and Caspar Cove. Average densities were higher for the recent surveys compared to 1999-2000. Four more index sites will be surveyed to determine the status of red abalone stocks (See Index Sites in Section 7.1.2.2).

Stocks that fall below the MVP are at risk of collapse (Figure 5.1). A description of how the MVP level was established may be found in Section 6.2.2.1, Criterion 2 - First Density Level (2,000 ab/ha).

Criterion 3: CPUE and Serial Depletion

“CPUE” as used in this section means “the catch obtained per unit of fishing effort”; for example, the number of abalone taken per day. The CPUE and serial depletion criteria are based on the success of fishermen, as determined in creel (fishery-dependent) surveys. The CPUE will be statistically compared to determine if any sites have significantly lower success rates. Because of inter-annual variation in catch success due to ocean conditions, data averaged over several years will be used when making comparisons among sites. Beginning in 2002, abalone permit report cards began providing CPUE information linked to 51 coded areas designated on the cards. When punch card return compliance increases, high-use sites can be determined, and a decision can be made to either augment or replace the CPUE data from the creel surveys with the punch card CPUE data.

Besides CPUE, a measurement of serial depletion at local areas is also used to determine Criterion 3. Serial depletion results when areas are sequentially depleted, beginning at locations close to access points. Serial depletion is reflected in a significant increase in distance that fishermen travel from access points to take locations. Changes in distance traveled over a 4- to 6-year period will be tested for significance against a baseline period from 1990 to 1994. Distances traveled from access points are recorded in creel surveys to the nearest one-fifth nautical mile (CDFG 2001b).

7.1.2.2 Total Allowable Catch

The interim management plan establishes the target TAC at 400,000 abalone per year, based on the projected catch for 2002. Because this TAC was estimated from abalone permit report card returns for a single year (2000), the figure may need to be

revised as more data are accumulated in subsequent surveys (Section 7.1.2.3 Regulation of Actual Catch Levels). The 2002 catch level was projected from the annual and daily limits established by the California Fish and Game Commission in 2001. The limits were intended to reduce the annual catch by 40% from the 2000 level. The interim plan sets this reduced catch level as the TAC in order to conserve stock and protect remaining populations. The TAC can be adjusted based on evidence of recruitment and density conditions at index sites.

Index Sites

In the absence of broad-scale surveys across the fishery range, population conditions at index sites are used as an indicator of stock status in the interim plan. Four heavily fished sites in northern California have been surveyed: Van Damme State Marine Conservation Area and Arena Cove in Mendocino County, and Salt Point State Marine Conservation Area and Fort Ross State Marine Conservation Area in Sonoma County (Figure 7-1). Although the Arena Cove site was not surveyed during the 1999-2000 period for abalone fishery densities, it was surveyed in 2003 and will be included in future assessments.

Because these index sites are heavily fished, they may fall below the MVP level before other sites. Reliance on these sites alone to determine MVP could close the fishery prematurely. Because of this, four moderately fished index sites (Todd's Point and Caspar Cove in Mendocino County, Timber Cove and Ocean Cove in Sonoma County) (Figure 7-1) have been added to the survey protocol. These index sites will be used for assessing fishery-independent criteria used in TAC determination and fishery closure (see *Fishery Closure*, below) in the interim plan. As part of the interim management plan, these index sites will be sampled triennially. These sites will be surveyed more frequently if additional funds and resources become available

Determining TAC Adjustments

The TAC determination table (Table 7-2) is used to adjust the TAC for the fishery, based on changes in average conditions among the index sites. The table describes the combination of criteria that will lead to each of five management actions:

- Increase the TAC
- Maintain the established TAC
- Reduce the TAC
- Close the fishery
- Reopen a closed fishery

The TAC determination table uses two criteria: recruitment and density (at refuge depths and across all depths). References to adjustments in the TAC are from the baseline level of 400,000 abalone per year, or from a revised baseline TAC (Sections 7.1.2.2 Total Allowable Catch, and 7.1.2.3 Regulation of Actual Catch Levels).

Baseline TAC - The baseline TAC will be maintained (Table 7-2, Action 2) as long as densities at the index sites remain within 25% of sustainable fishery densities at refuge depths and all depths (approximately 3,300 and 6,600 ab/ha respectively). This will apply regardless of the prevalence of recruitment because the baseline TAC was established to be effective in the event of a poor recruitment condition.

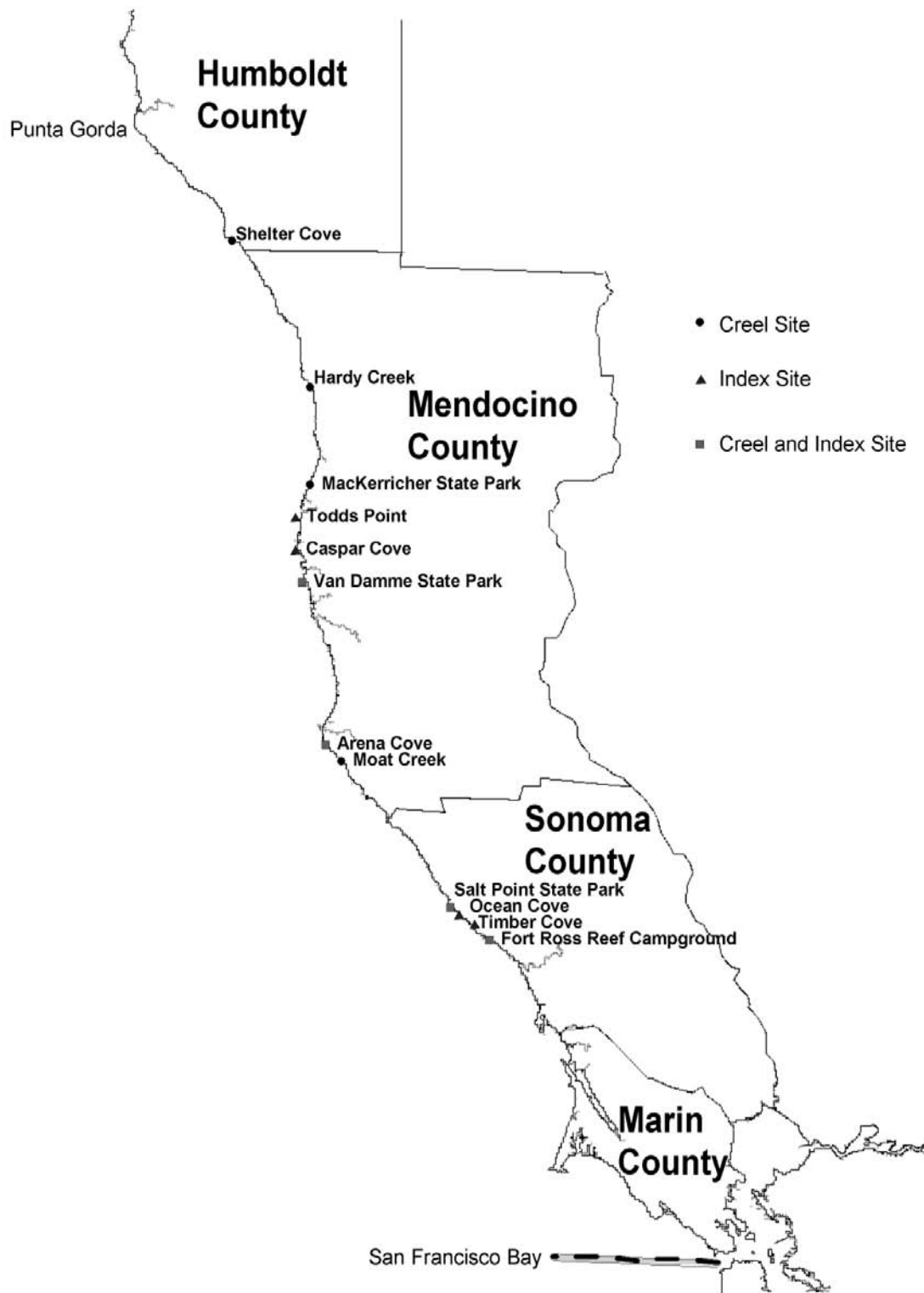


Figure 7-1. Northern California recreational abalone fishery creel and index survey sites

Table 7-2. Total allowable catch (TAC) adjustment decision table using established criteria. Adjustments to the TAC are from the baseline of 400,000 abalone per year or from revised TAC baselines (Sections 7.1.2.2 and 7.1.2.3)*.

CRITERIA					ACTION
Recruitment		Density (ab/ha) – emergent surveys			
		Refuge (deep)		All depths	
Yes	AND	More than 4,100	AND	More than 8,300	1) Increase TAC by 25% (to maximum of 500,000 ab/yr or 125% of revised TAC)
NA		3,300	AND	6,600	2) Maintain TAC (400,000 ab/yr or revised TAC)
No	AND	Less than 2,500	OR	Less than 5,000	3) Reduce TAC by 25% increments
NA		NA		Less than 3,000 at all surveyed index sites combined	4) Close fishery until stocks are recovered according to recovery criteria AND enough data are collected to shift to long-term management plan
NA		More than 3,300	AND	More than 6,600	5) If recovery criteria are also met, reopen closed fishery under long-term management plan

* The specific density targets in this table are based upon the best available data at the time of adoption and may be changed without full plan amendment pursuant to Section 4.4.1.

Note: A closed fishery will not be opened unless recovery criteria are met.

NA = Not applicable

Increased TAC - An increase of up to 25% (Table 7-2, Action 1) will be warranted when recruitment is evident and densities at refuge depths and at all depths increase from the sustainable fishery densities by 25% (to more than 4,100 and more than 8,300 ab/ha respectively). An increase beyond 25% would likely result in a bag limit increase to four abalone per day. A bag limit of four has been demonstrated to result in serial depletion in high use and intertidal areas. Given the history of decline in abalone fisheries in southern California and recent concerns about declines in northern California red abalone, a TAC increase greater than 25% is not considered sustainable (see Section 2.2.1.1 Concentration of Fishery Effort and Increased Take). The interim plan operates in a data-limited environment and adjusts take levels with management tools that are crude and that do not account for increases in effort or in the number of fishermen (Section 7.1.2.6). This ceiling value effectively sets the maximum TAC for the interim plan at 25% above the current level (500,000 abalone or 125% of a revised TAC - Sections 7.1.2.2 Total Allowable Catch, and 7.1.2.3 Regulation of Actual Catch Levels).

Reduced TAC - A 25% reduction in TAC will occur if densities decline by 25% from sustainable fishery densities in either refuge depths (to less than 2,500 ab/ha) or all depths (to less than 5,000 ab/ha). If conditions show continued density decline in subsequent 3-year cycles (but have not reached the threshold for fishery closure), then additional 25% reductions in the TAC will be implemented incrementally. If no additional change in density has occurred, no further reduction will be implemented.

Conversely, if densities return to sustainable fishery densities in all depths and refuge depths (6,600 and 3,300 ab/ha respectively), the baseline TAC will be reinstated.

Fishery Closure - The fishery will close when average densities at the surveyed index sites fall below 3,000 ab/ha. This target density for fishery closure is based on the MVP level of 2,000 ab/ha (Criterion 2) with a 50% precautionary buffer. Populations below this level are at a high risk of collapse (Section 6.2.2.1 Criterion 2 - First Density Level (2,000 ab/ha)).

Fisheries that have been closed will be considered for reopening only when recovery criteria are met, and the stock has rebuilt to sustainable fishery densities at refuge depths and all depths (more than 3,300 and more than 6,600 ab/ha respectively). Fisheries will be initially reopened with low TAC levels that can be incrementally increased to former levels over a number of years, depending on stock conditions.

TAC Adjustments in the Event of Site Closures

The interim management plan allows for site closure in the event of localized population declines (Section 7.1.2.4 Site Closure). In the event of a site closure, the TAC will be reduced to address the potential shift in effort to other areas. With discrete area codes from the report cards, an estimate of specific site productivity can be determined and the TAC can be adjusted. However, an adjustment in the TAC would not completely protect areas outside the site closure from effort shift and subsequent population declines.

7.1.2.3 Regulation of Actual Catch Levels

Total allowable catch levels in the interim plan are based on projected catch levels. Altering TAC can only be accomplished using existing management tools, such as daily and annual take limits, and seasonal closures. These tools do not allow for the precise adjustment of TAC.

When TAC is adjusted, projections for daily and annual limits aim to maintain catch levels consistent with the new TAC. For example, a 25% reduction from the baseline TAC could be accomplished with a daily limit of two abalone and an annual limit of 28 abalone (Table 7-3), with a projected take reduction of 24%. Because only certain percent reductions can be accomplished with combinations of daily and annual limits, additional seasonal closures will be used to augment catch reductions if necessary.

Table 7-3. Projected changes (percent) in the baseline total allowable catch (400,000 abalone) with various combinations of daily and annual limits. Projected changes are only shown for annual limits that can be achieved with a given daily limit.

Daily Limit	Annual limit											
	8	9	10	12	15	16	18	21	24	28	30	32
4	-22			-15		+7			+37	+49		+59
3		-59		-44	-32		-10	-5	0		+22	
2	-71		-61	-56		-46	-34		-29	-24	-22	-12

The actual catch will need to be continually monitored and compared to the projected catch (set in accordance with the TAC) to ensure that the desired catch level is not exceeded. For example, the baseline TAC of 400,000 abalone per year represents a 40% reduction to the fishery from year 2000 catch levels. The abalone permit report cards from the year 2002 will be used to determine if the regulatory changes for bag limits (reduced to three abalone per day and 24 abalone per year) achieved the desired 40% reduction in catch. If the TAC is exceeded, then additional take restrictions or seasonal closures will be implemented as part of the Commission's triennial recreational regulation change cycle. If current catch levels estimated from returned abalone permit report cards and random telephone surveys are more than 50,000 below the 400,000 baseline TAC, a new baseline TAC will be calculated by averaging the estimated actual catch for the most current three years.

7.1.2.4 Site Closure

Other than established reserve areas (Section 7.1.1.3 Marine Protected Areas), local sites have not been closed to abalone fishing in northern California to date. However, site closures may be necessary to respond to localized depletion before stock size falls below MVP. Failure to close depleted sites can lead to collapse of local abalone populations (Karpov *et al.* 2000).

Creel Survey Sites

Fishery use is not evenly distributed, and some sites are more or less productive. More productive sites will be monitored annually in fishery-dependent creel surveys to gather information on catch levels and patterns of take. Each creel site that shows indications of stock decline (in other words, lower CPUE or increases in distance traveled) will become a candidate for site closure (see Decision Framework for Site Closures, below). If a creel site is closed, a comparable non-surveyed, high-use site may be established as a new creel site. Any new creel sites will be selected using detailed site-specific report card information (Section 7.2.1.1 Fishery-dependent Data).

Currently, eight fished sites (Figure 7-1) are monitored biennially in creel surveys in northern California. These sites have been monitored since 1975, and were established because they are thought to be among the most highly used locations. Abalone report card returns have verified that these are high-use sites. The Fort Ross Reef area and Van Damme State Marine Conservation Area were the two most heavily used sites according to abalone permit report card data, and Salt Point State Marine Conservation Area was the fourth most heavily used site. Four of the other creel survey sites were in the top 20 most heavily used sites. As more resources become available, additional creel survey sites may be included.

Decision Framework for Site Closures

The site closure criteria presented in Table 7-4 will be used to determine whether sites should be closed due to low density, and whether previously closed (but recovered) sites should be reopened. Two criteria are used in this decision table: density and CPUE/serial depletion.

When a site demonstrates a significant decrease in CPUE or a significant increase in distance traveled from access points to take locations (Criterion 3), density surveys will be conducted to determine if densities are approaching the MVP. Because

Table 7-4. Site closure decision table using established criteria*				
CRITERIA				ACTION
Density (ab/ha) - emergent		All Depths	CPUE and Serial Depletion	
Refuge (deep)				
NA		NA	Significant decrease in CPUE, or increase in distance traveled	Density surveys to determine if closure is warranted
NA		Less than 2,500	NA	Close affected site and reduce baseline TAC
More than 3,300	AND	More than 6,600	NA	Reopen closed site

* The specific density targets in this table are based upon the best available data at the time of adoption and may be changed without full plan amendment pursuant to Section 4.4.1.

CPUE data can be affected by factors other than low population densities, these data are only used as a trigger for density surveys and not for closing a site.

If diver surveys at any site show densities below 2,500 ab/ha (the MVP level of 2,000 ab/ha with a 25% precautionary buffer), that site will be closed to fishing. A 25% precautionary buffer is sufficient for individual sites because precautionary measures do not need to be as great when risking the loss of a single site as opposed to the entire fishery, which has a closure density of 3,000 ab/ha (Section 7.1.2.2 Total Allowable Catch). A lower precautionary buffer for individual sites will prevent unnecessary site closure due to sampling variance.

If diver surveys at a closed site show that sustainable fishery densities (more than 3,300 ab/ha at refuge depths and more than 6,600 ab/ha at all depths) have been reestablished, reopening of that site will be considered. However, no closed site will be reopened unless the entire range of the fishery meets the minimum criteria for an allowable fishery (as established under the recovery guidelines and the TAC adjustment decision process presented in Table 7-2).

Implementation of Site Closures

When a site is closed due to abalone stock declines, enforceable site boundaries (easily recognizable to both the public and enforcement staff) will be defined surrounding the site and its coastal access point. The extent of the closure area will be determined as the area encompassing most of the effort at the site, based on creel survey data. Adjacent areas that can be reached from other access areas will not be included. When transiting a closed site with abalone taken legally outside of that site, all abalone fishing gear must be stowed and not readily accessible for use. Because coastal access points are limited, this restriction will protect abalone at the closed site and limit take in adjacent areas that may have been impacted by fishing.

7.1.2.5 Interim Management Regulatory Time Frame

The interim plan will be implemented upon plan approval. The necessity for regulatory change will be reviewed every 3 years, corresponding with the Commission's recreational fishery regulatory review cycle.

The eight index sites will be surveyed every three years depending upon

available funding to obtain fishery-independent data. The eight high-use sites will be creel surveyed every other year to collect fishery-dependent data.

Adjustments to the TAC will be evaluated every 6 years and implemented with the approval of the Commission. The 6-year period provides an opportunity for catch to stabilize after new regulations are implemented. Regulatory changes that adjust catch levels (to ensure that the TAC is not exceeded) may occur every three years as part of the Commission's regulatory review process. Closure (Section 7.1.2.4 Site Closure) or lowered limits (Section 7.1.1.6 Catch Limits) for high-use sites can occur on 3-year cycles as part of the Commission's regulatory review process.

Fishery closure can occur during any triennial review cycle, or as an emergency action at any time when the condition of the stock is jeopardized.

7.1.2.6 Limitations of the Interim Management Plan

The interim management plan provides a logical decision framework for managing the fishery given limited data availability. However, the interim plan is restricted by the data-limited environment in which it operates, as well as by the imprecise regulatory tools upon which it relies.

The limited data available during the interim plan results in broad spatial and temporal scale management. The data used to determine overall stock conditions provide bases for making fishery-wide management decisions; however, they do not necessarily provide bases for evaluation of conditions at individual sites, and may not be representative of the entire fishery range. In addition, since the TAC applies to the entire fishery range, a large portion of the TAC can potentially be taken from a small number of high-use sites. The ability to close individual sites is meant to compensate for this limitation by providing a mechanism for local management action. However, the ability to close these sites is an all-or-nothing tool which is unable to locally scale down take to maintain site sustainability. Furthermore, the fishery-dependent data used in site closure decisions must be analyzed over a number of years to take into account the data's high variance. As a result, site closure can only be implemented on a 6-year cycle, with possible delays between population impacts and subsequent management actions.

The imprecise methods used to control take in the interim plan (daily and annual limits with the option of seasonal closures) have several disadvantages. These tools do not allow for fine scale TAC adjustments. Although the information provided in Table 7-3 implies that small adjustments can be made, TAC changes must be made in large increments (for example, 25% of the TAC) because current management constraints do not allow finer adjustment. In addition, the tools cannot absolutely limit take, because actual catch levels will depend on ocean conditions as well as the number and behavior of fishermen in any given year. The catch resulting from any set of daily limits, annual limits, and seasonal closures can only be estimated from the previous year's abalone permit report card and creel data, and is an approximation at best. If conditions or fishing behavior differ from the previous year, the projected catch may be exceeded. The actual catch must therefore be periodically compared to the TAC, and may be adjusted with additional regulatory changes. Because further adjustments must occur during subsequent Commission review periods, there is an implicit three-year delay in the review and adjustment process. Finally, the daily and annual take limits are difficult to enforce, which may cause the possible underestimation of both the projected and actual catch.

7.1.2.7 Scenario for No Fishery-independent Monitoring

In the event all fishery-independent index sites are not sampled as scheduled (Chapter 9, Implementation (Activities, Timelines and Costs)), a more precautionary TAC should be established. Relying on fishery-dependent data increases the chance of not detecting actual declines in stock and recruitment. A more precautionary TAC than is currently used would be applied under this scenario. The TAC would be reduced incrementally by 25% (initially, for example, to 300,000 abalone per year) to achieve this more precautionary management. It is still possible that under this scenario, an impending stock collapse would go undetected.

7.1.3 Long-term Management Plan

The long-term plan will use many of the elements of the interim plan including criteria for stock status and TAC. However, to address the limitations of the interim plan, the long-term management plan will also establish management zones and develop new management tools to improve control over local take. These improvements will require increased financial support for survey efforts, management and enforcement, which will move abalone management from a data-limited condition to one that is data-rich, and allow for more refined controls. With increased information, the long-term plan can be less precautionary than the interim plan. Elements of the long-term plan such as zones and increased surveys will be developed and put into use before complete implementation of the plan.

Implementation of the long-term plan is not expected before 2011 and will require resources to support assessment and management that are currently unavailable. Any future reopening of a closed area, including the currently closed central and southern areas of California, should be managed under the long-term plan. Any other approach would require a large precautionary buffer.

7.1.3.1 Zonal Management

Zonal management allows increased flexibility in controlling levels of take within the fishery. The general strategy for zonal management is to divide a resource into regional sub-units that can be managed more effectively than a single unit. A TAC for each zone can be calculated using fishery-independent data or existing take levels derived from abalone permit report card data. Managers have the option to close areas or reduce take as local populations decline, while keeping open those areas with healthy populations. Requirements for effective zonal management include information about the status of the fishery in each zone and effective enforcement.

Zone boundaries will be based on abalone reproductive characteristics, fishing effort, habitat quality, and enforcement considerations. While zone boundaries are not likely to change as characteristics change, they are adaptive and can be changed if needed for more effective management. The number of zones will depend in part on the resources available to adequately monitor them using fishery-independent survey sites. The main sources of data for defining zones will be abalone permit report card summaries, kelp surveys, habitat mapping, and fishery-independent surveys.

7.1.3.2 New Management Tools

Tags

A tag system, similar to that used in wildlife management, could be used to limit the total number of animals taken from a zone and to identify legally taken animals. For abalone management, tags would be issued for a specific zone, as with deer tags, and unused tags and abalone permit report cards would be returned to the Department at the end of the season. Abalone tags would likely be thin, flexible plastic strands which would be threaded through open holes in abalone shells and locked in place. By designating the number of tags issued for each zone when the TAC is established, managers could control the number of abalone removed from a zone. Tags would be conspicuous so that legally taken abalone could be readily distinguished.

A tag system would require additional effort on the part of the Department and the fishermen for administration, distribution, and compliance, and may require lotteries for tags from popular zones. Manufacturing and inventory control of nearly 500,000 tags, coded by zone, would be an added expense.

Zone-based Abalone Permit Report Cards

An alternative to tags may be abalone permit report cards that are only valid for specific zones. By limiting the number of cards issued in a zone, managers would control the TAC for each zone. The advantages of this system are that fishermen would not have to handle and apply tags, and the Department would not have to distribute tags or have them manufactured. However, zone-based report cards do not have the enforcement advantages of tags.

7.1.3.3 Data Sources and Refinements

Information useful to the management of the northern California fishery is obtained from fishery-independent diver surveys at index sites, fishery-dependent creel surveys, permit report card data, and telephone surveys. It is recognized that more and better information is needed to improve fishery management, but current fiscal and personnel limitations prevent improvement.

Diver surveys provide the best scientifically based data for the management of the northern California fishery. These surveys are fishery-independent, and when conducted in a statistically significant manner provide the best indicators of the health of the abalone resource.

Diver surveys can assist in defining the resource and the fishery, including the condition of deep water populations within *de facto* refuges, movement studies, and the condition of abalone populations in general.

In the absence of fishery-independent information, several fishery-dependant surveys have been developed to address specific aspects of the fishery (Section 7.2.4.1 Fishery-dependent Monitoring). Creel surveys, which are on-site surveys of fishermen's take, have been conducted since 1975 and provide the best time series of abalone fishery data available. There are currently eight high-use sites monitored by creel surveys. These surveys can address size distribution of the catch to determine whether an area is being fished down to the legal size, and may be useful in addressing how far fishermen go to find their catch. While these data are useful in determining how many abalone are being taken at a location, they reveal nothing about the non-fished part of the resource. Improvements to creel data collection under the long-term plan include

increasing the frequency of surveys and expanding the surveys to include individuals using vessels.

The abalone permit report card is another source of fishery-dependent data that addresses take throughout the fishery. Over time, it is hoped that a dynamic picture of the catch can be determined by viewing trends in the location of take.

Abalone permit report card data have the advantage of large sample size and wide area coverage, but depend on the accuracy of reporting by fishermen. These data also lack the information on abalone size and precise take location that creel data can provide. They also do not provide information on sub-legal abalone abundance, which can be provided by fishery-independent data. Under the interim system, accurate catch data from abalone permit report cards are needed to monitor how well regulations maintain the total take within the TAC. In a tag-based system, the abalone permit report card, and the telephone interview program would still be useful in providing information on CPUE and catch distribution within a zone. This information is critical to the long-term plan. A primary improvement will be a point-of-sale system that enables the Department to block sales of new abalone permit report cards to fishermen who failed to return their cards the previous year.

7.1.3.4 Closing and Reopening Fisheries

An existing fishery will be closed if half the zones have been closed due to low abalone abundance as established through fishery-independent surveys. This provision may help prevent a repeat of the collapse of the central and southern California abalone fisheries, in which abalone populations were sequentially depleted until populations in all but the most remote island areas had been extirpated.

A fishery may be reopened when 75% of the zones have reached sustainable fishing levels (6,600 ab/ha). Long-term management will provide controls and responses to changes in local stock conditions. This may prevent future stock collapse and reduce the likelihood of closures that would have been made under interim management.

7.1.3.5 Long-term Plan Timeline

Implementation of the long-term plan is targeted for 2011. Before implementation, elements of the long-term plan will be initiated, including analysis of diver, creel, and permit report card surveys. After report card data are analyzed in 2007, zones will be established as outlined in Section 7.1.3.1, Zonal Management. TAC adjustments and possible closures for each zone will be made as described for the whole fishery in the interim plan (Section 7.1.2 Interim Management Plan). An increased number of survey sites will be established if funding is available. Implementation will depend upon the resources available for monitoring, and an evaluation of the usefulness of zones in management.

7.1.4 Reopening of Recovered Fisheries

Fish and Game Code §5522 states that the Department may apply to the Commission for the reopening of recreational or commercial fishing in all or any portion of closed areas if the Commission finds that the resource can support abalone harvest. Under the ARMP, reopening of recovered fisheries should occur under the long-term management plan following a planning process that ensures sufficient resource data are collected for effective management (Section 7.1.3, Long-term Management Plan).

The former central and southern California abalone fisheries are currently closed due to stock collapse. The five species of abalone that were fished in central and southern California (red, pink, green, black, and white abalones) are all in need of recovery at this time. Once the final ARMP recovery criterion is met for a species, reopening of a fishery for that species may be considered. Northern California red abalone currently supports a recreational fishery. In the event that the northern California fishery is closed, reopening following recovery may take place under the guidelines established here.

7.1.4.1 Planning Process for Fishery Reopening

When stock levels at three-quarters of the sites where recovery success is measured meet the management criteria for sustainable fishing densities (6,600 ab/ha), a planning process for fishery reopening will begin.

Fisheries that have been closed should be reopened under the long-term management plan. Therefore, the information required in the long-term management plan should be determined as part of the fishery planning process; this information includes the development of zone boundaries and zone-specific TACs based on stock conditions. An economic assessment will also take place to ensure that there are adequate resources to enforce regulations and assess populations throughout the fishery range.

For fisheries in southern California, additional planning will occur. For example, resource allocation between recreational and commercial fisheries must be determined and a network of no-take reserves should be established prior to reopening any southern California fishery.

The information developed during the planning process will be incorporated into the ARMP through plan revision or amendment under Commission authority prior to reopening any fishery.

7.1.4.2 Application of the Long-term Plan to Reopen Fisheries

When fisheries are reopened, allowed take will be gradually increased over a period of six years, with a 25% increase in fishing per year (in each zone) until the established TACs are met. This allows for a precautionary approach to the reopening of the fishery to ensure effective implementation of management and enforcement efforts needed to protect the stock.

The following sub-sections describe how long-term management components should be applied to reopened abalone fisheries. At this time specific details are premature since recovery to fishery levels may require decades.

Species-specific Management Elements

Before considering the opening of a fishery, the recovery and management criteria must be met for a species. The guidelines of the long-term plan may be used for management of all species. If used, specific regulations such as zone boundaries, size limits, or zonal TACs may vary by species. Each Region may contain fisheries for more than one recovered species, each individually managed.

Zone-based Management

The establishment of fishing zones is important for long-term management. Absent this tool, large precautionary buffers will be necessary. Species-specific zones

should be established within a fishery Region prior to a fishery reopening. Zone boundaries will be based on abalone reproductive characteristics, fishing effort, habitat quality, and enforcement considerations. However, because the Southern California Region and the Central California Region outside of the Central California Sea Otter Range are not currently fished, zone boundaries cannot be based on fishing effort. Therefore, zone boundaries will be determined by abalone distribution, the quantity of abalone habitat, and enforcement considerations.

The long-term plan suggests that in order for a Region to be opened, at least 75% of the future management zones in that Region need to meet the recovery and management criteria. This specification will apply to any reopened fishery regardless of the number of zones established.

Zonal Total Allowable Catch

Under the long-term plan, TACs will need to be established for each zone. In the Southern California Region and Central California Region outside of the Central California Sea Otter Range, TACs cannot be based on former catch levels within a zone, as those levels were not sustainable. As a result, zonal TACs will likely be determined from data on abalone population densities and available abalone habitat. The determination of TACs will therefore require enough data collection (through diver surveys and habitat mapping) in each zone to determine the amount of abalone that can be sustainably fished.

7.1.4.3 Management Regions

Northern California Region

The Northern California Region, which extends from the California-Oregon Border south to San Francisco Bay, will be maintained as a recreational-only fishery (FGC §5521.5). If the Region is closed to fishing in the future under the interim plan, it would be reopened under the long-term plan as a recreational-only fishery. The Department has begun to develop a long-term plan scheduled for completion by 2011 (Chapter 9 Implementation (Activities, Timelines, and Costs)). Since a fishery exists in northern California, catch and other information will be used to determine zonal boundaries and their respective TACs if a closure occurs.

Central California Region

The Central California Region extends from San Francisco Bay to Point Conception, including the Farallon Islands. The area between Point Año Nuevo (San Mateo County) and Point Conception (Santa Barbara County) encompasses the Central California Sea Otter Range, where natural predation has reduced abalone populations to well below minimum legal size. These populations cannot support a fishery. The remaining area of the Central California Region consists of two management zones, the Farallon Islands and the otter-free mainland coast between Point Año Nuevo and the San Francisco Bay entrance.

Two potentially fishable abalone species exist in the Central California Region: red and black abalones. However, the black abalone is at the periphery of the species range in central California, and the risk for population collapse under fishing pressure is high. Therefore, only red abalone will be considered for a fishery in the Central California Region.

If recreational and commercial fisheries for recovered red abalone are reopened in central California, management should be based on models developed for re-opening the southern California red abalone fishery, and the issue of resource allocation should be addressed at that time.

Southern California Region

The Southern California Region extends from Point Conception to the border with Mexico. Although future management of the southern California fisheries will be similar to that in northern and central California, some components of management will vary due to differing abalone distribution and the possibility of a more extensive commercial fishery than the one that may occur in central California. Southern California is also the only Region where more than one species may be fished.

With the exception of pink abalone, abalone depth distributions in the Southern California Region do not mirror those in the Northern and Central California Regions. Depending on the species, the stock is either mostly at refuge depths (red and white abalones) or exclusively at shallow depths (black and green abalones). As a result, *de facto* depth refuges (created by allowing only free-diving) that have been critical in providing protection to a portion of the red abalone stock in the Northern California Region would not work for any species other than pink abalone in the Southern California Region. Therefore, prior to opening a fishery for red, white, black, or green abalones in this Region, a network of reserves should be established in appropriate habitat that provides a level of protection similar to that provided by the depth refuge in the Northern California Region. When this network is in place, all recovery and management criteria have been met, and the fishery planning process has been completed, fisheries that allow the use of scuba or surface-supplied air may be reopened in the Southern California Region.

Because the possibility for a commercial fishery still exists in the Southern California Region, resource allocation between recreational and commercial fisheries will need to be determined for each species under consideration prior to fishery reopening. Ultimately, resource allocation is a political decision that can most readily be addressed when populations have recovered and the number of potential resource users is known.

7.2 Research Protocols - Managing a Sustainable Fishery

The essential fisheries information (EFI) requirements of the management plan, particularly for the decision tables (Tables 7-3 and 7-4), define the main elements of the research plan. Research protocols are divided into northern, central and southern management, and further sub-divided into fishery-dependent and fishery-independent elements. Within these elements, interim and long-term management plan research protocols are described. Northern and Southern California Regions are treated separately due to their different management and research histories. The Central California Region, outside of the Central California Sea Otter Range, falls under the research plan for the Southern California Region. Unlike traditional fishery management strategies, active adaptive management requires more frequent feedback than that provided through a largely passive approach, in order to make adjustments to fishing levels as biological reference points are met (Hilborn and Walters 1992).

7.2.1 Northern Management

Consistent with each fishery management plan developed by the Department since the adoption of the Marine Life Management Act, the northern research protocol section shall identify EFI including relative abundance and size frequency, age and growth, minimum size at maturity, and spawning season. Ongoing and future information to be collected as well as methods to be used will be described. The ARMP suggests continued improvement in fishery monitoring and assessment, as well as collaboration with outside entities in the collection of EFI.

7.2.1.1 Fishery-dependent Data

Interim Management Plan

The interim plan calls for the maintenance of current fishery-dependent information gathering systems. These include recording catch and effort data from abalone permit report cards by location, and estimating total catch and effort for the fishery annually. This post-season estimate will be compared to the TAC to assess the effectiveness of the take regulations in targeting the TAC. There have been about 40,000 report cards issued annually since inception. Return rates since 2000 have been poor, ranging from 18% to 43% of the cards returned each year, despite the legal requirement to do so. It is anticipated that with improved return rates and the ability to randomize sampling, report card information from 51 discrete access points will provide a vastly improved picture of the distribution of abalone catch, effort, and catch success (CPUE) along the fishery coastline and throughout the season. This information will be valuable in assessing the abalone stock in the vicinity of individual access points, and subsequently in directing survey efforts to areas of concern, leading to the possibility of area-specific regulation changes.

At this time, the creel survey is conducted biannually at minus tides (mostly in the spring months) to assess catch, effort, abalone condition, and demographic data (Section 7.1.2.4, Creel Survey Sites; Figure 7-1). This survey can be coordinated with other surveys to obtain independent estimates of effort and take. In the late 1980s, coordinated efforts were undertaken with the federal Marine Recreational Fisheries Statistics Survey to estimate catch and effort prior to the inception of the abalone permit report card (Karpov 1991). Coordination may need to be maintained as an independent check of the reliability of the permit report card database, especially in the initial years of the card's implementation.

One of the unique features of the creel survey is its ability to pinpoint diver and shore-picker catch and effort locations within a 0.2 nautical mile grid in the vicinity of the creel sites. This information is used in a variety of ways, particularly as a criterion in assessing the level of serial depletion at each site, for use in the management decision table.

Long-term Management Plan

Both the creel survey and the permit report card system can be improved to better monitor and allocate abalone catch and effort. Implementation of a zonal management system in the future would require an increased capability of monitoring catch and effort. In the event of the closure of one or more zones, it may be necessary to reduce the total TAC to avoid a shift of effort to the remaining open zones. The abalone permit report card could be linked to a tag system in which a predetermined

number of tags are issued each year, with the total number of tags corresponding to the TAC.

The creel survey could also be improved by use of a stratified random survey during the fishing season to improve the accuracy of the estimated parameters by reducing minus-tide bias and including access points other than the historically surveyed ones.

7.2.1.2 Fishery-independent Data

Fishery-independent data, information collected from sources not connected to the fishery, often provide the most complete information about a resource. Although these data are often more costly and difficult to obtain, they are necessary to effectively manage the fishery. These data will be obtained from the assessment and monitoring of populations at established index sites, from other research agencies such as the Channel Islands National Park (CINP), the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO), Cooperative Resources Assessment of Nearshore Ecosystems (CRANE) and others, as well as from programs involving constituents in research activities.

Fixed index transects and broad-scale random transects provide two sampling approaches which have specific advantages and disadvantages. Index transects are better at providing the relative change in variables between sampling periods and can reduce sampling variance and cost, while random (or variable) transects are better at estimating the actual average value of the measured variable over the area (Carr *et al.* 2001). A combination of GPS-based fixed and random transect sites offers the benefits of both approaches and will be incorporated into the state-wide, multi-species sampling program currently being developed.

Constituent involvement may be helpful for certain assessment methods such as timed swims, where the number of abalone counted per minute of diver search time is recorded. This information can be used to detect qualitative population trends over time, but is not a density-based fishery assessment. Timed swims may have particular utility in southern California, where study areas are large and abalone populations are too depleted to effectively assess with traditional area-based methods.

Interim Management Plan

If funding for monitoring index sites is increased, the interim management plan will include monitoring the four previously used index sites and four additional sites in northern California. The index sites will also be sampled at an increased frequency. The basic data collected along transect lines will include the relative abundance (density) and size frequency of emergent abalone as well as sea urchins. Densities of pinto abalone, flat abalone, and purple sea urchins will be recorded. Densities of certain associated organisms, the species and percent cover of algae, and substrate characteristics will also be determined along transect lines. During the interim phase, eight sites (four sites in Mendocino County and four in Sonoma County) will be surveyed on a three-year cycle. At each site, transect placement will be stratified by depth, with the dividing line between shallow and refuge categories at 8.5 m (approximately 28 ft).

If fishery-dependent data at a site indicate a statistically significant decline in CPUE, a fishery-independent survey will be initiated to assess the population. Protocols for transect placement and survey methods will be similar to those at the

index sites. In 2008, a diver survey may be implemented at James V. Fitzgerald State Marine Park in San Mateo County to assess the recovery of depleted populations along this closed section of coastline. If criteria for recovery have been met, the frequency of surveys in this area may be increased in preparation for long-term management.

Long-term Management Plan

The research protocols for this phase of the plan call for the augmentation of interim plan protocols with additional survey sites, which are stratified and randomly sampled during a three-year cycle. The number of additional sites would be a function of future need (for example, according to the number of management zones) and the accompanying cost. However, these additional sites could be surveyed by the Department's pool of research divers. Protocols for transect placement and survey methods will be similar to those used for the index sites. Selection of the sites would be random within particular strata, which might include management zones in the future. Long-term protocols will entail coordination and collaboration with various agencies such as PISCO in order to maximize efficiency and minimize redundancy, and to perform assessments for other managed species.

7.2.2 Central and Southern Management

The recovery of southern California's five abalone species will be monitored by the Department and its collaborators using protocols described in Chapter 6, Abalone Recovery. The Central California Region, outside of the Central California Sea Otter Range, falls under the research plan for the Southern California Region.

In the event of recovery to sustainable fishery population levels at key index sites, these protocols will be changed. Sampling will continue at the same index sites, but will be shifted to density-based sampling, similar in design to the fishery-independent protocols described for the northern California fishery. There will be separate index sites for each species. The much larger habitat area and species diversity of southern California make management monitoring much more challenging than in the northern part of the state. The collection of EFI will be exclusively fishery-independent for the short-term and well into the long-term, due to the absence of fisheries for these species in the foreseeable future.

Reopening closed fisheries requires the implementation of long-term management. An interim management plan for southern California abalone populations will not be needed due to the paucity of manageable populations. Monitoring will be conducted in collaboration with agencies such as CINP and PISCO. At this time it would be premature to design a fishery-dependent monitoring plan without knowledge of the resource allocation system.

7.2.3 Future Research

Future research areas include:

- Improving estimates of abundance, both of the total population and of individual size classes in order to improve calculation of sustainable catch levels
- Obtaining reliable estimates of essential habitat area for use in direct stock size estimates

- Improving knowledge of key population parameters such as growth, mortality and recruitment rates, and defining the stock-recruit relationship for each abalone species, which is essential information for abalone population modeling

As better information becomes available, it will be possible to develop and adjust a system of zone-based decision criteria in the long-term management plan to reflect this improved understanding of abalone population dynamics.

In addition, it may be valuable to determine aggregation indices (patchiness factors) to examine the effect of low densities on abalone behavior and reproduction, and to determine how easily abalone may be taken under these conditions (Post *et al.* 2002). Since fertilization success depends on adequate densities of abalone, maintaining these aggregations may be important to ensure sufficient larval production. More information about the effect of El Niños and other environmental fluctuations on abalone reproduction and disease will aid in developing better fishery management plans. Knowledge of the genetic structure of abalone populations, such as the numbers and size of the individual populations, should be integrated into management models. Additionally, ecological interactions including feeding, spatial, and behavioral relationships should be factored into future abalone management. Future research will include the use of ROV survey techniques in order to extend the survey depth-range and area.

7.2.4 Summary of Past and Current Fishery-dependent Monitoring and Fishery-independent Assessment

7.2.4.1 Fishery-dependent Monitoring

Since 1975, the Department has relied on creel surveys at sites along the northern California coast to obtain estimates of catch and effort. Beginning in 1998, the abalone permit provided managers with the total number of potential abalone harvesters in a given year. With the introduction of the abalone permit report card in 2000, the Department has gained a potentially more accurate means of measuring effort and take by county, month, and day. In the previous southern California fisheries, the commercial passenger dive boat (CPDB) log book system was used to estimate the number of passengers per dive boat and the total number of abalone landed by each boat.

Creel Surveys of Recreational Abalone Fishermen

Creel surveys were initially conducted in 1960 and 1972 in central and northern California and have been conducted on a continual basis since 1975 in Sonoma, Mendocino, and Humboldt Counties (Miller *et al.* 1974; Karpov 1991; Tegner *et al.* 1992). Typical survey information includes size of abalone taken, take per fisherman-day (or take per trip), take per hour, the number of sub-legal abalone returned per fisherman-day, and catch location. These surveys are generally conducted in areas where a high level of effort is expected each year, and a historical time series can thus be created for comparison. Sampling focuses on minus-tide periods in the spring, to maximize encounters with recreational fishermen. Retained abalone are examined for the type and degree of cuts to the foot; this can be used to estimate expected mortality of returned abalone.

Abalone Permit Report Card Returns

In 2000, only about 10,000 permit report cards were returned out of 39,347 sold, despite the regulatory requirement to return cards. Even with this large sample size, returned cards may not be representative of the entire population of abalone fishermen; thus, catch and effort statistics are affected by an unknown degree of bias. Telephone surveys are used to address this bias (see Telephone Surveys, below). Total catch, trips, and CPUE by county and date can be calculated accurately for the first time in the northern California recreational abalone fishery. In addition, a demographic database of fishery participants allows tracking of fishermen's county of residence, and can be used for targeted surveys and questionnaires.

Telephone Surveys

Random telephone surveys of households in central and northern California were used from 1986 through 1989 to estimate the number of abalone trips and abalone caught per household. Sample sizes were small since relatively few households contained abalone fishermen. A database was created from receipts for permit report cards and is used for random telephone surveys targeting abalone fishermen. The random telephone surveys are needed to check for bias in the returned cards and to collect data that are not available from the cards, such as numbers of unsuccessful attempts to catch abalone (Section 7.1.2.1, Criterion 3: CPUE and Serial Depletion).

Commercial Passenger Diving Boat Log Book System

A detailed analysis of CPDB red abalone catch and effort data in southern California is available for 1978 through 1987 (CDFG 1991, 1993b). The CPDB log book information from southern California presents catch and effort data combined for entire boat-loads of fishermen, whereas the northern California recreational fisherman creel survey presents catch and effort data for individuals or small groups of fishermen.

7.2.4.2 Fishery-independent Assessment

Underwater surveys allow the estimation of size-selective, relative and absolute abundance by combining size measurements and abalone counts per unit area with estimates of the extent of habitat. The latter can be derived using side-scan and multi-beam sonar. The tagging of individual abalone in their habitat provides information about age, growth, and movement patterns, while the use of abalone recruitment modules can provide an index of annual recruitment.

There are two main types of area-based underwater survey techniques for counting abalone: emergent and invasive. For both techniques, abalone are counted and measured on either side of a transect line of fixed length and width. Both types of surveys are normally stratified by depth. Invasive surveys are intended to find both cryptic (hidden) and emergent (exposed) juvenile and adult abalone, while non-invasive surveys assess emergent abalone only (Parker *et al.* 1988; Tegner *et al.* 1989). Invasive surveys are performed using flashlights, and involve overturning rocks and other seafloor habitat generally within a 2 x 5 m (7 x 16 ft) transect. Emergent surveys are performed without using flashlights or disturbing the habitat, generally within a 2 x 30 m (7 x 96 ft) transect, and tend to underestimate the number of cryptic, pre-emergent individuals (Parker *et al.* 1988; Tegner *et al.* 1989; Davis *et al.* 1992; Karpov personal communication). In recent years, ROVs have shown promise for emergent surveys, as

technicians use visual records obtained by ROVs to determine abalone counts and size measurements.

Since 1983 CINP has conducted emergent abalone and invertebrate surveys at 16 locations within its borders. Stations were established cooperatively with the Department and other scientists in areas thought to be representative of kelp forest communities on each island. Ten to twelve random, 3 x 20 m (10 x 66 ft) transect surveys have been conducted annually at each station, providing counts of exposed abalone and major invertebrates (Davis 1988, 1989a; Davis *et al.* 1992). Studies conducted at Johnson's Lee on Santa Rosa Island from 1978 to 1982 also included invasive diver surveys to find both cryptic and exposed abalone within a fixed area (Tegner *et al.* 1989).

An alternative to area-based surveys is counting animals per unit of search time underwater, or timed swims. This method has been used in southern California for several decades by the Department in areas where abalone densities are too low for traditional transect-based methods to be practical. In 1999, timed swims were used in northern California in an effort to calibrate them with unit area methods.

7.2.5 Socio-economic Data Needs

Information about the effect of abalone regulations on employment (job loss or creation) is presently non-existent. Expenditures by abalone recreational fishermen have been studied by a number of researchers (CDFG 2001b). Random telephone surveys (Section 7.2.4.1 Fishery-dependent Monitoring) can also be used to provide socio-economic data.

7.2.6 Collaborative Research Efforts

The Department is currently involved in planning a collaborative research initiative known as the Cooperative Research and Assessment of Nearshore Ecosystems. Existing survey efforts by the Department, PISCO and others are to be coordinated to obtain essential data such as density and size frequency of abalone, sea urchins, and other species including nearshore finfish. Surveys will be primarily SCUBA-based at depths from 6 to 20 m (20 to 66 ft), and ROV-based at depths down to 100 m (328 ft), should ROV technology prove practicable in this environment.

7.3 Management Alternatives

The management alternatives presented here modify either the overall management approach or individual components of the management plan. Additional management plan alternatives are presented for determining the TAC, moving the boundaries of the recreational fishery, and allowing some sort of fishing during recovery in the moratorium area. These alternatives were created in response to public comment and peer review.

7.3.1 Alternative 1: Limited Fishing Without Full Achievement of Criterion 3 (*applies to recovery areas within the moratorium area*)

This alternative was suggested by former commercial abalone fishery constituents, to be implemented specifically for red abalone at San Miguel Island (SMI). The alternative allows fishing for a species that has only recovered in part of the Range prior to reaching the recovery Criteria 3 (three-quarters of the recovery areas at 6,600 ab/ha). Areas that are recovered will be considered for this alternative. Areas or

locations in need of recovery would remain closed. For example, only index sites and other key locations within a recovery area that actually have average densities at or above the target density will be eligible for fishing and all other locations would remain closed until populations reach the target density.

Advantages:

- Provides a limited fishing opportunity during recovery process

Disadvantages:

- The Department's preferred alternative follows the legislative intent that the impact of harvest on recovery of "adjacent areas" be considered prior to allowing harvest (recreational or commercial). The Department believes this alternative violates the intent of ARMP code Section §5522 (a)(C) by suggesting these remnant populations be harvested during the recovery process. If any take is allowed on remnant populations recovery may be jeopardized.
- A fishery prior to full recovery is unlikely to be sustainable - providing a short term gain at the cost of future fishing opportunities.
- Allowing fishing prior to recovery elsewhere does not provide "insurance" against further declines. Other natural events, including El Niños, sea otter expansion, and disease may further impact the resource, making the remaining populations more important for recovery.
- Reducing the abalone population by fishing will reduce the reproductive potential of the population in recovered areas, and will reduce the number of available individuals for relocation to nearby key locations and recovering areas.
- This alternative may introduce increased poaching opportunities.
- By allowing take of remnant populations prior to a more robust recovery at multiple areas, this alternative will delay or possibly reverse recovery at depleted areas.

7.3.1.1 Options for Implementing Alternative 1

If the first alternative is selected, strict guidelines for a limited fishery must be implemented to ensure that overall recovery continues until Criterion 3 is reached. Guidelines for a limited fishery should have specific management measures and research protocols (resource monitoring) to ensure fishery sustainability in recovered areas. The following is a summary of the proposed option with advantages and disadvantages to selecting the option. The entire proposal, as submitted to the Department by commercial abalone constituents, is located in Appendix H.

Proposed Management Measures

Management of limited fishing within an existing moratorium will require special regulations and tools in addition to current management. Such a fishery would require detailed planning and allocation of the proper personnel and resources by the Department to manage and enforce fishery regulations prior to the fishery opening. The following management measures are suggested to execute such a fishery:

- A Position Indicating Transponder (PIT) should be required aboard all fishing vessels participating in the fishery. The cost of the PIT and its installation would be borne by the participant
- Only red abalone would be harvested at SMI
- Gear restrictions include the use of hookah gear by commercial participants and SCUBA or breath-hold diving for recreational fishermen. Current restrictions on abalone irons would apply
- A minimum size of 7.75 in. (197 mm) and a maximum size of 8 in. (203 mm) for both commercial and recreational sectors
- A fishing season consisting of three summer months (July, August, September)
- A prohibition on the export of red abalone outside of California
- A trip limit of eight dozen abalone per commercial diver and a maximum of two divers per vessel
- A TAC consisting of a percentage (10% to 20%) of the estimated harvestable population that falls within the slot size limit. The percentage would be set to have a minimal impact on the entire population as a whole and to maintain a sustainable fishery. An initial TAC of 15,000 red abalone is proposed for SMI (Appendix H).
 - The TAC would be managed through an abalone take reporting system that relies on tags that would be attached to the shell of an abalone upon harvest. Each tag will have a tracking number or diver permit number which will associate fishermen to each abalone at landing. Recreational participants would be required to return report slips issued for each tag with similar information.
 - The TAC would be allocated between the commercial and recreational sectors. The proposed recreational sector allocation will be set based on the historic catch ratio between commercial and recreational fisheries or 3,000 abalone, whichever is greater.
- An Individual Quota system for commercial fishermen will be implemented based on the TAC and will be initially allocated to all divers permitted at the time of closure.
- Only two points of landing, Santa Barbara and Halfmoon Bay, will be allowed to better control and account for the TAC.
- To defray the costs of implementation and management, fees or “resource rent” would be levied.
 - For the commercial sector, an additional fee of 10% of the landed value will be collected along with existing landing taxes already required for commercial landings (FGC §8051 and §8051.3). This money would be used to administer the commercial segment of the fishery, and any remaining funds would be deposited in the Fish and Game Preservation Fund for use by the Abalone Resources Restoration and Enhancement Program as defined in FGC §8051.4.
 - For the recreational sector, a flat fee for each tag purchased would be assessed along with the cost of the recreational fishing license and abalone stamp. Proceeds from the tag sales would be used to administer

the fishery. As with the commercial fishery, remaining funds would be deposited in the Abalone Restoration and Preservation Account within the Fish and Game Preservation Fund and used as defined by FGC §7149.9.

Proposed Research Protocols

To establish a limited fishing alternative during recovery, more information is needed on the status of the red abalone resource at SMI. To help fill this knowledge gap, the commercial constituents have proposed setting up monitoring sites in good abalone habitat at SMI. The monitoring sites will conform to CINP Kelp Forest Monitoring protocols. Installation of these sites will be funded through the use of Abalone Resources Restoration and Enhancement Program funds, administered by the Commercial Abalone Advisory Committee (CAAC) under FGC §8051.4.

The proposed monitoring sites at SMI, which will be installed by the California Abalone Association (CAA) using CAAC funds, will be located at Castle Rock, Adams Cove and Crook Point. These three sites will complement three existing monitoring sites at the island, two CINP Kelp Forest Monitoring sites (Hare Rock, Wyckoff Ledge) and an existing site established by the CAA (Tyler Bight). The Adams Cove and Hare Rock sites fall within state marine reserves, and will serve as controls for the other sites which would be open to fishing under this alternative and option.

The six monitoring sites would serve as an anchor to assessing the abalone population at the island as well as other closely associated species. Government agencies and academia would be encouraged to use the sites set up by the CAA as part of a collaborative research effort. Additionally, the research protocols should follow the guidelines of the long term management plan as outlined in Section 7.2.1.2.

Advantages:

- A commercial fishery would be beneficial to the commercial divers and would result in associated economic benefactors
- A recreational fishery would provide resource use to recreational divers and would result in associated economic benefactors
- The state would derive funds from “commercial resource rents,” permit fees, and taxes
- Fishery-dependent data could be obtained and used for management

Disadvantages:

- The option does not provide for refuge by depth, which has been successful in the recreational-only fishery in northern California. Current MPAs may not protect sufficient abalone resources to offset potential overfishing.
- The option suggests resource allocation biased towards commercial users. The allocation of resources between recreational and commercial segments of the fishery needs to be better addressed and equitable.
- The proposed method of resource evaluation (or monitoring) does not meet scientific criteria for evaluation of a resource, because it does not contain randomly selected evaluation survey sites. The ARMP requires robust density surveys at larger areas than CINP-type index sites to gauge whether recovery has first exceeded minimum viable population (2,000 ab/ha) levels and then

sustainable fishery levels. Recovery to either threshold cannot be determined using the proposed methods, or with the proposed limited funding.

- The proposed initial TAC of 15,000 abalone is not scientifically based and calculations for biomass estimation on which it is based are flawed:
 - The initial TAC is based on a biomass estimate of 3 million emergent abalone. This figure is derived by taking the calculated number of abalone harvested in 1997 (30,000 abalone) and applying a raising factor of 1% (the percentage of legal-sized animals found on Department cruise surveys at SMI that year). These surveys were not random and thus cannot be used for abundance estimates.
 - This method of biomass estimation is too simplistic and would not stand up to peer review. For example, it does not allow for the calculation of confidence bounds on an estimate.
- Abalone fisheries are high in commercial and recreational value, and will attract considerable effort in take (legal and illegal) thus increasing the necessity for more enforcement coverage. The increased enforcement is needed on a continuing basis to:
 - Minimize the “gold rush” effect of reopening the fishery
 - Protect MPAs from inadvertent take
 - Assure proper utilization of resource at SMI
- The resulting increased need for enforcement effort at SMI could adversely affect other areas if enforcement resources are not supplemented.
- The ARMP currently provides a minimum level of Department biological staff for implementing and carrying out recovery tasks. Opening a limited fishery prior to full recovery may divert Department resources away from recovery tasks to manage the fishery.
- The proposed “resource rent” is insufficient to cover the increased costs associated with operating a fishery, such as increased enforcement and management needs.
- The proposed season for the fishery may closely precede the reproductive period of red abalone, thus reducing reproductive potential.

7.3.2 Alternative 2: Limited Fishing at Reduced Criterion 3 Density Level and Establishment of New Criterion 4 (*applies to recovery areas within the moratorium area*)

Under this limited fishing alternative, an additional recovery criterion would be created. A target emergent abundance level of 3,000 ab/ha would become Criterion 3, in place of the preferred recovery strategy level of 6,600 ab/ha, which would become Criterion 4 (Figure 7-2, Table 6-1). The other elements regarding Region-wide attainment of Criterion 3 would remain intact (Section 6.2.2.2 Criterion 3 - Fishery Density Level (6,6000 ab/ha)). Following attainment of the alternative Criterion 3, a limited fishery would be considered and the new Criterion 4 (density level 6,600 ab/ha) would be the next target to reach before the long-term recovery goal is met. Under this alternative, the stock assessment for fulfillment of Criterion 4 will have a dual purpose of

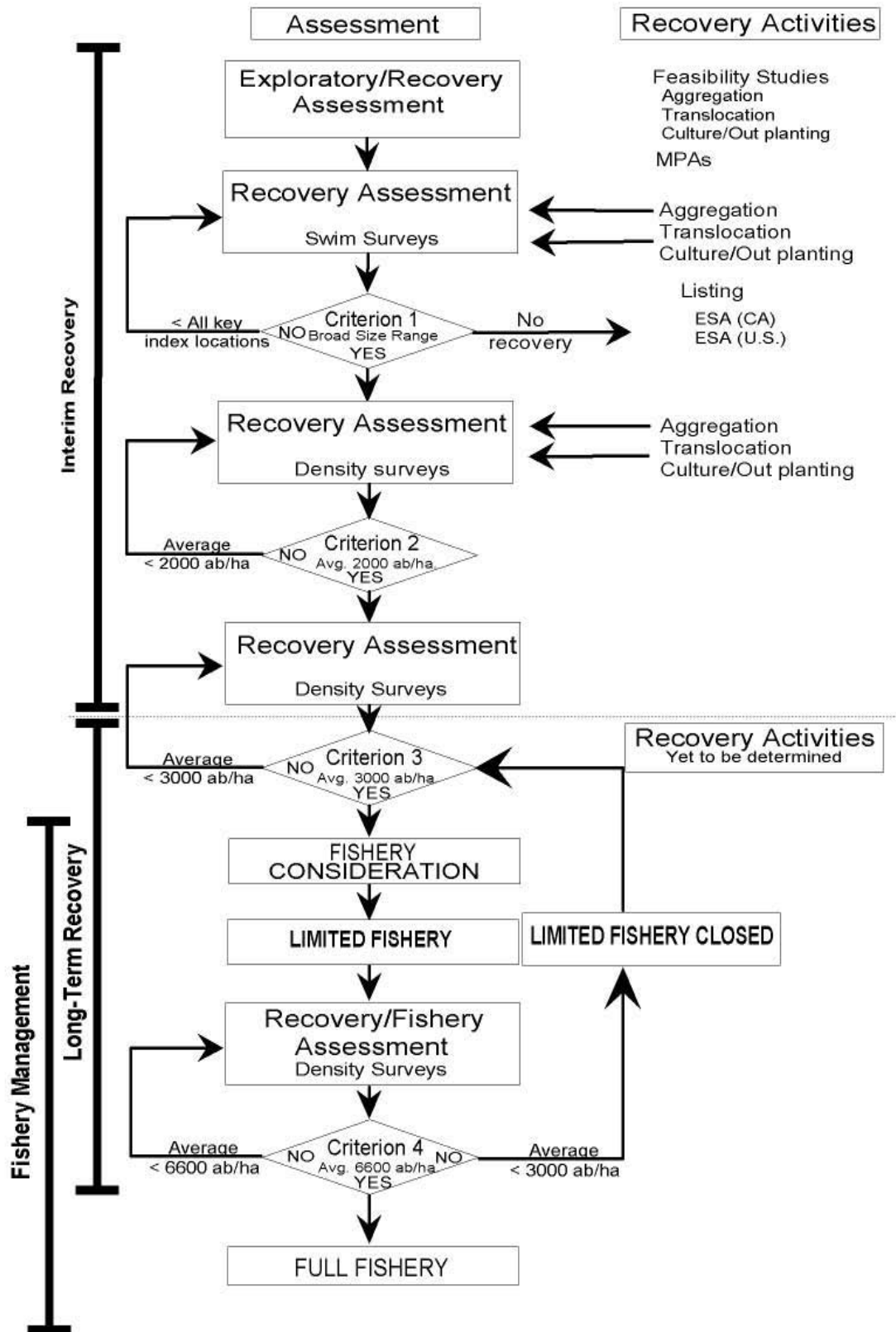


Figure 7-2. The flowchart of the recovery approach revised to reflect a limited fishing alternative

continued assessment for recovery and additionally for managing the limited fishery (Figure 7-2). The assessments will continue to focus on the index sites for each recovery area.

Advantages:

- Provides fishing opportunity sooner than preferred alternative

Disadvantages:

- Reduced density level criterion for reopening fisheries and provides less protection for recovering populations.
- Assessments will have to be done more frequently to ensure that stock densities do not fall below MVP, and will most likely be done on a triennial basis (every three years) rather than every six years as is proposed for the preferred recovery.

7.3.3 Alternative 3: Opening a Limited Fishery for Red Abalone in Areas of Imminent Otter Reoccupation Without Full Achievement of Criterion 3

(applies to recovery areas within the moratorium area)

This alternative would allow some form of limited fishery in areas that will soon be reoccupied by sea otters. The premise of this alternative is that all emergent abalone will be lost to otter predation relatively quickly once otters reoccupy an area. With reoccupation, these emergent abalone would no longer contribute to recovery. Allowing fishery access prior to otter occupation may not have a negative impact on recovery that is significantly different from that due to sea otter predation.

This alternative would include specific criteria for implementation to ensure that these areas are not depleted beyond sustainability in the presence of otters. The criteria for consideration of this alternative include:

- The recovery area in question must have at least emergent densities at or above the MVP level (2,000 ab/ha)
- A trigger event verified by the Department of at least 20 otters that have occupied the area either seasonally or permanently
- Fishery control rules that would be specific to that area and would include a level at which to terminate the fishery

Advantages:

- Low prey abundance may increase the rate of sea otter range expansion - a sea otter recovery goal

Disadvantages:

- Opening a fishery in advance of imminent sea otter reoccupation removes primary prey items from a federally endangered sea otter population, which may jeopardize its long term recovery.

- Human take may reduce crevice populations of abalone that are critical to long-term sustainability within sea otter reoccupied habitat

7.3.4 Alternative 4: Immediately Open Closed Areas to Take of Red Abalone

(applies to recovery areas within the moratorium area)

Populations of red abalone remain inside and outside of the Central California Sea Otter Range. This alternative would reopen these areas to fishing immediately.

Advantages:

- Will provide short term fishing opportunities

Disadvantages:

- This strategy was not successful in southern California and led to the closure of the fishery
- This alternative would violate the provisions of the Abalone Recovery and Management Act which requires recovery of multiple areas using specific criteria prior to fishery consideration
- When combined with other cumulative impacts such as disease, warm water events, etc., this alternative could drive red abalone populations to extinction.

7.3.5 Alternative 5: Lower the TAC by the Estimated Amount of Illegal Take

An accurate estimate of illegal take could be incorporated directly into the TAC. The TAC would then be reduced by the estimated amount of illegal take.

Advantages:

- This alternative would more effectively ensure that legal and illegal take do not threaten the long-term sustainability of the resource.

Disadvantages:

- There is presently no reliable way to estimate illegal take.
- The recent reduction in take was partially in response to illegal take.

7.3.6 Alternative 6: Immediate and Complete Closure of the Northern California Red Abalone Fishery

In the existing data-moderate environment there is recognized uncertainty regarding the sustainability of the northern California fishery. Application of the precautionary approach and its risk-averse principles would provide time to assess the status of the stock. If the fishery is completely closed, there is an increased likelihood that when the fishery is reopened at some future time, the resource will have achieved a sustainable fishery level.

Advantages:

- Increases the likelihood of a sustainable fishery

Disadvantages:

- If current fishery levels are indeed sustainable, then a fishery closure would cause unnecessary economic loss.

7.3.7 Alternative 7: Allow Future TAC Increases Above Current Maximum Increase of 25%

This alternative would implement the interim plan with potential for TAC increase to levels above the currently proposed maximum 25% increase (if stock conditions warrant such TAC increases). Fishery-dependent and fishery-independent data would be collected as currently specified in the interim plan.

Advantages:

- A larger TAC would allow more abalone to be caught

Disadvantages:

- A TAC increase of greater than 25% of the currently proposed level would approach historical take levels and may not be sustainable
- The interim plan is intended to be precautionary in nature because it relies on less data than the long-term plan and is limited in its ability to control take.
- Allowing a TAC increase of greater than 25% of the currently proposed level would not be precautionary management.

7.3.8 Alternative 8: Limited Abalone Fishery at Selected Areas at a Reduced Density and Prior to Full Recovery in All Areas (*applies to recovery areas within the moratorium area*)

The alternative allows the Commission to consider abalone (*Haliotis* spp.) fisheries in specific locations that have partially recovered prior to achieving full recovery as defined in the ARMP. This alternative would be implemented initially for red abalone at San Miguel Island using a reduced density criterion. It recognizes that viable abalone populations currently exist, and that a broad size range of abalone is present at San Miguel Island. It also recognizes that densities of abalone appear to be above MVP levels at San Miguel Island, and the fact that no-take reserves implemented after the fishery closure will help to ensure continued abalone populations. Other areas, such as the Farallon Islands, may be considered once data are available to show the acceptable density criterion has been met and the fishery at San Miguel Island proves to be practicable.

Alternative 8 allows fishing prior to achieving Recovery Criterion 3 (three-quarters of the recovery areas achieving a specified density). In this alternative, fisheries may be considered in individual areas that show a broad size range and an average abalone density above an established MVP level. The initial abalone density to open a fishery would be developed using sound scientific data and following standard fisheries

management guidelines. This number would be based in particular on the most recent San Miguel Island abalone density surveys. If populations drop below MVP levels, the fishery would be closed and re-evaluated.

Under this option, data collection would continue in the fished area to determine whether populations were stable, increasing, or decreasing. An independent contractor would develop an overall management plan and review data collected each year to make recommendations on any changes to the fishery. Guidelines governing the contractor's responsibilities will be developed jointly by the Department and potential fishery participants with approval by the Commission. Management recommendations made by the contractor would be reviewed by the Department prior to potential Commission action. Cooperative effort for data collection would include fishery participants to maximize the amount of information available.

If this alternative is selected, strict guidelines for a limited fishery must be implemented to ensure that overall recovery continues in both the fished and unfished areas. Several implementation options would be considered in order to ensure a viable and well-managed fishery. Specific regulations would be developed in consultation with potential fishery participants once an option is decided upon. The following is a summary of some fisheries management measures that would need to be developed (others measures, in addition to these, may also be necessary):

- Fishery Opening Density Level - This level would be set by the Commission at a level above MVP and would be based upon recent density surveys at proposed harvest areas.
- Total Allowable Catch (TAC) - The TAC would be determined based upon estimates of abalone abundance above minimum legal size. The TAC would be a fraction of this amount to maintain both a sustainable population and an economically viable fishery.
- Recreational and Commercial Allocation - The TAC would be allocated between recreational and commercial take based upon pre-determined criteria established by the Commission. Included in this would be discussions on the number of participants allowed into the fishery. Priority for participation in the commercial fishery shall be given to those persons who held a commercial abalone permit during the 1996-1997 permit year [Title 14, sub-section 5522(e)]
- Regulatory Measures - Specific regulations would be developed cooperatively with potential fishery participants in order to ensure a well managed fishery. Potential regulatory measures include the following, but would be determined as part of the normal regulatory process:
 - Larger than historic size limits - An equal size limit for commercial and recreational take would be set above the historic size limit. This would help ensure an increased abundance of breeding abalone when reproduction occurs.
 - Restricted seasons - A seasonal fishery may provide for ease of enforcement and allow review of biological survey data to provide management recommendations in the off season. It could also allow for undisturbed reproductive periods.
 - Restricted landing locations - This would help prevent illegal activities by limiting the number of areas where abalone could be landed.

- Tag requirement for all commercial and recreational abalone taken.
 - By individually marking abalone at point of collection potential illegal take would be limited as all legally taken abalone would be tagged. Tags could also be used as a source of detailed catch data and be linked individually to specific permittees. Additionally, tag fees could help defray management costs.
- Additional taxes and/or permit fees to support management and enforcement.

Advantages:

- A commercial fishery would be beneficial to the commercial divers and would result in associated economic benefits
- A recreational fishery would provide resource use to recreational divers and would result in associated economic benefits
- The state would derive funds from permit fees, and taxes
- Fishery-dependent data could be obtained and used for management
- Funding for ongoing enhancement projects will continue and a structure will be developed to efficiently direct those funds
- Monitoring data will direct changes in management and enhancement efforts
- The presence of commercial divers on the fishing grounds may enhance enforcement efforts

Disadvantages:

- This alternative may limit recovery elsewhere by allowing limited harvest during the recovery process
- Reducing the abalone population by fishing may reduce the reproductive potential
- This alternative will increase the enforcement burden on the Department and the resulting increased need for enforcement could adversely affect other areas if enforcement resources are not supplemented
- In order to initiate the assessments necessary to implement the recreational portion of this alternative, the Department would need to divert staff and funding from other priorities. Existing State law also requires the Department to expend dollars to manage the commercial portion of this alternative commensurate with the commercial-related income we receive from the fishery.