limit for cabezon and greenling combined. California and Oregon are proposing slot limits for cabezon; cabezon must be between 15–22 inches in California and 15–19 inches in Oregon to be retained. There is no size limit in Washington and recreational fishers are limited to 15 bottom-type fishes daily.

Historically, commercial landings of cabezon were monitored as part of a mixed group called "Other Fish". This group of species includes sharks, skates, rays, grenadiers and other groundfish. This group has been defined historically as groundfish species that do not have directed or economically important fisheries. The coastwise ABC for this entire group of species was 14,700mt during 1999–2002 (5,200mt for the Eureka, Monterey and Conception INPFC areas and 9,500mt for the Columbia and Vancouver INPFC areas). In California, the cabezon fishery is independently monitored and regulated by analyzing two-month cumulative trip limits. In 2004, the season closed on 4 September when the annual commercial allocation of 75,600 pounds was reached before ends year.

Assessment Data Sources

Data for species managed by NOAA Fisheries and the Pacific Fishery Management Council are collected by both federal (and/or quasi-federal) and state agencies. This can complicate analysis because several agencies may collect the same types of data. Where this occurs, the analyses below are based on those data that are most likely to be informative regarding changes in population size.

Removals
Whenever possible, removals are characterized as landed catch plus fish released and presumed dead. Historical catches (prior to 1980) are reconstructed from historical documents, and reported and inferred relationships among fishing sectors. This is a change from the approach of inferring historical catches from state reports or backward projections of more recent catches as was done for the 2003 assessment.

Recreational Fishing History in California
Recreational fishing in California became popular in the late 1890s, but was limited to mostly big game fishes (tuna, marlin, and swordfish) and wealthy participants (Holder 1914). There remained in California limited recreational fishing opportunities to most people before 1920. Private boat access to nearshore fishes increased after 1920 (Croaker 1939), but it was not until Commercial Passenger Fishing Vessels (CPFVs) began operating in earnest off southern California in 1928 that the general public gained extensive accessibility to many nearshore fishes (Scofield 1928; Young 1969). Both barges – large, flat, open-spaced ships – and more traditional CPFV boats comprised the fleet. There were 15 barges and 20–30 boats off southern California in 1928 (Scofield 1928). The period 1929–39 saw a rapid increase in the popularity of CPFVs (Fig. 4; Croaker 1939), which also spread northward to central and northern California. By 1932, sportfishing in Monterey was very popular, with cabezon a major target species (Classic 1932). Pier and shore fishing modes also provided major recreational fishing outlets during this time of increased CPFV activity (Scofield 1928; Croaker 1938; Baxter & Young 1953; Young 1969). In all modes, most fishing occurred during the summer and autumn months, with some fishing extending into spring (Fry 1932; Baxter & Young 1953). CPFV captains have been required to submit logbooks detailing catches since 1936 (Croaker 1939; Baxter & Young 1953;

Young 1969), although compliance rates were and are not 100%. In 1937, the sportfishing catch exceeded the commercial catch for many species (Conner 1937).

The popularity of CPFV fishing continued to increase until the war years of 1942–46 when CPFV activity was considerably reduced (Fig. 4; Calhoun 1950). The CPFV fleet underwent a period of rapid re-establishment, reinvention, and growth after 1946 (Young 1969). Fleets, boat size, and passenger interest all increased throughout California. This expansion continued into the 1970s with the fleet peaking in 1973 (Baxter & Young 1953; Young 1969; Hill & Schneider 1999). A concomitant increase in private boat, shorefishing, and pier/jetty modes also occurred during this time, particularly in central California (especially in Monterey and Morro Bay), where cabezon are well represented, during the 1950s (Baxter & Young 1953).

Reconstructing Recreational Removals

This assessment uses a reconstructed catch history back to 1916 for both cabezon substocks. This initial year was selected because of the availability of commercial catches back to 1916 (see *Reconstructing Commercial Removals* below). Four recreational fishing modes are distinguished: 1) Man-made (piers/jetties), 2) Shore (beach/bank), 3) Private Boat and Rental (PBR), and 4) CPFV. These modes were distinguished for analysis and modeling purposes because of differences in selectivities and the length-frequency of the catch: the man-made and shore modes generally catch smaller individuals than the PBR and CPFV modes. Most cabezon are taken from jetties in the man-made mode (Pinkas *et al.* 1967). There was almost certainly very little recreational catch before 1916 so the fishing mortalities before 1916 for the four recreational modes are set to zero when conducting the assessment.

Information on the activities of recreational fishermen is collected by both state (CDF&G) and federal (MRFSS) programs. Since 1980 (excluding the years 1990–92), the MRFSS program (available via the RecFIN database: **http://www.psmfc.org/recfin/**) provides effort information from a random-digit dialing protocol and catch/trip information from intercept interviews. These data can be used to calculate total catches by mode. In 2004, the CDF&G, in cooperation with the PSFMC, started the California Recreational Fisheries Survey (CRFS) program to replace the MRFSS sampling program in California for all modes. This program aims to increase sampling effort for better catch and effort estimation, to increase spatial resolution of catches, and to identify targeted species. Before the CRFS was implemented, CDF&G only collected logbook catches from the CPFV fishery. Very few estimates of the removals by the man-made, shore, and PBR modes are available for the years before 1980. The CPFV fleet therefore provides the longest time-series of measured catches (1936-present) and is used to reconstruct the removals by the other three modes for the years prior to 1980.

Total recreational removals for each cabezon substock for each recreational mode were reconstructed in three steps: 1) the historical CPFV removals (in numbers) were reconstructed, 2) the CPFV removals were used to estimate the removals (in numbers) by the other three modes, and 3) the average weights per mode were used to estimate total removals in kg.

1. Historical CPFV removals

The historical CPFV catch (1916–2004) was reconstructed as follows:

- **Year 2004**: CRFS database, extracted 17 February, 2005.
- **Years 1957–78; 1980–2003**: Hill and Schneider (1999) performed a data recovery exercise to extract catch, effort, block (CDF&G designated 10 x 10 nautical mile statistical areas), and month information from the California CPFV logbooks. This information provides area-specific catches (in numbers) for each cabezon substock for 1957–2003, excluding 1979 (the data for this year are lost). This data set was obtained on 24 January, 2005.
- **Year 1979:** Oliphant *et al.* (1990) report the total catch of cabezon by the CPFV fleet for 1979. This total is allocated to substock using the geometric mean of the ratio $Catch_{NCS}$:$Catch_{SCS}$ for 1976–78 and 1980–82.
- **Years 1936–40; 1947–56**: Hill and Schneider (1999) provide CPFV catches for the SCS only. The total California CPFV catches for these years are found in Best (1963). The difference between total California catches and the catches from the SCS give the catches from the NCS.
- **Years 1941–46:** O'Connell (1953) provides the catch by the CPFV fleet in 1946 for each substock. No data are available for 1941–45; the catches during these years have been assumed equal to that for 1946.
- **Years 1928(SCS)/1929(NCS)–1935:** No data on catches are available for these years. Scofield (1928) identified the major start of the CPFV fleet in southern California to be 1928, which then moved into central and northern California in 1929 (Young 1929). These start years reflect the beginning of the CPFV time-series for the SCS and NCS, respectively. A linear increase in catch from the start year through 1935 is assumed because the CPFV fleet is known to have increased rapidly during these years (Fry 1932; Young 1969),
- **Years 1916–27(SCS)/–1928(NCS):** The catches by the CPFV fleet were assumed to be zero for these years.

Heimann & Miller (1970) reported that cabezon are rarely discarded in the CPFV fishery because of their large size and trophy status. Furthermore, discarded cabezon have a higher probability of survival because they are not affected by barotraumas. Even though a size limit has been imposed in recent years (see Appendix A), the analyses of this document assume that there is no discard mortality by the recreational sector. The reconstructed raw CPFV catches are shown in Fig. 5.

It was recognized early in the CPFV reporting process (Croaker 1938; Baxter & Young 1953) that logbook records may be inaccurate for two main reasons: 1) mis-reporting of catches (either over- or under-reporting; Karpov *et al.* 1995), and 2) less than 100% reporting compliance rates (Hill & Barnes 1998). Baxter & Young (1953) investigated these inaccuracies in CPFV catch and concluded that cabezon catch rates reported by the CPFV fleet are accurate and reliable. Reported CPFV removals are therefore not adjusted for mis-reporting. Since 1936, compliance rates have always been less than 100% though, and necessitate the adjustment of raw CPFV removals. Compliance rates (as reported from several sources) are provided in Table 3 and were assumed to be the same for the NCS and the SCS fleets. The reported compliance rates were then used to interpolate compliance rates for the years for which rates were not available, and CPFV removals in numbers were expanded to correct for lack of reporting compliance (Fig. 6). There are no compliance rates for the period 1962–1980. Values used for these years were semi-arbitrarily set to account for the expanding fleet during the 1960s and 1970s.

2. Estimating removals for the man-made, shore, and PBR modes via CPFV ratios

Removals (in numbers) for the other three recreational modes (man-made, shore, and PBR) were determined in two ways: 1) based on surveys of the modes, and 2) based on an estimate of the ratio of the catch by the mode to the catch by the CPFV mode multiplied by the catch by the CPFV mode. Surveys are available for only a small numbers of years:

a) the RecFIN database contains estimates of removals for the years 1980–89 and 1993–2004 (2004 via CRFS). This data was extracted 17 February, 2005.
b) Miller & Gotshall (1965) provide estimates of NCS removals for the period 1957–61.

The ratios of the CPFV catches to the catches by the other modes from RecFin were used to estimate removals when data were missing for the years 1980–2004 (Tables 4 & 5). The work of Miller & Gotshall (1965) and Pinkas *et al.* (1968) provide ratios for the years of their study (Tables 4 & 5). These ratios were used to make inferences about the ratios for the years for which no data are available. The PBR fishery was assumed to start in the same year as the CPFV fishery. The man-made and shore modes began before the CPFV fishery, so the estimated catch in these modes for the years before the CPFV fishery began were projected back to 1916.

3. Calculating removals in kg

The average annual weight of the removals (in kg) for each mode are given in Tables 4 and 5 for the NCS and SCS respectively, with shaded values indicating reported weights. The reported weights for 1980–2004 are taken from RecFIN. The reported weights for the NCS for the years before 1980 are: 1) 1947–51: Baxter & Young (1953) and 2) 1957–61: Miller and Gotshall (1965), while the reported values for the SCS for 1964–66 taken from Pinkas *et al.* (1968). The weights for all remaining years are assumed values, based on these sources, averaged RecFIN weights, or a mid-point of the two (Table 4 & 5). The weights for the PBR mode for the years prior to 1980 are set to those for the CPFV mode because these fisheries catch similar sized fish. The removals in the NCS by mode are heaver on average than those in the SCS. Removals (in kg) were calculated by multiplying numbers by average weights. The total removals (in kg) by the recreational sector by mode are shown in Figure 7 and by sub-stock in Figure 8A. Figure 8B compares the total recreational removals (in kg) between the current and the 2003 assessment. Despite the complete reconstruction of the removals by the recreational sector, the two series of catches are not notably different. Removals in weight were converted to metric tons before being included in the assessment model.

Sensitivities to assumed pre-1980 removals

The removals are considered known without error in the assessment, but the above reconstruction is subject to considerable uncertainty. Two types of sensitivity tests are considered to examine the implications of this uncertainty: 1) using numbers instead of biomass for the recreational removals, and 2) doubling and halving the pre-1980 removals.

Recreational catch in 1980

The 2003 assessment and subsequent STAR panel identified the extraordinarily high recreational removal for 1980 as an area for further investigation. Figure 7 reveals that the high 1980 removal is attributed primarily to the catch by the PBR mode from the SCS. Further investigation reveals that RecFIN waves (*i.e.* bi-monthly totals) 1, 2, 3, and 5 have notably higher removals (in kg) in 1980 than during 1982–89 (Figure 9, upper panel), but that average wave weights are not markedly different among years (Figure 9, lower panel).

Commercial Catches

Several sources of California commercial landings are available to reconstruct commercial cabezon landings by substock back to 1916 (the first year of required reporting in the commercial fishery):

- **Years 1978–2004**: The CalCOM database provides annual landings (in pounds) by gear. Data was extracted on 19 April, 2005.
- **Years 1930–77**: The Pacific Fisheries Environmental Laboratory (PFEL) live access server (http://las.pfeg.noaa.gov:8080/las_fish1/servlets/dataset) and the California Explores the Ocean (http://ceo.ucsd.edu/fishcatchtables/fish-catch-download.html) website provide electronic summaries of CDF&G fish ticket receipts originally reported in the Fish Bulletin series (available electronically at: http://ceo.ucsd.edu/fishbull/). These sources were compared with landings in the Fish Bulletin publications and found not to be different for these years. All landings are reported in pounds. Data was obtained on 8 March, 2005.
- **Years 1916–29:** The publication *California Fish and Game* (vols 1–16) are the original source of landing reports before the Fish Bulletin series and are used for this time period. During 1916–29, cabezon was included in the category "sculpin" which included the California scorpionfish. Given the limited northern range of the scorpionfish (Love *et al*. 1987), 100% of the "sculpin" catch from Monterey north was assumed to be cabezon. Fish Bulletins 74 (CDF&G 1949) and 149 (Heimann and Carlisle 1970) provide summarized commercial cabezon landings for 1916–47 and 1916–69 respectively and were used to cross-compare cabezon catches from the *California Fish and Game* volumes. Both sources provided the same estimates of total cabezon landings.
- **Years 1916–77 adjusted**: The spatial resolution of landings from the CalCOM database is sufficient to separate landings into substocks. All other sources used the port complex "Santa Barbara" which included Morro Bay of the NCS and Santa Barbara of the SCS. Landings in the "Santa Barbara" port complex are therefore allocated to substock using the geometric mean of the ratio of the Morro Bay to Santa Barbara landings for the years 1978–82 from CalCOM (Figure 10).

Finally, total cabezon landings in pounds were converted into metric tons. Two fleets are distinguished for assessment purposes: 1) non-live, and 2) live. Cabezon commercial landings for each substock are given in Table 6. California landings of cabezon were low until the early- to mid-1990s when the live-fish/premium finfish fishery began targeting cabezon (Fig. 11). Commercial cabezon landings reached a peak of over 150mt in 1998 and averaged more than 80mt since the mid-1990's, most of which came from the NCS (Fig. 12A). There is no discernable difference between the commercial landings in the present assessment and those used in the 2003 assessment (Fig. 12B).

Cabezon are caught commercially using a variety of gears-types, but have been taken almost exclusively by hook-and-line and pots recently (Fig. 13). All catches are assumed to be taken using a single gear-type for the purposes of this assessment.

There have also been spatial and temporal patterns in cabezon commercial landings. Historically, much of the landings were reported in the late winter/early spring months, but much of the catch has been taken in the summer and fall months since the start of the live-fish fishery (Fig. 14). Currently, no commercial fishing for cabezon is allowed in March and April. All catch is assumed to be taken in the middle of the year for the purposes of the assessment. Figure 15 shows the port complexes affiliated with commercial cabezon landings. The "Santa Barbara" complex contains both Morro Bay and Santa Barbara, with Morro Bay contributing the most to the recent live-fish fishery catch. All NCS ports report higher commercial landings than either of the SCS ports.

Commercial Discards

Discard mortality is assumed to be negligible for the purposes of this assessment because of the shallow habitat of this fish, its physiology, and its hardiness. The lack of any appreciable cabezon discard in the West Coast Groundfish Observer Program (WCGOP 2005) supports this assumption. Further information regarding discards in the nearshore life-fish fishery is being collected by the West Coast Groundfish Observer Program, but this information was not available for this assessment (J. Cusick, pers. comm.)

Total Removals

Given the nearshore depth-distribution and latitudinal range of cabezon, it is not surprising that the bulk of the historical removals are by the recreational sector north of Point Conception (Fig. 16). Recently though, the landings by the live-fish fishery have surpassed those by the recreational fishery as the main source of cabezon removal. Total removals (kg) used in the current assessment are not noticeably different from those used in the 2003 assessment, particularly for recent years (Fig. 16).

Size Compositions

Cabezon otoliths and other ageing structures have not been collected routinely during port sampling. Therefore, the only information on the biological structure of the catch is from length and weight measurements. Sex is not recorded when sampling for length or weight, so all of the catch length-compositions considered in this assessment are sex-aggregated. Catch length-compositions (Table 7A) were developed for each substock, fishery sector, and fleet (Table 8; Figs. 17–19).

The catch length-compositions for each state and year for the recreational fisheries were obtained from the RecFIN website (extracted on 17 February, 2005). RecFIN expands the sampled length proportions by port, fishing fleet (mode), and wave (bi-monthly period) to estimate the proportions-at-length for the entire year. It was noticed that not all lengths retrieved from RecFIN were true lengths; many were weighed fish converted to lengths (Fig. 20). Instead of using these data as lengths (as was done during the 2003 assessment), these weighed fish were used to calculate mean body weights (in kg) for each year (Table 9). This reduced the number of length measurements substantially, especially during 1980–89 (Tables 7B & C; Fig. 20).

The commercial length-compositions for California were extracted on 19 April, 2005 from the CALCOM database. Commercial length samples are expanded using the standard routine at the port-gear-month level and then aggregated for the state. No body weights are available for either commercial fleet.

The sample sizes for each year and fleet used in the assessment were ultimately determined by an iterative re-weighting method that compared the inputted sample sizes to the model-calculated fleet-specific effective sample sizes. The model-calculated annual effective sample sizes replaced the initial sample sizes and the model was re-run until the inputted sample sizes matched the effective sample sizes. The initial sample sizes for the commercial fishery were based on the number of clusters from which the raw length samples were obtained. The initial recreational sample sizes were based on the number of unique sampling opportunities (as identified by the ID_CODE field in the RecFIN output). Sensitivity of the model results to the use of the initial sample sizes was investigated.

Several additional sources of length-composition and mean weight data were investigated for the SCS:

- CDF&G southern California commercial fishery sampling program (1993–present)
- Los Angeles County Sanitation Department trawl survey (1972–present)
- City of Los Angeles Sanitation Department trawl and rig surveys (1987–present)
- Orange County Sanitation Department trawl survey (1970–present)
- San Diego County Sanitation Department trawl survey (1991–present)
- Southern California Coastal Water Research Program (1994,1998)

Cabezon did not occur in any of these databases frequently enough to provide additional information for the assessment of the SCS and will not be discussed further.

Indices of Abundance

There is no standardized survey designed to provide biomass indices for cabezon along the U.S. west coast. All surveys presently used to provide biomass indices for groundfish populations are conducted at depths that are largely outside the depth preference of cabezon. Cabezon are caught so infrequently in the standardized trawl surveys that those data sources are not considered further in this assessment. A nearshore trap survey, designed to monitor cabezon abundance in the Morro Bay area, is in its first year of implementation and will be valuable for future cabezon assessments (and possibly those for other nearshore fishes). Therefore, in common with the assessments of yelloweye rockfish (Methot *et al*. 2002), cowcod (Butler *et al*. 1999), and bocaccio (McCall 2003), this assessment is based on recreational CPUE data, larval abundance indices from standardized egg/larvae surveys (as a possible index of reproductive output), impingement rates of young-of-the-year cabezon (considered as a possible index of recruitment), and the results of fishery-independent surveys of adult cabezon.

Three potential indices of abundance (in addition to several indices based on data from the CPFV fleet) are developed for each substock by fitting generalized linear models (GLMs) to the proportion of zero and non-zero records, and then to the non-zero catch rates (or whatever quantity was being measured, such as number of larvae impinged). This approach is known as the "delta method" and is described in detail elsewhere (Lo *et al.* 1992; Vignaux 1994; Maunder & Punt 2004). The product of the year effects from each GLM (which can conveniently be based on different error structures) yields the index of abundance. Table 10 lists the data sources considered in this assessment for each substock, the years for which data are available, the number of data points, the number of non-zero records for each data source, and the percentage of the data points for which the catch rate is non-zero.

The proportion of non-zero records was modeled as a binomial random variable; both gamma and lognormal error structures were explored for the positive records. Only main-factor models were considered and no interaction terms were explored, though year-area interactions, if present, can seriously compromise the development of abundance indices (Maunder & Punt 2004). A variety of alternative fixed-effects models were explored, and the final fixed-effects model for each choice of error model was selected using AIC (Burnham & Anderson 1998). Tables 11 and 12 list the fixed-effects models considered and the associated AIC values, and Tables 13 and 14 list the index values for each data source. The results of the analyses for the CPFV fleets are illustrated by plots of the results of the gamma and lognormal models along with non-GLM derived indices produced using the geometric mean of positive catch rates (Fig. 21). The CVs in Tables 13 and 14 and Fig. 21 were calculated by bootstrapping the best fitting model and should be viewed as under-estimates of the true variation of the index about the trend in the population. Index values for the CalCOFI and impingement series were taken from the 2003 assessment.

CPFV CPUE indices

The CPFV logbooks contain information on effort from 1947 for the southern California fleet and from 1957 for the central/northern California fleet (Hill & Schneider 1999). Effort was recorded as angler days prior to 1959 and as angler hours from 1962. Effort was recorded in angler hours and angler days in 1960 and 1961. Young (1969) estimated a conversion factor to relate the two measures of effort and estimated angler hours for 1947–59, the assumption being made that conditions in the CPFV fleet did not change over this period. Unfortunately, this was one of the most dynamic periods during the history of the CPFV fleet (Young 1969; see also *Recreational Fishing History in California*), so this assumption may not be valid. Considering this uncertainty, three sets of CPUE indices were developed for each substock: 1) separate indices for 1947/57–61 and 1962–present, 2) an index for the entire period based on angler hours, and 3) an index for the years for which effort was recorded in angler hours (1960–present). The last of these three indices was chosen for the base-case model and the others were used in the tests of sensitivity. Factors considered in the GLM were year, month, and location. Instead of using CDF&G blocks to define location, blocks were collapsed into groups based on major fishing ports or areas. The final fixed-effects model chosen for each substock included all factors (Tables 11 and 12). Both lognormal and gamma error structures were considered, but the lognormal model was ultimately selected for the base cases based on the work of Dick (2004) who found the lognormal error model appropriate for California CPFV indices. Sensitivity to the choice of error model when standardizing the catch and effort data was not explored because the lognormal and gamma indices were essentially indistinguishable (Fig. 21). Diagnostic plots for the base case CPFV index are provided in Figures 22 and 23.

The spatial nature of catch rates along the California coast was explored in two ways. First, the percent index of relative importance (%IRI; Pinkas *et al*. 1971; Cortez 1999) – using numbers of cabezon, weight of cabezon catch, and frequency of cabezon occurrence – was used to summarize the contribution of each location (Fig. 24) and blocks within location (Fig. 25) to the CPFV fishery. For the NCS, Halfmoon Bay and Morro Bay comprised over two-thirds of the total IRI (Fig. 24). In both of these complexes, multiple blocks contributed to the total location IRI (Fig. 25). In the south, most of the IRI is contributed by the northern-most locations (Fig. 24) and no one block dominated the catch. Second, CPUE indices were developed for each location to compare trends on smaller spatial scales (Figs. 26 and 27). Trends varied among locations within substocks indicating potentially different patterns in abundance through time. In general, the most distinctive declines were found in the southern locations of the NCS and in more recent years throughout the SCS.

An index from the central California CPFV observer program (1987–98), operated by CDF&G, was also considered during the 2003 assessment. The CPFV logbook and CPFV observer series exhibit similar trends (Cope *et al*. 2004). The index developed from the observer data was not used in this assessment because the observer program information is not independent from the information contained in the CPFV logbooks and the indices based on the logbook data represent the longer time series.

Adult Surveys

Two fishery-independent surveys were investigated for potential use in the NCS assessment (Table 10). The first is a visual count of adult fish among nearshore rocky reefs in the Monterey area during 1993–98 (the "Monterey adult survey"). Transects were either randomly assigned or repeated on permanent transects. Lengths of transects varied from a few minutes to over an hour. All cabezon were counted and assigned to different life history categories (YOY, juvenile, subadult, and adult). Adults were used to develop an abundance index using year, month, location (reef) and depth as factors (Table 11).

The second fishery-independent survey was a nearshore benthic survey of adult fishes, conducted from 1977–2002 by TENERA Environmental (an environmental consulting firm in San Luis Obispo, CA) at one site just south of Point Buchon (Figure 1). Transects were 50m in length in depths from 3–10 m along high to moderate relief rocky reefs and kelp forests. Abundance indices were developed using the factors year and month (Table 11).

These two indices were not included in the NCS base case model for two reasons: 1) SCUBA surveys may not provide reliable abundance indices for cryptic species such as cabezon; and 2) the spatial coverage of these surveys, which is limited, is such that abundance indices based on them may not be representative of coastwide trends. To explore the second issue, the standardized abundance estimate from the TENERA survey was compared to its nearest fishing location, Morro Bay (Fig. 26). The trends are quite different, supporting the conclusion that the TENERA data is not appropriate to include in the current assessment base case model. Despite not including either of these adult surveys in the base case, sensitivity of the results of the assessment to their inclusion is examined.

CalCOFI
The Southwest Fishery Science Center (SWFSC) has conducted larval tows off California since 1950. Tows are generally made at stations from the Mexican border to roughly 36°N, so these data relate primarily to southern California. Surface (manta) and subsurface (oblique) tows are taken, but the subsurface tows catch few cabezon (Table 10) and are therefore not considered further in this assessment. Surface tows made south of 31°N during June-September and west of 122°W are also excluded from the analyses due to few positive tows. Additionally, data for the years 1977, 1979, 1982 and 1983 are excluded because of changes in survey methodology. The factors considered in the analyses were: day and night (day: between 6AM and 6PM), latitude (north and south of 34°N), longitude (east and west of 121°W), and month. The resultant index is shown in Figure 28.

Power-plant Impingement
An index of recruitment was created using impingement data obtained from the Edison power plants in California (Figure 29). These data (catch in numbers per standardized flow volume) come from only the extreme southern California Bight (33-34°N) and are consequently used only for the assessment of the SCS. The factors considered when developing this index were: station (some stations had multiple intake areas), and season (Dec-Feb, Mar-May, Jun-Aug, and Sept-Nov). This index is considered to pertain to recruitment rather than to reproductive output because the lengths of the fish impinged were primarily those of fish aged 0 and 1 years (Figure 30).

Ichthyoplankton Indices
Cabezon larvae are initially neustonic and available (and readily identifiable) to planktonic sampling gears. The SWFSC has conducted ichthyoplankton surveys off the west coast and developed databases with information on the abundance of cabezon larvae. Generally the size of fish collected during these studies is <15mm (pre-settlement) and therefore not thought to correlate well with recruitment to age-1. However, the abundance of this size group may relate (in a linearly proportional way) to the amount of reproductive output the year before the year of sampling. The possibility of developing an index using the Santa Cruz mid-water juvenile rockfish survey was investigated. However, cabezon are only a very small component of the catch in this survey (Steve Ralston, SWFSC, pers. comm.) so no attempt was made to develop an index of pre-settlement cabezon using these data.

RecFIN
The 2003 assessment considered a recreational CPUE index based on data for the shore and PBR fleets combined. An index of abundance based on CPUE data would be required separately for each fleet for this assessment because it considers each of these modes separately. The catch and effort data for the PBR fleet was explored and it was found that there are few records with cabezon (Table 10). An abundance index based on RecFIN is therefore not considered further in this assessment.

Southern California Sanitation Districts Fish Surveys
The sanitation districts of Los Angeles, Orange, and San Diego Counties and the City of Los Angeles conduct fish surveys every year to monitor the effects of sewage outfall on nearshore communities. As was the case with the size composition data,

none of these data sources provided sufficient information to develop indices of abundance for cabezon.

Data Input Files
The SS2 input files for each substock are provided in Appendices B-1 (NCS) and C-1 (SCS).

Assessment

Assessment Model
This is the second assessment of the cabezon resource off the California coast. It differs in several key ways from the past assessment (Cope *et al.* 2004). The past assessment was based on an age- and sex-structured population dynamics model developed specifically for cabezon in AD Model Builder (Otter Research Ltd.). In contrast, the present assessment is based on Stock Synthesis 2 (SS2; Methot 2005), a flexible length- and age-based population dynamics modeling environment. The two models differ in terms of how the recruitment bias-correction is modeled, whether the impact of selectivity on weight-at-age is accounted for, and whether additional survey index variability is estimated. A formal comparison of the two models is provided in Appendix D.

Another major difference from the past assessment is that California is divided into two regions for the purposes of this assessment. The ecology of nearshore reef fishes leads to the expectation of low rates of movement among reefs. This, combined with the different fishing histories of central/northern California and southern California, imply different time-trajectories of population size in these two broad regions. Although even finer scale assessments would be desirable (e.g. by conducting assessments separately for northern and central California), the two-substock approach is the only one that can be supported by the currently available data. Results from a one-stock model with twelve fleets representing the area-specific fleet designations of the two-substock model are also presented for comparison. This model includes all of the indices used in the assessments of the NCS and the SCS.

The population dynamics model
The base case assessment for each substock is based on the following assumptions:

1. There are two fishery sectors (commercial and recreational). The commercial sector consists of two fleets and the recreational sector consists of four fleets.
    - Fleet 1: Commercial non-live-fish fishery
    - Fleet 2: Commercial live-fish fishery
    - Fleet 3: Recreational mode: Man-made
    - Fleet 4: Recreational mode: Shore
    - Fleet 5: Recreational mode: Private boat and rentals (PBR)
    - Fleet 6: Recreational mode: Commercial Passenger Fishing Vessel (CPFV).

    Fleet distinctions imply different length-specific selectivity patterns.
2. Selectivity is assumed to be dome-shaped for the commercial live-fish fishery and the man-made and shore fleets in the recreational fishery because each of these fleets tends not to land the larger sized fishes. Selectivity is assumed to be asymptotic and related to length by a logistic function for the remaining