4. DATA SOURCES AND INITIAL ANALYSIS

4.1 Fishery Catch Data: We divided the catches into four separate fisheries, three commercial and one recreational. The commercial fishery was divided by three gear groups: hook and line, trap and setnet. We attributed all commercial landings to the hook and line fishery prior to 1978, when the Pacific States Marine Fisheries Commission (PSMFC) began a sampling program so catch could be estimated by gear. The recreational catch is landed primarily by the Commercial Passenger Fishing Vessel (CPFV) fleet. Logbook-based catch estimates consistently began around 1947. Table 4.1 summarizes commercial (by gear) and recreational catch used in this assessment.

Commercial Catch: Commercial landings date back to 1916 and come from three sources. We used landings from 1916 – 1977 that were reported in *California's Living Marine Resources: A Status Report*, which include landings brought into California from Mexico. We did not have catch data for any other fishery prior to 1947, so we calculated the mean catch from 1937-1946 (55.47 metric tons, assumed all hook and line) for the historical catch value used in the baseline model.

We obtained the estimated catch by gear for 1978 – 2003 (1980 data missing) from the California Cooperative Survey (CALCOM) database (Brenda Erwin, Pers. Comm.). Expansion procedures were used to estimate commercial catch from sampling commercial market categories (Pearson and Erwin 1997). The Sheephead market category is fairly clean, which makes estimating catch for Sheephead more precise than for other species (e.g. rockfish). Catch for trawl, miscellaneous and unknown gears were low and were allocated proportionally to the annual landings of the other gear groups. All commercial landings were converted from pounds to metric tons. During the 1980s some Sheephead were landed under the "miscellaneous rockfish" market category (Chris Hoeflinger, Pers. Comm.). This practice was not detected by the limited amount of port sampling at that time. The contribution of "miscellaneous rockfish" landings to Sheephead catch is treated as negligibly small in this assessment.

We considered three other sources of commercial landings for this assessment: Pacific Coast Fisheries Information Network (PacFIN), Pacific Fisheries Environmental Laboratory (PFEL) and the Commercial Fisheries Information System (CFIS). We found no significant differences in the overlapping time periods for all available sources (Figure 4.1a). We therefore used the CFIS estimates (also separated by gear) to fill in for the 1980 missing year in the CALCOM data. We also compared sources that included catch brought into California from Mexico. PFEL reports landings not including Mexico catch beginning in 1928. *California's Living Marine Resources: A Status Report* includes Mexico catch beginning in 1916. The landings between the two sources from 1928-1977 showed no significant difference (Figure 4.1b).

Recreational Catch: Recreational catch estimates came from two sources. We obtained recreational landings in numbers of fish from 1947-1979 for the Commercial Passenger Fishing Vessel (CPFV) fleet from historical Department of Fish and Game (DFG) Fish Bulletins. We converted numbers of fish to metric tons using an average 3.1 pounds per

fish (Young 1969). Landings were also inflated to account for recreational dive take and discards. We estimated dive removal to be 2700 fish per year (Young 1973) and applied this back to 1955, which is approximately the time SCUBA began. Discards were estimated by using the mean discard rate (15%) for 1980-1989 from the Recreational Fisheries Information Network (RecFIN). We compared this rate to the logbook discard information from 2000-2003, which was also 15%.

In 1980, the Marine Recreational Fishing Statistical Survey (MRFSS) began sampling, and from 1980-2003 (with a hiatus from 1990-1992) estimated landings, effort and discards are available from the RecFIN website. We increased the RecFIN estimated landings by an additional 3.84 metric tons per year (an average 2700 fish per year at 3.1 pounds per fish) to account for the estimated dive take. For the years 1990-1992, we used the landings data from the DFG Fish bulletins and estimated catch (including dive) and discards as described above for the 1947-1979 time period.

We did not include the removals of Sheephead taken by spearfishing in this assessment for two reasons. To calculate dive take we used an estimated 3.1 pounds per fish (Young 1973), which would underestimate removals with this gear in the model, considering they target larger fish. If the 3.1 average sized fish were used, that would account for an additional 0.043 metric tons a year, which is minor. We concluded there was not enough information to identify Spearfishing as its own fishery. Secondly, these fish were speared in Central California, and we focused our assessment on the Southern California population.

4.2 Abundance and CPUE: We used four surveys in this assessment, one to produce an index of larval abundance and three to produce indices of catch per unit effort (CPUE) in the recreational fishery.

CalCOFI Larval Survey: To create an index of larval production for Sheephead, we used the California Cooperative Oceanic Fisheries Investigations (CalCOFI) data (Richard Charter, Pers. Comm.). These data have been collected in most years since 1951, and are used to track trends in larval production in southern California and Mexico (Moser et al. 2001).

The initial analysis began with manta and bongo tows pertaining to southern California and Mexico (lines 77-120), with all stations and months included. We used data from the typical Sheephead spawning season (June through October). If less than 5 larvae were examined in the survey over all years in a single month, those months were excluded from our frame. Station numbers greater than 65 were excluded, since no larvae were found outside of the nearshore area. Subsetting this dataset resulted in some years being excluded from the analysis, where in other missing years, surveys were not attempted at all.

We ran this subset of CalCOFI data through a delta-lognormal Generalized Linear Model (GLM) with year, month and station effects (Stefansson 1996). The spawning output index and catch are variable from year to year (Figure 4.2). Several years had only one

positive tow with Sheephead larvae, so we could not jackknife estimates of precision (at least two are needed).

Recreational Catch per Unit Effort (CPUE): Beginning in 1936, CPFVs were required to turn in a daily log, reporting the number of anglers aboard as well as the total catch in numbers of fish by species. Due to World War II, there was a delay in recreational fishing and partyboats did not begin turning in the mandatory logs and reporting catch consistently until 1947. Initially, effort was reported in angler days, which switched to angler hours in 1960. Recreational catch and effort data were taken from 2 sources: CPFV logbooks reported in Fish and Game Bulletins (1947-1979) and logbook block data provided by the Department of Fish and Game (1980-2003) (Wendy Dunlap, Pers. Comm.).

We separated the CPFV logbooks reported in Fish and Game Bulletins into two time periods due to differing units of effort. From 1947-1961, we used catch per angler day and from 1960-1981 we used catch per angler. We did not use angler hours due to missing angler hour information from 1977-1981. We also investigated converting the earlier CPUE estimates in units of angler days to anglers (1.216 conversion factor) for a one-unit time series from 1947-1981 (Figure 4.3). There were differences in the 1947-1961 time period based on the differing units of effort ($p=.004$), but they showed similar trends. After running a sensitivity analysis on the one-unit time series CPUE (which did not affect the outcome), we felt that using the separate two-unit time series for CPUE would avoid additional uncertainty error. In all cases, the model is more tenuous in the earlier years.

The third CPUE index (catch per angler hour) was calculated using block data from CPFV logbooks for the time period 1980-2003. In the initial analysis of this time series, we calculated an index for the entire area with all blocks included using 1980-1994 data (data available at the time). We ran a delta-gamma GLM with year, month and block effects (Stefansson 1996). We found that 70% of the cumulative sum of block values came from 40 individual blocks. We limited further analysis to these 40 blocks because the GLM assumes a proportional change is equally meaningful in all blocks. This assumption seems to be better met for those blocks in which Sheephead are most abundant.

We charted the top 40 blocks and came up with 5 distinct geographic fishing areas: the Channel Islands (including San Miguel, Santa Rosa and Santa Cruz Islands), San Nicolas Island, Santa Catalina Island, San Clemente Island and the Banks (Tanner and Cortez) (Figure 4.4a). We found each area had different seasonal and annual patterns (Figures 4.4 b & c) using all data from 1980-2003 (once available) so we ran five separate delta-gamma GLMs to estimate a local index value for each area (I_j). To estimate precision, we used the jackknife function so there would be a variance associated with each index in each area. We assume the local index represents the density of fish in each area and that blocks (n_j) are of equal area. The population of fish is proportional to the product of density and area. The combined index, I, is

$$I = \sum (I_j n_j) \tag{4.2}$$

Similarly, we estimated the variance for the combined index using combined variances:

$$Var(I) = \sum (n_j^{\,2} \operatorname{var}(I_j)) \tag{4.3}$$

Figure 4.4d represents the combined catch per unit effort index for the 5 geographic areas in the southern California CPFV fishery from 1980-2003, reconstructing the population as a whole. We further analyzed a sixth nearshore area and the catch per unit effort was so small that it did not affect our previous analysis.

The reduction in bag limit enacted in 2002 probably had a small effect on CPUE. Based on bag size compositions from 1998 to 2001, truncating bags larger than five down to five fish results in a 2.5% reduction in CPUE (indicating that the 2002 and 2003 CPUEs might be a slight underestimate of abundance). The actual reduction is smaller than this because of sharing over-limit catches with other fishermen ("bag-sharing") and because bag composition in 2002 and 2003 indicate that the limit was not strictly enforced. No correction for the change in bag limit was made in this assessment. Overall, the results of regulations from management in recent years (bag limits, trip limits, mesh size in the trap fishery) should be further analyzed once there is enough information to detect the impacts.

4.3 Fishery Length Composition Data: Length compositions came from many sources, commercial and recreational. Since all length composition data were reported in either fork length or total length (mm), we converted all lengths in the model to fork length using the conversion equation provided by RecFIN (see Equation 3.2). Once converted to fork lengths (cm), we set up 2 cm bins to calculate length compositions, starting at 18 cm. We did not have any size at age data above 50 cm, so all lengths 50 cm or larger were binned together in the 50 cm bin. We excluded any length compositions in which five or less individuals were sampled per fishery in a given year. If more than one data source covered any one year, the source with the largest sample size was used. Table 4.2 summarizes sample sizes available and used for the baseline model. Length compositions for each fishery are shown in Figures 4.5 a-d.

Commercial Lengths: We obtained fork length compositions for commercial landings from two sources. The CALCOM sampling database covered years 1993-2003 (no data in 1994). Average lengths of Sheephead were fairly similar over the years in the hook and line (49.9 cm) and trap fisheries (51.5 cm). We did not use the CALCOM lengths for trap gear because only one or two samples were taken in each year; however, CALCOM is our main source for lengths in the hook and line fishery (n=107).

The second source used for commercial lengths were from the Archive Market Data provided by the Department of Fish and Game (Steve Wertz, Pers. Comm.). Sheephead did not appear in the dataset until 1993, and lengths were available for most years from

1993-2003. All trap lengths used came from this data set (n=1064) as well as the lengths from the setnet fishery (n=58).

Recreational Lengths: There were more data on length available from the recreational fishery than for the commercial fishery. We used CPFV length information from RecFIN and two CPFV sampling programs conducted in southern California during the 1970s and the 1980s. The length information from Central California (CenCAL) Spearfishing Tournament was also evaluated (Dave VenTresca, Pers. Comm.). We chose not to use this source because they represent large targeted Sheephead in Central California, and this assessment is focused on the Southern California population.

We generated recreational length compositions (n=2849) for CPFVs from 1980-2003 (no data 1990-1992) through RecFIN. The peak frequency of Sheephead lengths sampled on CPFVs centers around 30cm (fork length) with 88% of all measured fish ranging between 22 and 44 cm. We assumed all fish measured were landed with hook and line.
We also used Sheephead length compositions collected from two southern California CPFV sampling programs. The first program sampled from 1975-1978 and 1683 Sheephead were measured (Collins and Crooke In prep.). The second sampling program was conducted from 1984-1989 (Ally et al. 1991) where 3472 Sheephead were measured. The average size of fish landed from 1975-2003 (no lengths in some years) is variable throughout the time period (Figure 4.6).