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DOCUMENTATION OF THE CALIFORNIA CATCH RECONSTRUCTION PROJECT

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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Introduction

The Pacific Fishery Management Council (PFMC) manages groundfish on a biennial cycle, with stock assessments being completed in odd years and harvest specifications and management measures being developed in the following even year. This cycle results in an "off-year" for assessment scientists, creating an opportunity for the Council to identify topics of special interest for focused research by analysts. Following completion of the assessment cycle in 2007 the Council identified two off-year science activities of importance and requested that the NOAA Fisheries Northwest and Southwest Fisheries Science Centers take the lead in coordinating those efforts. In response, in 2008 the NWFSC held a workshop to develop Bayesian priors for survey catchability (***q***) parameters and the SWFSC led an effort to reconstruct groundfish landings on the US west coast.

The Council's interest in catch reconstruction stemmed from a recommendation made by a Center for Independent Experts (CIE) reviewer who had attended all of the groundfish STAR panel reviews conducted in 2007 and who had noted that various stock assessment authors had approached the problem differently or, even worse, not at all. Of particular importance was a data recovery effort that had been underway by the SWFSC Groundfish Analysis Team (Fisheries Ecology Division, SWFSC). The Groundfish Team had recovered several significant California Department of Fish and Game (CDFG) data sets and has received annual funding from the NOAA National Environmental Satellite, Data, and Information Service's (NESDIS) Climate Database Modernization Program (CDMP) to digitize the data. Three significant commercial data sets were recovered, i.e., block-summary data, trawl block-summary data, and commercial landing receipts (fish tickets). Each of these spanned a different time period and each contains unique information. Data entry is not yet complete and is an ongoing effort, particularly with respect to the fish-ticket data, which are extensive.

Since an analysis of the reliability of California's landing estimates was already underway (Pearson *et al*. 2008), and because the NMFS and NESDIS had begun a major effort to rescue and digitize historic landings data, the actual effort to reconstruct the California landings began in 2006. However, following the PFMC's recommendation to undertake a coordinated reconstruction of west coast groundfish landings a working group was formed to complete the task for the State of California (Appendix A). The working group views the catch reconstruction effort as an ongoing process. This documentation describes the process as it has developed thus far. Both the document and the data sets involved will be updated in the future as appropriate.

The catch reconstruction effort relies on a variety of data sets. This report summarizes the current status of these data sets and their uses in the catch reconstruction project. When complete, a database will be developed that includes all of these recovered data, plus two additional tables that will contain derived estimates of species-specific commercial and recreational landings for the State of California. The database will be accessible via Open DataBase Connectivity (ODBC) connections (see section on Data Access), although some of the data are subject to confidentiality restrictions. In addition, non-confidential data will be available through the CALCOM website. Finally, we anticipate that the landings estimates will ultimately be provided to PacFIN for inclusion in that database system.

Data Set Descriptions

A detailed description of all table structures used in the catch reconstruction project is presented in Appendix B.

Reconstructed Commercial Landings (RECON_COM_LANDS)

Summary: This is the end result of the commercial catch reconstruction efforts. It represents the Best Available Data for historic commercial fish landings in California. The data are considered to be dynamic because they will be updated as more data become available.

The rockfish landings data were generated by S. Ralston using methods described in some detail in this document. The non-rockfish data were summarized directly from the block-summary data. Both rockfish and non-rockfish data therefore relied heavily on the block-summary data.

Variables Included: Year, Region_Caught, Species, Gear, Pounds, and Source.

Strengths: As of this writing, these are the Best Available Data. Landings are from 1916 (rockfish) or 1931 (non-rockfish) through 1968. Landings after 1968 should be obtained from the CALCOM data set.

Weaknesses: The gear values are limited (trawl vs. non-trawl); however, there may be some improvement with additional analysis. A seasonal stratification variable (quarter) will be added once the monthly trawl block-summary data are keypunched.

Reconstructed Recreational Landings (RECON_REC_LANDS)

Summary: This is an interim result of the recreational catch reconstruction effort. It represents the Best Available Data for historic landings of recreational rockfish (*Sebastes* spp.) in California. The data are considered dynamic in that it will likely be updated as additional data are incorporated into the analysis.

This data set was generated by J. Field and M. Key. The methods used are described in the Reconstruction of Recreational Rockfish Landings section of this document.

Strengths: As of this writing, these are the Best Available Data for 1929-1980. To obtain more recent data, users are directed to the RecFIN database.

Weaknesses: This is an interim product. Although we do not expect it to change substantially, estimates may change modestly with further refinements. Landings are reported here by area (north and south of Pt. Conception) and are not separated into different fishing methods (CPFV, skiff, and shore) in these summary tables. However the two principle fishing modes (CPFV versus skiff/shore) were developed independently and can be provided upon request. Greater

spatial resolution of catches will be developed at a later date. Only rockfish are included, other recreational target catch estimates will be forthcoming.

U.S. Fishery Statistics

Summary: These data were keypunched from the annual summaries of California landings published by the US Fish and Wildlife Service. The data extend from 1927-1977. Each year of data is published within about four years of the actual landings and corrections/updates are almost certainly not included. For this project only elasmobranchs, flatfish, rockfish, and certain roundfish were keypunched due to budgetary restrictions.

Variables Included: Year, Area, Region, Gear, Gear Group, Species (based on market category), Market Category, Pounds.

Strengths: This is currently the best source of gear-specific landings going back to the 1920's. Its use for species-specific rockfish estimation will be valuable. The data for sablefish, lingcod, and whiting are believed to be reasonably accurate.

Weaknesses: Some of the published landings do not match well with landings in the BLOCK_SUMMARY database. The species are aggregated in unusual and variable ways making it difficult to use the nominal flatfish and elasmobranch categories. The data are annual and therefore obtaining quarterly estimates is not possible. The spatial coverage is quasi-regional with Regions 1 and 2 combined (Crescent City, Eureka, and Fort Bragg), and ports within Region 6 (Santa Barbara/Morro Bay) only occasionally distinguished.

Recommendations for the Future: These data should not be made accessible to the public through CALCOM because the data are published elsewhere and there are clearly problems associated with levels of aggregation. Its value will be in helping to verify the total commercial rockfish landings estimates.

Details: The data were entered by a contractor in September 2008, who was charged with entering only values for flatfish, rockfish, skates/rays, spiny dogfish, whiting, lingcod, and sablefish, as well as to combine all line gears into a single value and trawl gears into a single value. The data were entered directly from hard copy volumes from the FED library. To do this, the contractor entered the written species name, gear, year, region, and pounds into a spreadsheet. When the data entry was complete, D. Pearson matched the species names to the likely market category and stored the data into an SQL Server table called FISHERY_STATS_RAW.

To check for possible errors, we compared annual values for flatfish, elasmobranchs, lingcod, sablefish, whiting, and rockfish from the fishery statistics data table to their corresponding values in the block-summary data set. Direct comparisons between the block summary and fishery statistics data were nearly impossible because aggregation levels were very different between them. Therefore, we focused on sablefish, lingcod, whiting, and all rockfish market categories combined. These were selected because aggregation issues were minimized. It was expected

that there would be some differences since CDFG updates their data and some changes would likely have occurred after publication of the Fishery Statistics reports. Using only annual values eliminated problems with assignment to regions. When a large discrepancy was found between the two data sets, the total values for the species in the Fishery Statistics books were examined. In several cases, there were data entry errors from the Fishery Statistics books and those were corrected for lingcod, whiting, sablefish, and rockfish. In many cases, the published values from Fisheries Statistics were quite different, in some cases by 10% or more. In general, the values in the Fisheries Statistics published data were greater than their corresponding values in the block-summary data. It is possible that some discrepancies were due to landings from Oregon and possibly Washington being included in the Fisheries Statistics data, but that is not clear.

We believe these data can be used for rockfish, sablefish, lingcod, and whiting. Although the data for the flatfish are questionable, it can be assumed that the majority of flatfish landings are made by trawl. We do not believe that gear type for other groundfish species can be used with any level of confidence although further analysis of the data may be useful.

Commercial Landings (COM_LANDS)

Summary: The COM_LANDS data table is produced by the California Cooperative Groundfish Survey (CCGS). These data are the source of California's species-specific landings in PacFIN. The data table uses port samples, merged with landing receipts, to obtain species-specific landings estimates and is considered the Best Available Data. Landing estimates are available from 1969-2008; however, species composition port samples were only collected from 1978-2008 and borrowing of samples is often used to estimate unsampled strata. When this study was developed, it was primarily designed to estimate rockfish landings.

Variables Included: Year, Port Complex, Gear Group, Quarter, Live (y or n), Market Category, Source (method used to estimate), Species, Pounds.

Strengths: This is the Best Available Data, particularly for 1978-present. All commercial species are included; however, sampling has occurred only for groundfish (particularly rockfish).

Weaknesses: The spatial resolution is only to the port complex level. The gears are aggregated into five groups. The temporal resolution is quarterly. The use of borrowing to estimate landings in strata reduces the reliability of the estimates relative to complete sampling coverage. Species composition estimates of the flatfish began in the late 1990's.

Recommendations for the Future: The Groundfish Analysis Team at the Fisheries Ecology Division (SWFSC Santa Cruz) is exploring the merits of implementing a "model-based" scheme for estimating groundfish landings, in lieu of the current "design-based" approach. This may be an effective way of dealing with the inadequacy of sampling in all strata in the statistical design.

Details: These are the landing estimates provided to PacFIN. Details of the expansion process can be found in the CALCOM Database Documentation (Pearson and Erwin 1997) and are not

repeated here. Pearson *et. al*. (2008) found that most groundfish landings estimates were generally reliable.

Trawl Effort

Summary: These data were keypunched from trawl log summary reports which were rescued from CDFG. The summaries are by month. The data include all years from 1930-1952.

Variables Included: Year, Month, Block, Number of Drags, Minutes Fished.

Strengths: This is the best source of historic trawl effort available. This data have a spatial resolution to the block level.

Weaknesses: These data are limited to the north and central coast. It is unclear how far south the data extend. Frey (1971) indicates trawling south of Santa Barbara was prohibited prior to 1968; therefore, it is possible that the data are complete, or nearly so.

Recommendations: These data maybe of limited value to the catch reconstruction effort, although they should be quite valuable for characterizing fisheries development.

Details: These data were keypunched from annual CDFG reports by a contractor (O'Connor) in August 2008. The accuracy of the data entry has not been evaluated. However, the data are assumed to be as reliable as the trawl log catch data since they come from the same reports. There are many cases where the "minutes fished" variable is missing. There are four cases where the "number of drags" variable is missing.

At this time, the data have not been examined for trends or keypunch errors, although we hope to check the data in the near future.

Trawl Log Block Summary

Summary: These data came from the same source as the trawl effort data and therefore have the same limitations with regards to spatial distribution. The data are for 1925-1957. Efforts at comparing these data with the block-summary data indicate that the data are largely complete and accurate. It should be noted however, that the block-summary data do not have gear as a variable, so direct comparisons are not possible. Instead we compared flatfish landings between data sets, which should be almost exclusively trawl. We also verified that total landings of non-flatfish species did not exceed total landings in the block-summary data. These are summary data and differ from trawl log data currently maintained by CDFG and PacFIN in that those data (1978-2008) are not summarized but are actual individual trawl logs.

Variables Included: Year, Market Category, Block, Pounds, Region Caught (based on the report), and Area.

Strengths: These data are largely reliable, although data from 1944-1947 are questionable (see Figure 3). Monthly values have not yet been keypunched but are available.

Weaknesses: The species aggregations are somewhat inconsistent and this may be a problem for rockfish. Southern California may or may not be complete.

Recommendations for the Future: Monthly values should be entered for rockfish to allow quarter to be used in the species-specific estimations by adding another stratification variable.

Details: These data were going to be discarded until NMFS rescued it. One shortcoming is that it is unclear whether all of the landings in southern California are present. The data appear to be complete north of Monterey based on landings of important flatfish like English sole, which closely match the landings in the block-summary data. We recommend that only blocks numbered 100-599 (Appendix C) be used. The data set also includes catches from Oregon and Washington which were landed in California, so care should be used when extracting data. It is unclear whether all trawls made in Oregon and Washington waters and landed in California are included in this data set.

Block Summary

Summary: These data were provided to NMFS on microfiche by CDFG. Using funds from a Climate Database Modernization Program (CDMP) grant, the data were keypunched by SourceCorp. When the data were received by NMFS, they were checked for errors and then loaded into an SQL Server table.

Variables Included: Year, Month, Region, Block, Market Category, Importation, Region Caught, and Pounds.

Strengths: These data are comprehensive and they match landing receipts very closely. We consider them to be very reliable.

Weaknesses: The lack of gear specification in the data set is a serious problem which needs to be addressed. In addition, the reliability of the data for 1957 is questionable, and needs to be examined. We have other data to which we can compare the values, and feel these issues can be resolved.

Recommendations for the Future: None.

Details: The microfiche reports were in three different formats and this complicated the keypunching effort. The quality of the microfiche varied from poor to fair and this posed additional problems. One very valuable feature in the data set was monthly summary values by block which greatly facilitated error checking.

We instructed SourceCorp to keypunch all of the data but to use a special code to indicate if a value was unreadable. When the data were returned to NMFS, a program was run that searched

for the special error codes. In many cases, the value of the illegible data could be readily determined by examining the data values in the adjacent records. For example if year was unreadable, we knew that all of the records in each file had to be from the same year. We corrected all of these values or assigned a null (missing) value if we could not reliably determine the correct value.

The presence of the monthly summary values was also helpful when checking for errors. A program was run that manually summed the landing weights for the month and compared these values to the monthly summary total. All records showing a discrepancy were output to a file and the microfiches were checked manually to determine the source of the error and the data corrected.

The final step in error checking was to determine how the values from the block-summary data compared to other data sources. One test compared the landings from the 1960 and 1965 landing receipts to the block-summary data (see below). In both cases there was very good agreement between the two data sets (less than 0.1% difference in nearly all cases).

Landing Receipts

Summary: Landing receipts (also known as fish tickets) are the core of the catch reconstruction effort. Prior to the beginning of the catch reconstruction project, we had access to California's landing receipts from 1969 to the present. Using a grant from the CDMP program, we contracted with SourceCorp to keypunch landing-receipt data from 1951-1968. These data were stored on microfiche and were of variable quality.

Since the volume of data is huge, keypunching is a lengthy process. Being uncertain of continued funding, SourceCorp was asked to keypunch the receipts in the following sequence: 1965, 1960, 1955, and 1951. At the time of this writing, the 1965 and 1960 data have been keypunched and checked for errors; while the 1955, 1951, and 1957 data have been keypunched but have not been checked.

Variables Included: Boat Number, Gear, Block, Port, Dealer, Year, Month, Day, Condition, Price per Pound, Size, Market Category, and Pounds.

Strengths: These data are extremely valuable because they provide vessel-specific data including number of trips, number of vessels, and landing sizes. The data also provide specific gears and CDFG reporting block.

Weaknesses: The main weakness of the data is that some of the microfiche is of poor quality and is difficult to read. This introduces the possibility of errors, some of which may not be detectable.

Recommendations for the Future: We believe these data are valuable for the catch reconstruction effort. They help to verify the accuracy of the other data sets and provide useful gear-specific information which is essential to the catch reconstruction project.

Details: Error checking of the keypunched data was done by D. Pearson. As with the block-summary data, SourceCorp was instructed to use a special character to indicate unreadable characters. For questionable data, the microfiche was examined and in the majority of cases, it was possible to determine the correct value. For example, if a vessel had only landed a single market category, and the price was always the same, we felt justified in filling in a missing market category with the typical market category. There were many situations in whichit was possible to reliably determine the missing value. However, there were a few cases in which the values could not be determined. In those situations, we assigned a null value to the missing data.

Note: The landing-receipt data are highly confidential and may not be distributed to non-CDFG personnel without the explicit permission of CDFG.

Recreational Sample Data

Summary: The recreational sample data set was collected from party boats in 1978-1984. This sampling program was restricted to the central California coast and was conducted by commercial market samplers until funds for the survey ended. To our knowledge there is no documentation of this survey; which generally consisted of a sampler obtaining biological data from fishermen who had just returned from a party boat trip.

Variables Included: Sample number, Sample Date, Port, Sampler id, Boat Number, Depth (not always present), Block, Species, Sex, Length, and Age.

Strengths: This dataset provides species compositions for party boat landings.

Weaknesses: The temporal and spatial coverage of this data set are limited. The composition data are only from CPFVs, but are applied to total recreational rockfish landings (all modes combined); the lack of data from shore-based and skiff modes may bias the results.

Recommendations for the Future: None.

Details: These data were collected by CDFG personnel under a program run as part of the California Cooperative Groundfish Survey. It was part of an effort to obtain additional biological data on sport-caught rockfish. For the most part, samples were collected by commercial market samplers.

Port samplers met the party boats when they returned from fishing trips and determined where the fish were caught, what the vessel number was, and how many fishermen were onboard. The sampler then arbitrarily selected fishermen to interview. The fishermen were asked if they would allow their catch to be sampled. If the fishermen agreed, then all of the fish in their bag were examined. Since some bags contained the catch caught by more than one angler, the fisherman was also asked how many people contributed to the catch in the bag. The catch was then examined. The species were identified and each fish was measured (total length). If the fish were being cleaned at the time, the sampler would determine the sex and collect otoliths if

feasible. Often the fish was headed and gutted and it was not possible to determine length and sex. The data were sent to the NMFS Tiburon Laboratory and keypunched.

Some of the data have been lost and there were many problems with the original data set, including duplicate sample numbers. In the late 1980s, NMFS staff made an effort to rescue the data. The result of the rescue has been included in the CALCOM database. As part of the rescue effort, total lengths were converted to fork lengths.

This recreational data set contains very valuable information from the recreational fishery. We feel that the data in the system are reliable and will be useful in the catch reconstruction efforts.

Recreational CPFV logbook data

Summary: The recreational CPFV logbook block-summary data were compiled by Kevin Hill and was provided to NMFS for assistance with stock assessments. The data set includes the following years: 1936-1940, 1947-2008.

Variables Included: Year, Month, Block, Quarter, Region, Angler days, Angler hours, Market Category, and Retained Catch.

Strengths: This is the longest data set available for recreational groundfish landings, and includes both effort data and spatially explicit catch information.

Weaknesses: There is a gap in the time sequence during the war years, and a lack of individual species data for rockfish. Shore and skiff landings are absent. There are also problems with missing logs due to compliance issues.

Recommendations for the Future: None.

Details: This data set has restricted access and may not be provided to non-CDFG personnel without the explicit permission of CDFG. This is beyond the normal confidentiality restrictions.

Additional Sources of Information Used

Literature Search

As part of our reconstruction effort, a major literature search was undertaken to locate information that might be useful in estimating species and gear compositions of the historical groundfish catch. Most of the search was conducted by a UCSC contract employee (K. O'Connor), who recorded the information in an extended set of notes that are contained in a document (Literature Review.pdf), which is available from the senior author upon request (Steve.Ralston@noaa.gov). The information was used in part to ground truth our final results and in part to adjust the compositions.

Experts Meeting

Another part of the reconstruction project was to consult with individuals who had expert historical knowledge of California's fisheries. Therefore, a 1½ day meeting was held at the NMFS Santa Cruz Laboratory to discuss the reconstruction effort and to get a sense of how groundfish fisheries changed over time. A list of attendees and notes from the meeting were transcribed and are included in a document (Experts Meeting.pdf) that is also available upon request to the senior author (Steve.Ralston@noaa.gov). The meeting was helpful in identifying available data sources and in determining the limitations of the existing data. It was also particularly useful in getting a sense of how the groundfish fishery developed over time.

Reconstructions of Commercial Rockfish Landings (1916-1968)

Block-Summary Data

As noted above, the block-summary data contain summary statistics of commercial landings of all rockfish market categories classified into CDFG blocks (Appendix C) by month and year. Importantly, a fishing gear variable is not included. The data set extends from 1931-1968, with the exception that the data for 1938 were missing. All of these data have been keypunched and were available for analysis. For reasons described below, the block-summary data set was used as the primary sample frame for the reconstruction. As a consequence, landings statistics obtained from it were considered definitive. For the purpose of estimating historical rockfish landings, only market categories in the 'ROCK' species group, as defined in the California Commercial Landings (CALCOM) database, were included in the analysis (see Appendix D). Hence landings of *Sebastes* in non-rockfish market categories were excluded from further consideration, although those catches are believed to be negligible. A significant shortcoming in the data is that many records have missing or incomplete values for CDFG block, although it was possible to classify all landings to the "region_caught". For this analysis, region_caught is the hundreds digit of the block number, i.e., region_caught = Integer{block/100}. The following table lists the ports that were assigned to each of the 6 defined "region_caught" categories within California:

Region Caught	Ports
2	Crescent City, Eureka, Fort Bragg
4	Bodega Bay, San Francisco, Half Moon Bay
5	Santa Cruz, Moss Landing, Monterey
6	Morro Bay, Port San Luis, Santa Barbara
7	Los Angeles
8	San Diego

Note that region_caught 1 (Crescent City) was very limited in spatial extent and so it was pooled with Eureka. Also, CDFG blocks in the 200s spanned Cape Mendocino (Appendix C) and, as a consequence, Fort Bragg was pooled with the two most northern ports. Region_caught 3 corresponds to the San Joaquin and Sacramento Rivers, the Delta, and San Francisco Bay where no rockfish landings were reported. Finally, blocks in the 600s range spanned Point Conception, so that Santa Barbara was pooled with Morro Bay and Port San Luis into region_caught 6. We believe that these area assignments are sub-optimal, particularly the pooling of Fort Bragg and Santa Barbara with ports located on the opposite sides of major coastal headlands. Future work to separate Santa Barbara from region_caught 6 and Fort Bragg from region_caught 2 is planned.

Trawl Block-Summary Data

The trawl block-summary data are identical in structure to the block-summary data, i.e., variables exist for year, month, CDFG block, market category, and pounds landed, except that landings represent trawl catches only. These data extend from 1925-1957. At this time only annual summaries of landings, stratified by market category and CDFG block, have been

keypunched, i.e., monthly values are unavailable. An area caught variable was created in a manner identical to the block-summary data (area = Integer{block/100}).

Commercial Landings Receipts

Fish-ticket data from 1951-1968 were recovered and the data for 1960 and 1965 were keypunched from microfiche and made available for the catch reconstruction project. Landings receipts are the most comprehensive and definitive source of information to use for catch reconstructions as they include detailed information on the activities of individual vessels on specific fishing trips. Both the block-summary and the trawl block-summary data sets were derived from fish tickets. Efforts to fully keypunch this expansive data set are continuing and are expected to substantially extend the State of California's commercial catch records. Preliminary comparison of 1960 and 1965 landing receipts to the block-summary data indicates that the two sources of information are in very close agreement (Figure 1). It is for this reason that the block-summary data are considered definitive.

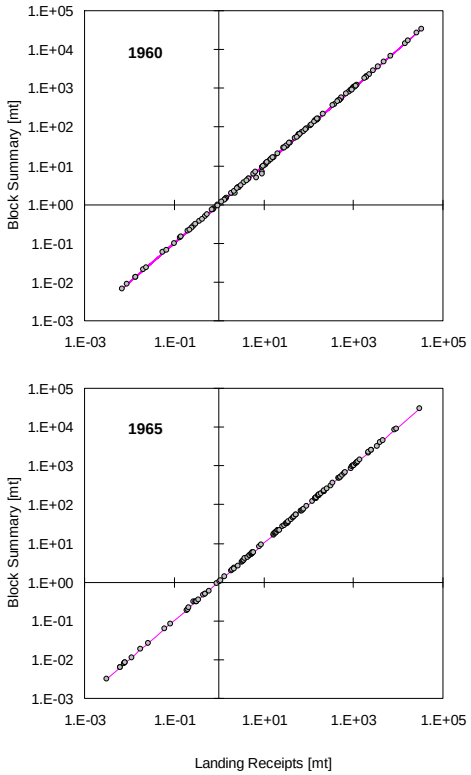


Figure 1. Comparison of market category specific total landings summarized from the fish ticket and block-summary data sets (1960 and 1965).

Reconstructing the Past

Heimann and Carlisle (1970) provide estimates of total "rockfish" landings from 1916-1968. A comparison of these data with the aggregated block-summary data over their period of overlap (Figure 2) shows that the data are in close agreement. Using a ratio estimator, the

Heimann and Carlisle data were used to extend the aggregated block-summary data to the earlier 1916-1930 time period and to fill in the single missing year (1938) in the block summary time series.

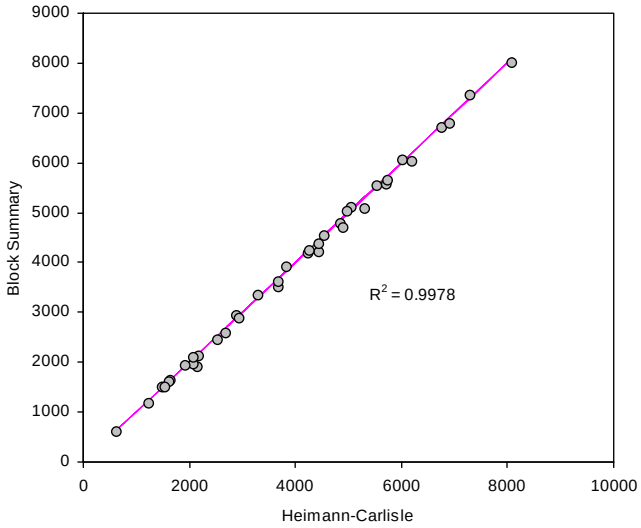


Figure 2. Comparison of Heimann and Carlisle (1970) rockfish landings statistics with aggregated rockfish landings statistics from the block-summary data set.

In addition, Phillips (1958) classified rockfish landings from 1916-1956 to northern, central, and southern regions of the State, effectively apportioning the data to these three broad "regions" within the State. To complete the estimation of landings, area-caught and market-category-specific ratio estimators were developed from the combined 1931-1932 block summary and Phillips data, and these were applied retroactively to the 1916-1930 period. In a similar manner, the combined data from 1937 and 1939 were used to develop a ratio estimator for 1938. The purpose of this step was to create a complete sample frame of rockfish landings extending from 1916-1968 that included year, area, and market category variables.

Stratification

Rockfish landings in the State of California are currently estimated based on a two-stage sampling design that has port samplers determine species composition, by weight, of cluster basket samples obtained from the landed catch. Species compositions are required because the sort groups used by industry (market categories) often contain multiple species. To improve the efficiency of port sampling, the estimation is stratified by important variables that affect the species composition of a market category, i.e., the particular area of the coast, season (quarter), and gear type. Given current sampling practices, it was deemed desirable to maintain the same sampling stratification, to the extent possible, in the reconstruction effort. Although gear is not formally in the block-summary and trawl block-summary data sets, a gear variable was created by subtracting trawl landings from total landings on a stratum-specific basis, yielding a "trawl" versus "non-trawl" gear classification. Both data sets contained the same "area" variable. However, because the trawl block-summary monthly data are yet to be keypunched, it was not

possible to maintain the seasonal stratification dimension in the current reconstruction. Pending capture of the monthly data, the current reconstruction was completed by characterizing area and gear-specific annual landings of all rockfish market categories.

A difficulty in differencing the extended total catch and trawl block-summary data was that each represents a different time period (1916-1968 and 1925-1957, respectively). To decompose the earliest "aggregate" rockfish catches to gear type, the proportion of all landings that were trawl vs. non-trawl in 1925-1926 were applied to the 1916-1924 time period on an area- and market category-specific basis. This assumed that there were no changes in catch composition due to differences in gear utilization from 1916-1924. Moreover, examination of the 1957 trawl block-summary data revealed a number of irregularities and those data were discarded. To estimate the proportion of trawl-caught landings by area during the period 1957-1968, the fish-ticket data from 1960, 1965, and 1969 were used to determine gear utilization rates. The fish-ticket data, in combination with the valid information from 1956, were used to interpolate the stratum-specific proportion landed by trawl in the intervening years. The interpolated proportions were then applied to the block-summary landings data by stratum to estimate gear-specific catches.

Another difficulty in using the trawl block-summary data was that catches from that data set during World War II contained irregularities. In particular, landings of certain flatfish species (e.g., Dover sole, petrale sole, and English sole) are almost exclusively taken by trawl fisheries. Hence, catches in the block-summary data set (representing all landings) should not greatly exceed those in the trawl block-summary data set. However, from 1944-1947 the trawl block summary catches of those flatfishes were substantially lower than expected (Figure 3).

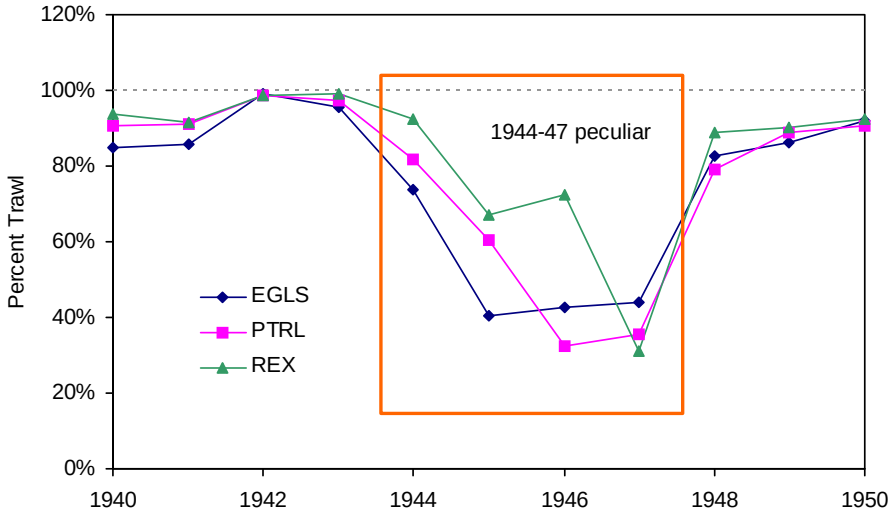


Figure 3. Trawl catches as a percentage of total catches of three flatfishes during the mid-1940s (EGLS = English sole, PTRL = petrale sole, REX = rex sole).

The reason for these discrepancies was not determined, but due to concerns over the accuracy of the 1944-1947 trawl landings, those data were excluded. Instead, stratum-specific trawl landings were estimated by ratio estimation using the joint block summary and trawl block-summary data from 1941-1943 and 1948-1950, i.e., three years on either side of the period in question.

A summary of all rockfish catches by gear type is presented in Figure 4 below. Note that prior to World War II trawl landings were a small fraction of the total catch, but that during the war trawl catches increased dramatically. Thereafter the trawl fishery dominated rockfish landings.

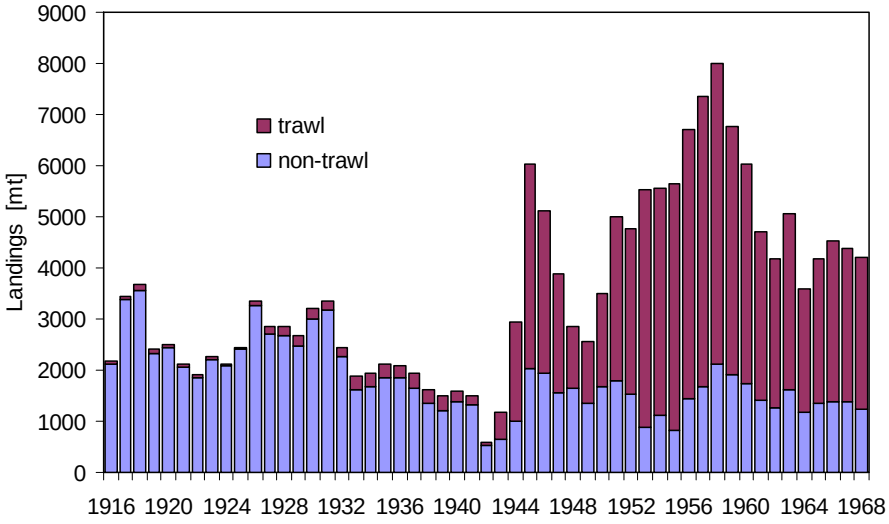


Figure 4. Time series of rockfish landings by gear type (1916-1968).

The end result of these steps was the development of a complete time series of rockfish landings from 1916-1968, classified by market category, area, and gear. The next step in the reconstruction was to convert market-category catches (by area and gear) into species-specific catches by application of stratum-specific species compositions. However, analysis of the CALCOM database from 1978-1984 showed that only five rockfish market categories were highly mixed. These well-mixed market categories were: 250=unspecified rockfish, 253=bocaccio, 254=chilipepper, 959=group red, and 960=group small. For the many remaining market categories (Appendix D) catches were assumed to be "pure" (consisting of only the nominal species). For example, all landings of market category 245 (cowcod) were assumed to be *Sebastes levis*. While this may at first seem to be a strong assumption, only 10% of all rockfish landings by weight fell into these "nominal" categories. The remaining 90% of the catch was reported from the five highly mixed market categories listed above (see below).

Species compositions for each of the principal market categories (250, 253, 254, 959, and 960), areas (2, 4, 5, 6, 7, and 8) and gear combinations (trawl vs. non-trawl) were then determined from the CALCOM landings data gathered from actual port samples collected during the 1978-1984 time period. This is the earliest period in which port sampling of rockfish market

categories for species composition was conducted on a regular basis. Given five market categories, two gear types, and six areas, a total of 60 species compositions were required. However, less than half the required sample combinations were available. One reason for the shortage of samples is that trawling is not allowed in the two most southern areas (Los Angeles and San Diego), reducing the effective number of strata to 50. In other instances samples simply did not exist (e.g., non-trawl market category 959 in area 2).

In order to deal with this undesirable situation, reconstruction of species-specific landings estimates were derived sequentially. In the first stage, all market categories other than 250, 253, 254, 959, and 960 were assumed to be pure and were assigned to the species bearing their name. In the second stage, if fully stratified (market category × area × gear) species compositions were available they were applied to the fully stratified data. In the third stage, if species compositions were not available the "gear" stratification variable was collapsed so that only market category and area were used. Species compositions from the 1978-1984 time frame were then re-calculated considering only those two dimensions. Finally, in the fourth stage, there remained a portion of landings that lacked market category × area samples and for those data the area variable was also collapsed so that only the market category dimension was used to estimate species composition. The pie chart below (Figure 5) shows how much of the landings were reconstructed according to each stage of the estimation procedure. The figure shows that 69% of the reconstructed commercial rockfish landings were based on a full stratification that included market category × area × gear.

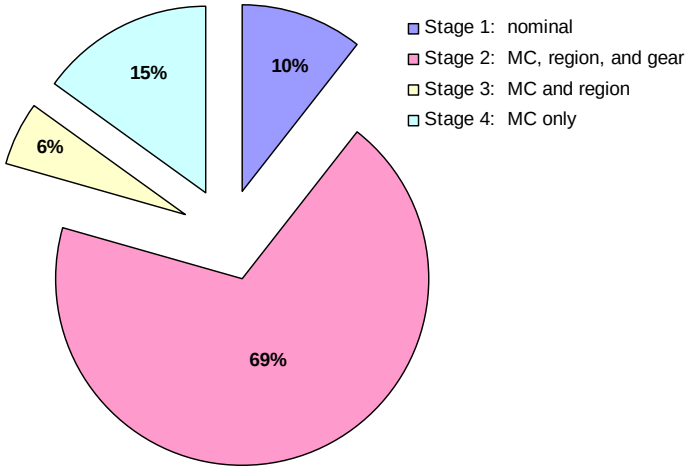


Figure 5. Reconstruction of species-specific historical landings by a tiered stratification procedure for estimating species compositions (MC = market category).

It was assumed that the proportional representation of a species in the reconstruction was stable over time and the estimated proportions were applied to the entire reconstructed time series from 1916-1968. Although this is a sweeping assumption, it is true that the species composition of market categories is strongly dependent on the type of gear used in harvesting and the general area where the catch was made and this is unlikely to have changed over time.

However, it is likely that the depths that were fished have changed over time, which would be expected to affect species compositions to some unknown degree.

To evaluate the validity of this "stability" assumption, the reconstructed landings estimates based on species compositions obtained from 1978-1984 were compared with the only focused study that determined species compositions of trawl caught rockfish from 1962-1963 (Nitsos 1965). That comparison showed that the reconstructed catch proportions did not deviate in a systematic or serious way from the observed catch proportions (Figure 6).

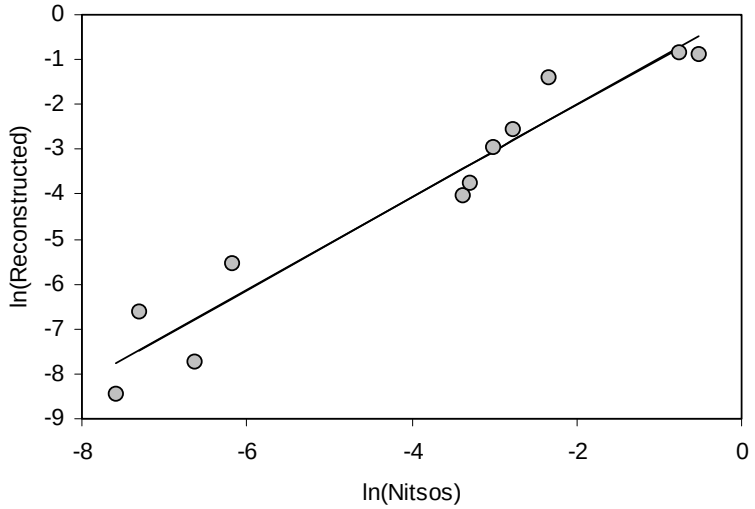


Figure 6. Comparison of reconstructed trawl species composition estimates ($\log_e$-transformed proportions) with observed trawl species compositions as reported in Nitsos (1965). The solid line is a line of equality.

Given the observed level of variability in the reconstructions relative to the Nitsos results ($\sigma = 0.69$), we advise that a reasonable bracketing of uncertainty in the reconstructed landings estimates is to either halve or double any particular value, which is very nearly equivalent to a confidence interval $\pm 1.0\sigma$ on log-scale.

Some Rockfish Reconstructions

Two example rockfish reconstructions are presented below that show both the time series of catches by gear and area; bocaccio (*Sebastes paucispinis*, Figure 7) and cowcod (*Sebastes levis*, Figure 8). Note that because species compositions were not available for all stratum combinations (i.e., market category × area × gear), some of the catches in these figures are unassigned to gear and/or area. The reconstructed data are available for any rockfish species by accessing the "Reconstructed Commercial Landings" database (see above).

A complete listing of all computer programs used in reconstructing historical rockfish landings, which were primarily written in the SAS programming language, is provided in Appendix E.

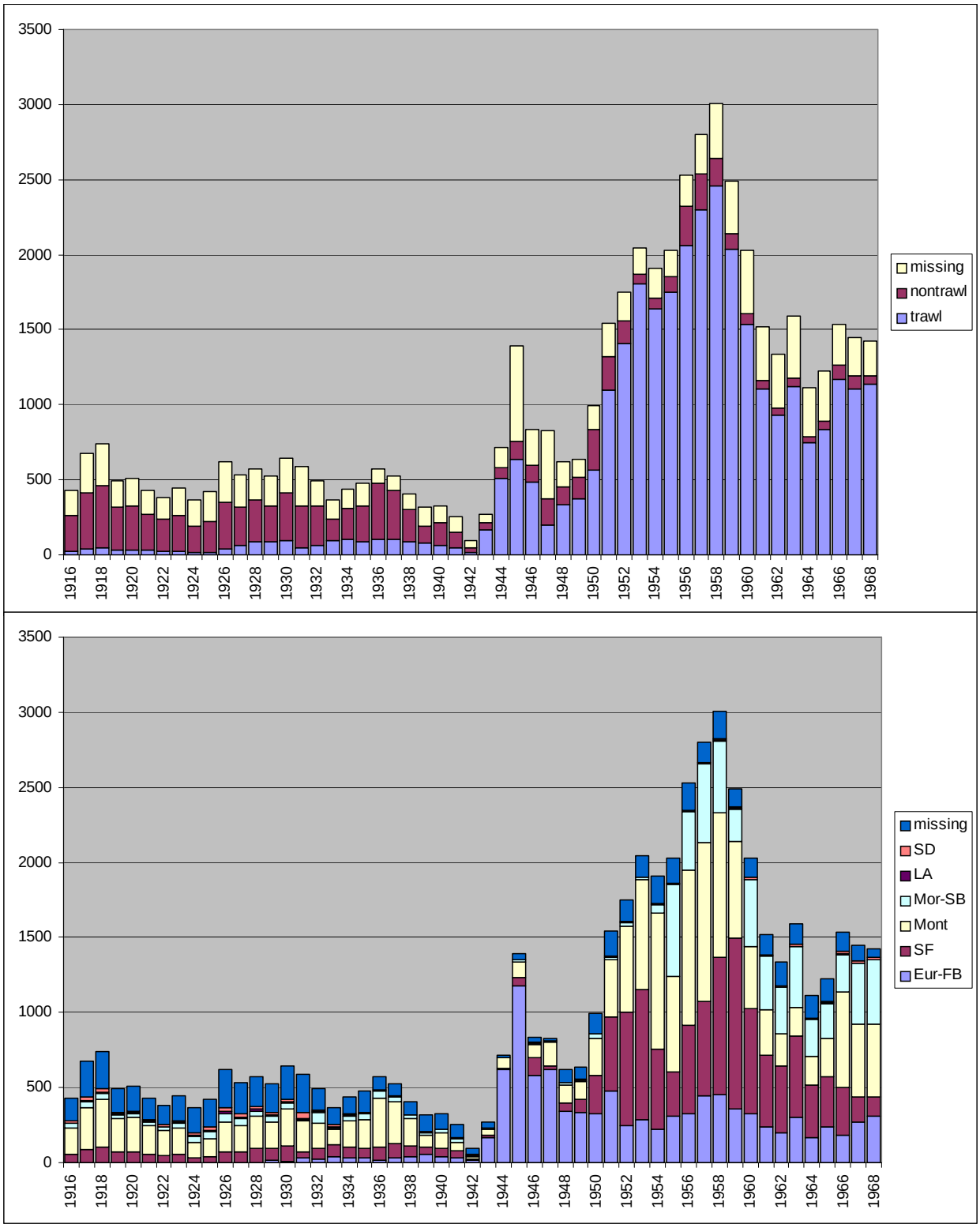


Figure 7. Reconstructed landings for bocaccio (*Sebastes paucispinis*) by gear and area.

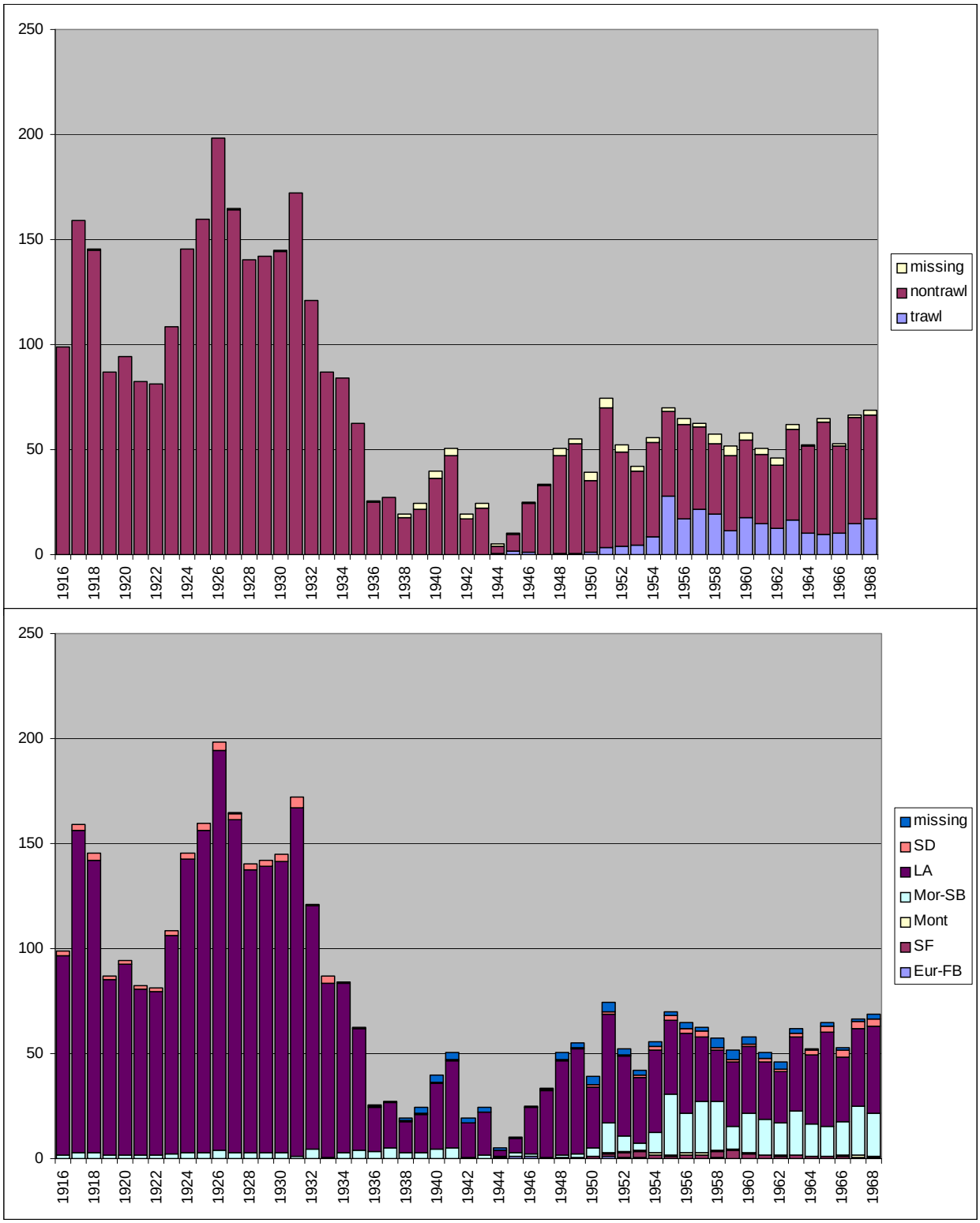


Figure 8. Reconstructed landings for cowcod (*Sebastes levis*) by gear and area.

Reconstructions of Recreational Rockfish Landings (1928-1980)

A combination of two surveys, the Marine Recreational Fisheries Statistics Survey (MRFSS, 1980-2003) and the California Recreational Fisheries Survey (CRFS, 2004-present), provides ready access to catch and discard estimates to the species level for the recent time period. Historical Commercial Passenger Fishing Vessel (CPFV) logbook information provides detailed historical catch data for many species (e.g., cabezon, lingcod, California scorpionfish) that have been frequently used for estimating catches. However, CPFV logbook data for rockfish (*Sebastes*) are not species-specific, and recreational catch reconstructions are increasingly dependent on *ad hoc* methods of apportioning the catch of "rockfish" (for both CPFV and much more poorly quantified historical catches of skiff and shore modes) to the species level.

Based on the recognition that the entire historical catch reconstruction exercise is likely to be an iterative and multistage process, our first pass in this effort focuses on resolving the species composition of recreational "rockfish" catches in California waters during the pre-1980 era. We have made a concerted effort to inventory the available information on rockfish catches and species composition over time and by area, including identifying potential sources of data that should be recovered for future efforts. We have used these data to explore plausible means of identifying the species composition of the catch, based primarily on linking the spatially-explicit CPFV logbook data to the species composition of rockfish catches for those CDFG blocks from more recent CPFV onboard observer data and other sources. Species composition information for skiff and shore modes is considerably more sparse and consequently estimations are much more uncertain. For the most part, we have relied on the species composition of MRFSS in the 1980s to apportion historical catches appropriately.

A more detailed explanation of the available information and the methodology we used for this first pass at estimating historical catches follows. We emphasize that this represents a first attempt at reconstruction. We recognize that there are imperfections and uncertainties in the approach that should be more thoroughly evaluated, and we intend to pursue refinements to this approach as well as explore other ways of addressing these issues. For example, as we are constrained to basing our analysis primarily on relatively recent species composition data, there is a very clear potential to fail to account for long-term trends in species composition and relative abundance in the catches (e.g., shift in catch composition to faster growing, higher turnover species). For the present, we have no way to resolve this beyond simply recognizing that this uncertainty exists.

Historical Data Sources

Table 1 provides a summary of the primary sources of information available and/or used in the recreational catch reconstruction, and Figure 9 shows an approximate timeline of the time periods for which these sources are available. The major sources of information themselves are described in greater detail below.

Table 1: Summary of primary sources of rockfish catch and species composition for California recreational fisheries.

Data source	region	timespan	sectors	species comp	discard data	port data	block data	depth data	effort data	length data
CPFV logbook	All CA	1936-present (no WWII yrs)	CPFV	no	no	yes	yes	no	yes	no
CDFG, Heimann and Miller	Morro Bay	late 1950s	CPFV, priv, shore, pier	yes	no	yes	no	no	no	no
CDFG, Miller and Gotshall	Central and North	1958-1961, 1962-1972	CPFV, priv, shore, pier	yes	no	yes	no	no	no	limited in 62-72
CDFG, Miller and Odemar	Central	1966	CPFV, priv, shore, pier	yes	no	no	no	no	no	no
Onboard observer	Central	1987-1998	CPFV	yes	yes	yes	yes	yes	yes	yes
Onboard observer	South	1975-1979, 1986-1989	CPFV	yes	yes	yes	yes	yes	yes	yes
CCRS intercept	Central	1978-1984	CPFV, priv	yes	no	yes	yes	no	no	yes
MRFSS	All CA	1980-1989, 1993-2004	CPFV, priv, shore, pier	yes	yes	some	no	no	yes	yes
CRFS	All CA	2004- present	CPFV, priv, shore, pier	yes	yes	yes	yes	yes	yes	yes
Recreational guides	various	various	various	limited	no	no	no	no	no	no

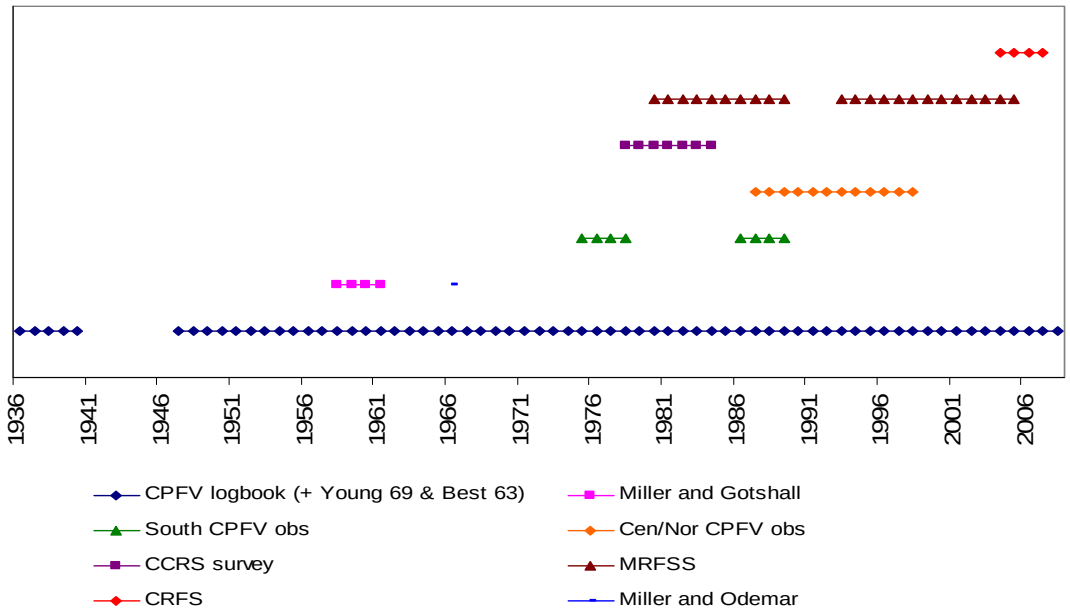


Figure 9: Timeline of the primary sources of catch and species composition data available for California recreational catch reconstruction.

The most important source of information is California's CPFV logbook data set, which begins in 1936 and extends to the present period. Recreational fishing effort for fishes other than big game fish such as tunas and salmon was relatively modest in California until about 1930, when CPFVs popularized recreational fishing (Croker 1931; Croker 1939; Young 1969). Initially, most effort was in the waters of the southern California Bight, and rockfish were not a major target of these efforts in early years. However, party boat fisheries soon became popular in Monterey, where rockfish were an important element of the catch during the development of the fishery. CPFV captains have been required to submit logbooks detailing catches since 1936, including the location (CDFG block; see Appendix C) of their catches in numbers of fish and the number of anglers onboard. However, no data are available for the WWII period, from 1940 through 1946, during which time recreational landings presumably declined, but did not cease entirely. Consequently, we scaled the catch for these years to the catch in 1939 by the ratio of CPFV licenses issued by CDFG in each year relative to 1939; for the peak war years (1942-1945) this suggests a roughly 50% decline in catches. While many recreational targets are recorded in the logbooks to the species level, the 50 to 60 species of *Sebastes* commonly or occasionally caught in recreational fisheries have traditionally been reported only as "rockfish."[1] These data with corresponding block information are available from the CPFV database for southern California effort between 1936 and 2007 and for central and northern California from 1958-2007 (Hill and Barnes 1998; Hill and Schneider 1999). For pre-1958 catches in central and northern California we used the total CPFV catches reported by Young (1969) for 1947-1957, and Best (1963) for 1936-1941. Compliance issues associated with these data will be discussed in the methods section.

Other available data sources include a CDFG study of recreational fishing effort and catches for central and northern California by Miller and Gotshall (1965) from 1958-1961. While the estimates of CPFV total landings were based on logbooks, there were surveys of skiff and shore modes of recreational fishing, as well as species composition and length information collected for all recreational fishing modes. They found that blue, yellowtail, olive, and bocaccio rockfish were among the most important rockfish species (together accounting for ~65% of the total catch by number). Chilipepper rockfish were reported in only trace amounts in this period, although they have been a major component of recreational catches since the early 1980s. Similarly, Heimann and Miller (1960) described Morro Bay party boat fisheries in the late 1950s; this fleet too was clearly targeting nearshore assemblages (blue, olive, yellowtail, and vermilion rockfish comprised over 80% of the catch). For this region, these data provide a critical means of either interpolating historical catches directly, or comparing reconstructions of historical catches from other sources to their results (we have opted largely for the latter in this effort).

Although the focus of the Miller and Gotshall study was on the 1958-1961 period, species composition and limited length frequency information (limited to blue rockfish and lingcod for most years) was collected by CDFG staff for both skiff and shore modes in the

[1] Although "cowcod" were often reported separately, it is not entirely clear that all "cowcod" were *Sebastes levis*, as other large species (such as *S. rubberimus* and *S. gilli*) may have also been reported as "cow" rockfish (R. Lea, pers. com.).

Monterey and San Francisco regions from 1962 through 1972 (data for 1966 is reported in Miller and Odemar 1968). Many of the Monterey Bay records were digitized in the 1990s to evaluate trends in species composition (Mason 1995) and length frequencies (Mason 1998) in the Monterey Bay region. These data were made available (J. Mason, ERD/SWFSC, pers. com.) during this effort, and represent an important source of information that could be used to refine future species composition estimates. Digitizing the remaining information for Half Moon Bay and San Francisco area ports is considered a high priority for further refinement of the recreational catch reconstruction effort.

Another source of information for central and northern California rockfish species composition and length data is the California Cooperative Rockfish Survey (CCRS) which collected data from skiff and CPFV fishermen from 1978-1984. This program collected data from over 33,000 fish (species ID, sex and length) from 44 species of *Sebastes*. Most data were collected from the Monterey and San Francisco regions, with limited data collected to the north (Ft. Bragg through Crescent City) and the south (Avila Beach, Morro Bay). Importantly however, these data did include CDFG block information (as well as vessel data), making them relatively compatible with later CPFV onboard observer data for estimating species compositions by block.

The most valuable source of species composition data comes from the Department of Fish and Game CPFV Onboard Observer Programs that operated in southern California from 1975-1978 and from 1986-1989, and in central and northern California from 1987-1998. These on-board monitoring of partyboat catches includes data on catch and disposition, angler effort, size composition of catches, date, location, and depth information. For the 1975-1978 southern California effort, CDFG collected block information as well as additional information on location and depth. This effort monitored over 2,500 trips and collected length and effort data on nearly 200,000 rockfish caught in CPFV fisheries (as well as large numbers of other species). However, the 1986-1989 southern California monitoring used a more complicated location system that reported fishing locations but not CDFG block. In an effort to derive the block information for these data (necessary to match historical catches by block), CDFG GIS staff, Gina Schmidt, mapped the location information to CDFG blocks. Much effort was put into this analysis with the goal of calculating the minimum, maximum and average depth by block, as well as the percent area of block by depth. Although this analysis was completed, it was difficult to develop a comprehensive approach for assigning locations that fell into multiple blocks or had locations within locations (Figure 10), then applying species compositions to calculate rockfish catches by block. There is room for future improvement in the treatment of the 1986-1989 data.

For the central and northern California observer data, information was collected from 2,267 recreational fishing trips from 1987-1998. The total number of rockfish observed was over 300,000. Trips were observed from Morro Bay (649 trips) to Eureka and Crescent City (12 trips), with the majority of observed trips originated from Monterey (821), San Francisco (444), and Bodega Bay (269) area ports. CDFG block information, as well as fishing site (457 sites) and the maximum and minimum observed depth information (ranging from 2 to 150 fathoms), were also available for all trips. Locations represented 68 separate CDFG blocks, but 90% of the

trips took place in just 27 of these blocks (consistent with the description of rockfish catch by block in CPFV logbook data). Between 1987 and 1998 most of the trips were in the 20 to 60

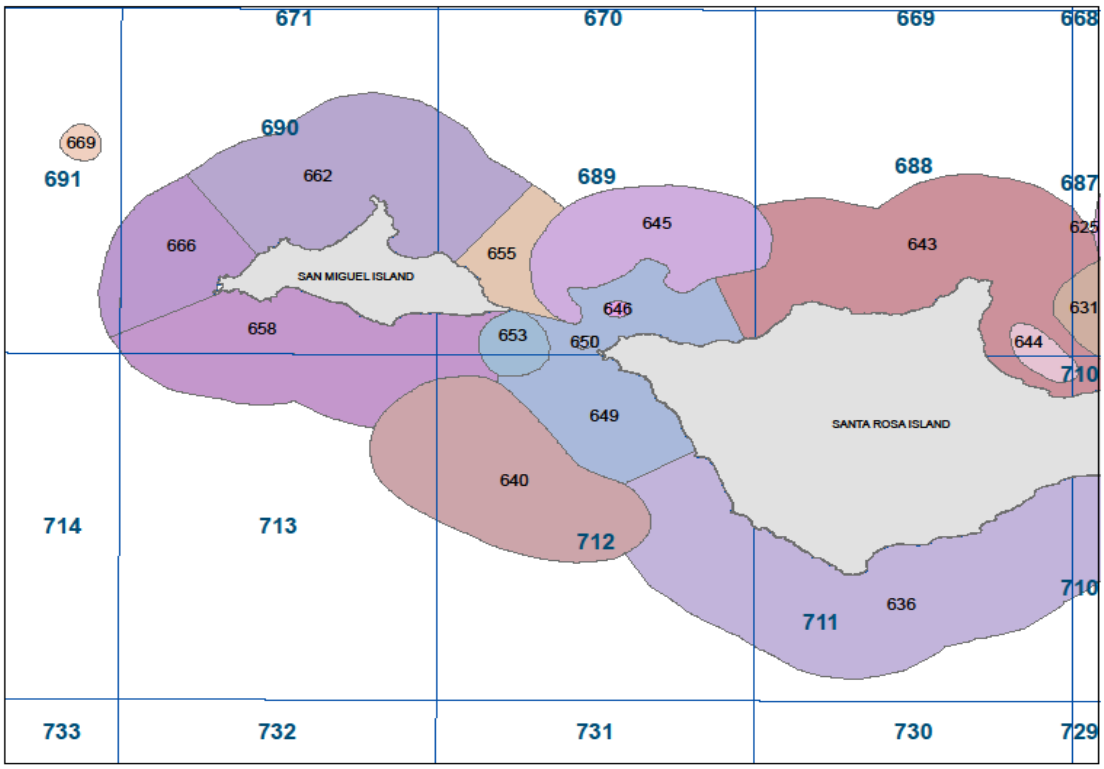


Figure 10: GIS map with location information from the southern California CPFV onboard observer program from 1986-1989. Specific locations (smaller font, colored areas) are assigned within CDFG blocks (larger font numbers in a 10x10 nautical mile area).

fathom range, however there was a slight increase in the percentage of trips in the 0 to 20 fathom range and a slight decrease in the percentage of trips in the 60 to 100 fathom range. Overall, the latter represented less than 15% of all trips observed, with nearly all of the deep water (>60 fathom) catches coming from a small number of blocks near Cordell Bank and Monterey Bay.

For 1980-2006, catches in both numbers of fish and weight of fish were also obtained from the RecFIN database in order to compare how our pre-1980 estimates compared to post-1980 estimates, as well as to develop species composition information for skiff and shore mode catches prior to 1980. RecFIN data are based on Marine Recreational Fisheries Statistics Survey (MRFSS) catch estimates, which are based on a combination of angler field surveys and randomized telephone surveys from 1980-2003 (with a hiatus in all data collection from 1990-1992 and from central/northern CPFV fishing modes from 1993-1995), with four primary fishing modes; CPFV, private (skiff), pier, and shore. Spatial resolution of the catch estimates is limited to northern and southern California (north and south of Point Conception). We note that there are many unaddressed issues with MRFSS sampling that we do not consider our responsibility to address in these efforts to estimate historical recreational rockfish catches. For example, from

1990-1992 there are no CPFV estimates in RecFIN, and some areas lack complete estimates for 1993-1995. Estimates have been generated by the CDFG for many of these years, using CPFV onboard observer survey data in conjunction with CPFV logbook information (D. Wilson-Vandenberg, CDFG, pers. com.). We will, however, continue a list of knowledge about these issues in hopes they can be addressed comprehensively in the future. Since 2004, the California Recreational Fisheries Survey (CRFS), a newly implemented state program, has also estimated catch, effort and discards in California, similar to MRFSS. These data have greater spatial resolution to county level. Data from each survey (MRFSS and CRFS) are available on the Recreational Fisheries Information Network (RecFIN) website (http://www.recfin.org/).

A final source of information considered here was anecdotal information on the relative abundance and importance of various rockfish species as described in CDFG fish identification bulletins and recreational fishing guides to central and southern California (see Literature Review under Additional Sources of Information Used). While purely qualitative, these sources of information are consistent with the general trends observed in the data sources described above.

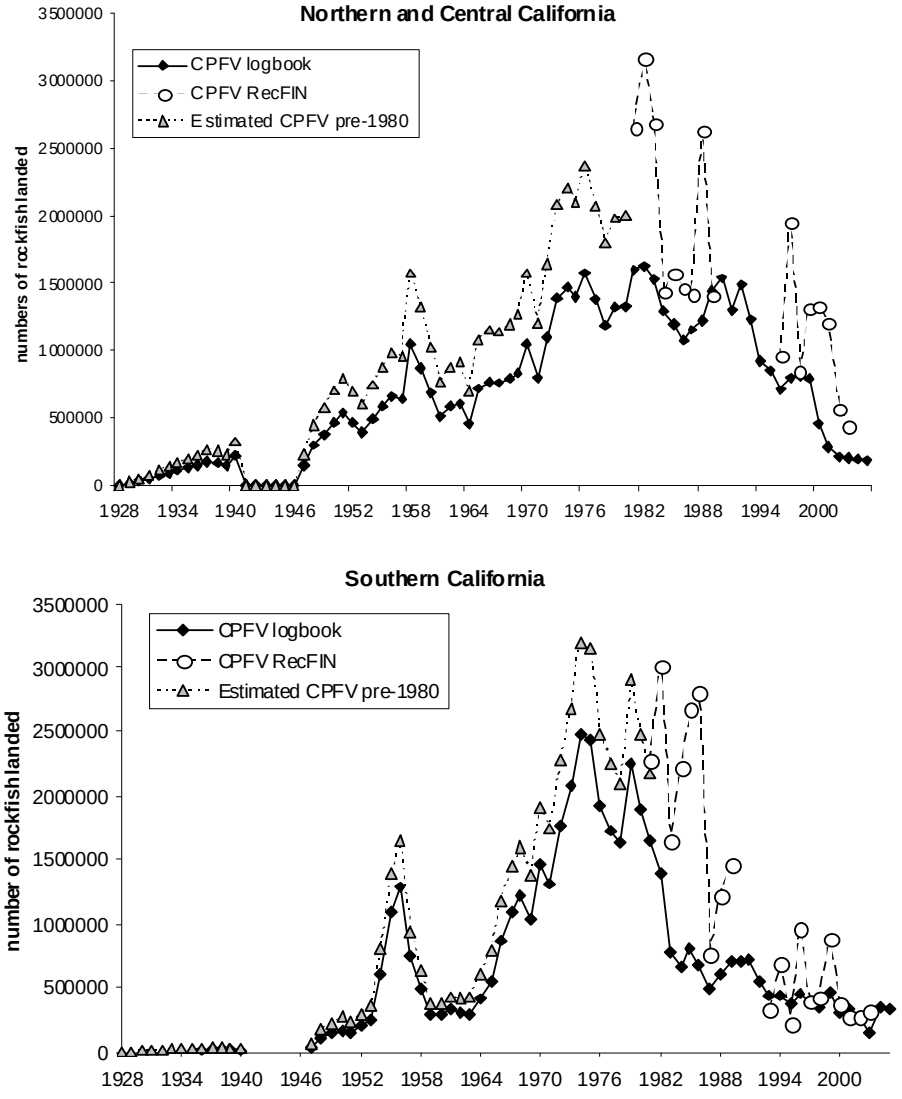
Methods

Part 1: Total CPFV Rockfish Catches

Total numbers of rockfish caught by CPFV fisheries were based on the logbook data described previously, which provide the foundation of the total rockfish catch reconstruction. We assumed that recreational rockfish catches were 0 in 1928 and increased with a linear ramp between 1928 and the first year of data in 1936. Although these data give few insights of catches from private vessel or other fishing modes (shore, pier), and compliance (reporting) rates have been less than 100% historically, historic catch estimates are based on the logbook data as adjusted by independent information on compliance rates and relative catch rates for private boats. Compliance issues are an important factor in interpreting these data; historically compliance has been shown to be less than 100% in terms of the trips reported to CDFG. Additionally, the number of rockfish caught in reported trips was often less than the number observed caught in some early years of the fishery (Baxter and Young 1953).

The 1987-1998 central and northern California observer program estimated that total compliance ranged from 48 to 91% in that period, with an average of 66.3% (D. Wilson-Vandenberg, CDFG, pers. com.) Interestingly, the ratio of RecFIN-estimated CPFV rockfish catches to logbook-reported rockfish catches in the 1981-2000 period is quite similar, with logbook catches representing (on average) 61.8% of the RecFIN catch estimates. Therefore, we assumed that logbook reported rockfish catches represented 66.3% of total historical CPFV catches for the pre-1980 period in central and northern California (Figure 11a). Estimated catches ranged from an average of less than 200,000 fish per year in the 1930s to nearly a million fish per year in the 1960s and nearly 2 million fish per year through the 1970s. Catches remained at approximately 2 million fish per year through most of the 1980s based on RecFIN estimates, declining back to an average of one million fish per year in the late 1990s and considerably less than that in recent years.

In southern California, logbook compliance has not been formally evaluated, but has generally been thought to be slightly greater than that in other parts of the state (S. Crooke, CDFG , pers. com.). Based on this generalization, and a comparison of the ratio of logbook reported catches to RecFIN estimated CPFV catches, logbook reported rockfish catches were assumed to be 80% of the total historical CPFV rockfish catch south of Point Conception (Figure 11b).



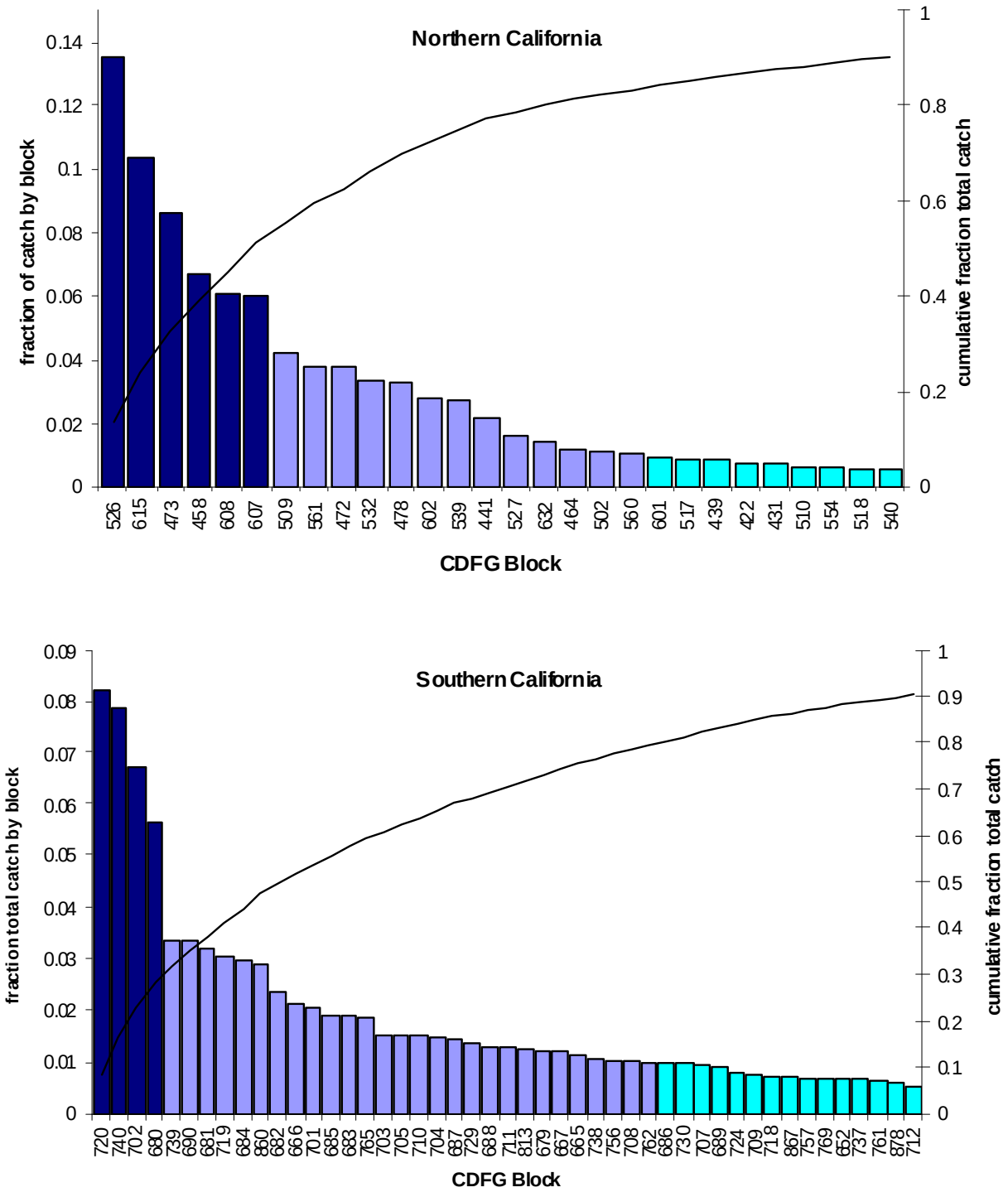
Figures 11a and 11b: Numbers of rockfish caught over time in central/northern California (top) and southern California (bottom), as reported in CPFV logbook data (1936-2005), estimated by RecFIN (1981-2005), and estimated for this historical catch reconstruction (1928-1980).

Part II: Species Composition of CPFV Catches

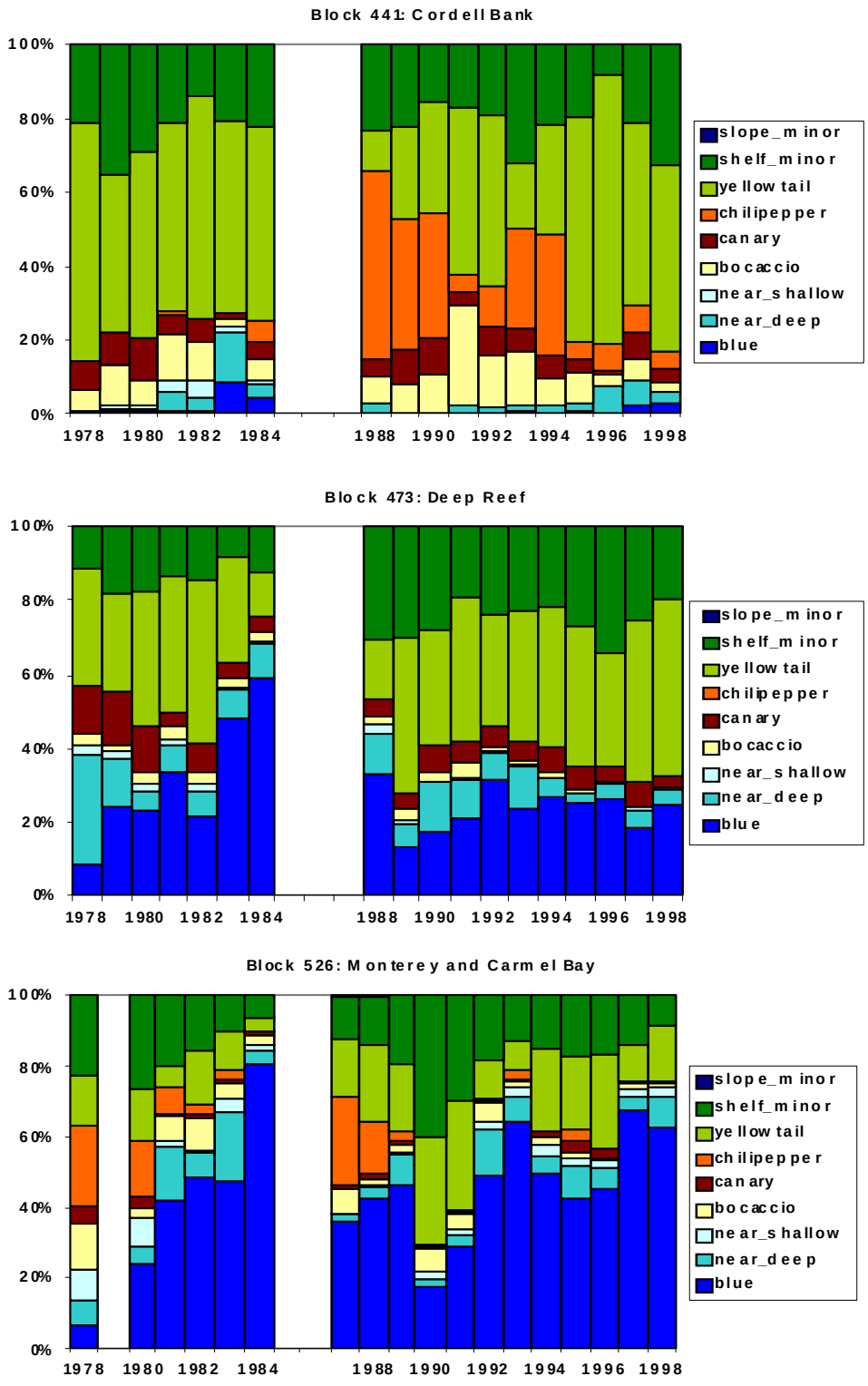
The CPFV logbook data include a spatial component and we utilize this information in the catch reconstruction. During the development of the CPFV fishery, effort tended to be distributed relatively close to several main ports, particularly in the coastal areas from Dana Point to Point Mugu in the southern California Bight (particularly the CDFG blocks surrounding the Palos Verdes Peninsula) and the blocks in the immediate vicinity of Morro Bay, southern Monterey Bay and Half Moon Bay in central California. With time, blocks further offshore (Channel Islands in southern California, Cordell Bank and Deep Reef region in central California) became regions of greater fishing pressure, with a changing mix of species reflecting both different habitats and depths fished. Throughout most of this period however, a relatively small number of CDFG blocks have represented the locations for catches of the vast majority of CPFV landed rockfish. In northern California, six blocks account for over 50% of the reported CPFV catches between 1957 and 1980, with another 22 blocks representing another 40% of the total catch between 1957 and 1980, such that over 90% of the catch was taken in only 28 blocks (Figure 12a; see Appendix C for maps of blocks and major geographic features). In southern California, four blocks accounted for 28% of the total catch between 1936 and 1980, with an additional 43 blocks accounting for 1 to 3% of the total catch each, such that 47 blocks accounted for over 90% of the total historical catches (Figure 12b).

The State's CPFV onboard observer programs can provide a source of species composition data by block; in both southern and northern California more than 95% of the historical catches came from blocks that had block-specific species composition data in later years. This allowed us to apply block-specific species-composition information to these historical catch data, which provides the basis for the reconstruction. To appreciate the respective differences in the species composition by block, Figures 13a-c and 14 a-c show the species composition by year for three blocks in each region, each of which represents a block with high historical rockfish catches and good coverage by CPFV onboard observer programs. The point to make is simply that most blocks exhibited a unique combination of species that is consistent with expectations; over Cordell Bank shelf species such as bocaccio, chilipepper, and yellowtail have been among the most important species, while in the blocks adjacent to Monterey and Carmel Bay, blue rockfish have been one of the most important species historically. There are considerably more data available for central California blocks, although very few of those data precede the RecFIN era. By contrast, only four years of data, all of which precede the RecFIN era, were available for southern California in time for this effort. We anticipate revisiting the southern California estimates to develop the mid-1980s species composition data, following the ongoing efforts (described earlier) to digitize the fishing areas used in the 1980s study and assign catches to block rather than fishing location.

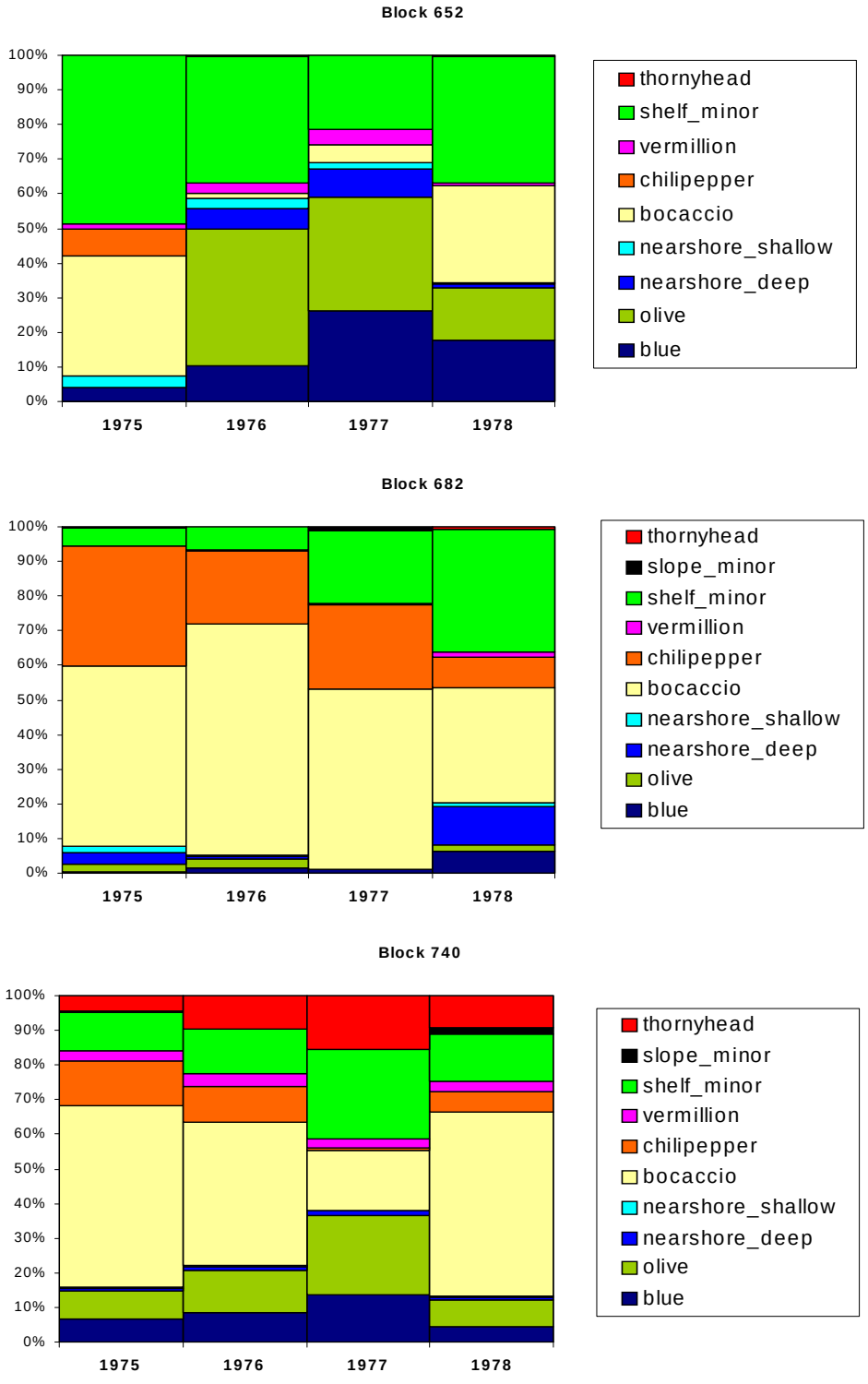
As the number of sampled trips varied widely from block to block (albeit, generally proportional to the relative fraction of total catch in a given block), we explored a tiered approach for applying the species composition information. Treating southern and northern California catches independently, we took the five most commonly caught species in each region based on the CPFV observer programs (boccaccio, vermilion, blue, olive and chilipepper



Figures 12a and 12b: Fraction of total reported rockfish catch by CPFV block for northern California (1957-1980) and southern California (1936-1980).



Figures 13a, 13b and 13c: Examples of the species composition by year for three central California blocks (block 441, 473 and 526, respectively).

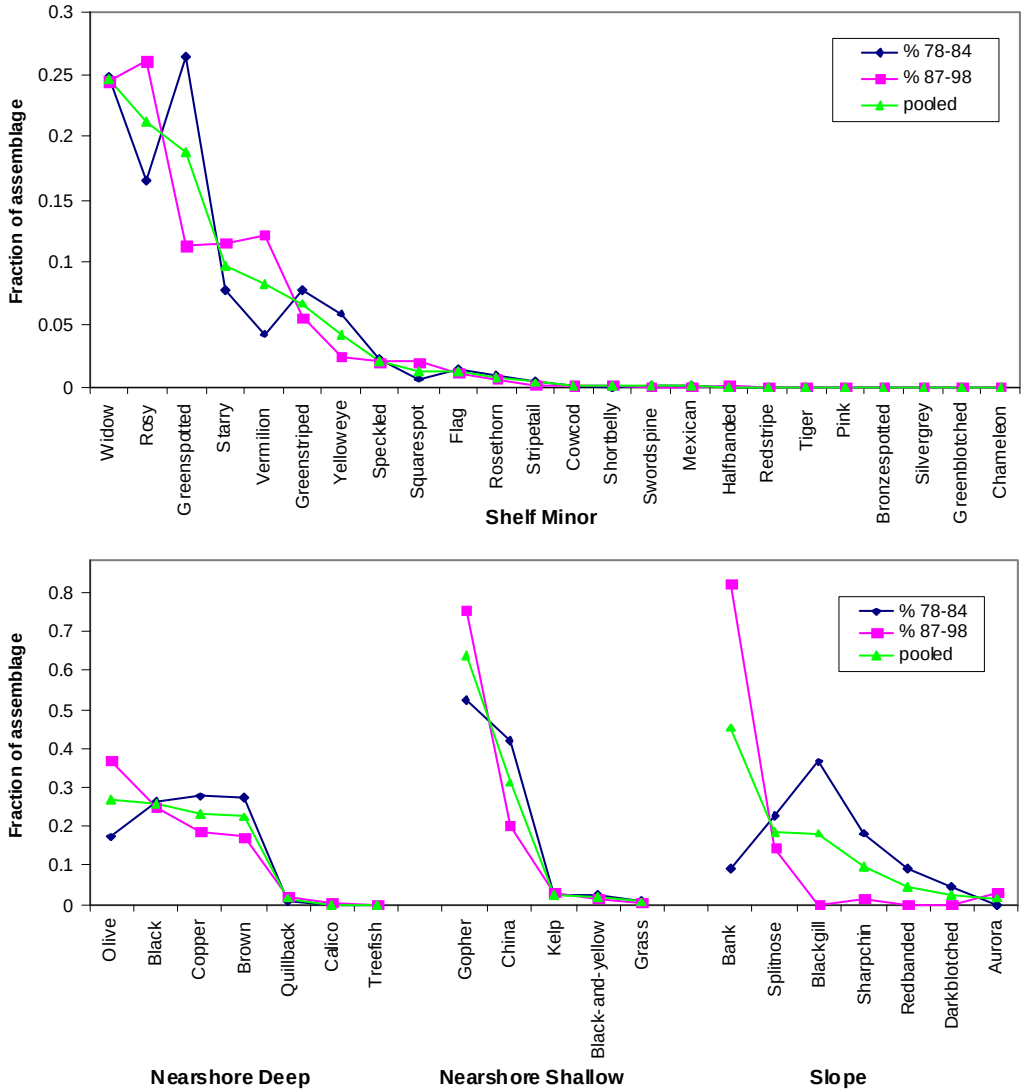


Figures 14a, 14b and 14c: Examples of the species composition by year for three southern California blocks (block 652, 682 and 740, respectively).

Table 2: Species assemblage assignments for recreational rockfish catches

Central/Northern California		Southern California	
Nearshore shallow			
Black-and-yellow rockfish	*S. chrysomelas*	Black-and-yellow rockfish	*S. chrysomelas*
China rockfish	*S. nebulosus*	China rockfish	*S. nebulosus*
Gopher rockfish	*S. carnatus*	Gopher rockfish	*S. carnatus*
Grass rockfish	*S. rastrelliger*	Grass rockfish	*S. rastrelliger*
Kelp rockfish	*S. atrovirens*	Kelp rockfish	*S. atrovirens*
Nearshore Deep			
Black rockfish	*S. melanops*	Black rockfish	*S. melanops*
Blue rockfish	*S. mystinus*	**Blue rockfish**	*S. mystinus*
Brown rockfish	*S. auriculatus*	Brown rockfish	*S. auriculatus*
Calico rockfish	*S. dalli*	Calico rockfish	*S. dalli*
Copper rockfish	*S. caurinus*	Copper rockfish	*S. caurinus*
Olive rockfish	*S. serranoides*	**Olive rockfish**	*S. serranoides*
Quillback rockfish	*S. maliger*	Quillback rockfish	*S. maliger*
Treefish	*S. serriceps*	Treefish	*S. serriceps*
Shelf rockfish			
Bocaccio rockfish	*S. paucispinis*	**Bocaccio rockfish**	*S. paucispinis*
Bronzespotted rockfish	*S. gilli*	Bronzespotted rockfish	*S. gilli*
Canary rockfish	*S. pinniger*	Canary rockfish	*S. pinniger*
Chilipepper rockfish	*S. goodei*	**Chilipepper rockfish**	*S. goodei*
Chameleon rockfish	*S. phillipsi*	Chameleon rockfish	*S. phillipsi*
Cowcod	*S. levis*	Cowcod	*S. levis*
Flag rockfish	*S. rubrivinctus*	Flag rockfish	*S. rubrivinctus*
Greenblotched rockfish	*S. rosenblatti*	Freckled rockfish	*S. lentiginosus*
Greenspotted rockfish	*S. chlorostictus*	Greenblotched rockfish	*S. rosenblatti*
Greenstriped rockfish	*S. elongatus*	Greenspotted rockfish	*S. chlorostictus*
Halfbanded rockfish	*S. semicinctus*	Greenstriped rockfish	*S. elongatus*
Mexican Rockfish	*S. macdonaldi*	Halfbanded rockfish	*S. semicinctus*
Pink rockfish	*S. eos*	Honeycombed rockfish	*S. umbrosus*
Redstripe rockfish	*S. proriger*	Mexican rockfish	*S. macdonaldi*
Rosethorn rockfish	*S. helvomaculatus*	Pink rockfish	*S. eos*
Rosy rockfish	*S. rosaceus*	Pinkrose rockfish	*S. simulator*
Shortbelly rockfish	*S. jordani*	Redstripe rockfish	*S. proriger*
Silvergrey rockfish	*S. brevispinis*	Rosethorn rockfish	*S. helvomaculatus*
Speckled rockfish	*S. ovalis*	Rosy rockfish	*S. rosaceus*
Squarespot rockfish	*S. hopkinsi*	Shortbelly rockfish	*S. jordani*
Starry rockfish	*S. constellatus*	Silvergrey rockfish	*S. brevispinis*
Stripetail rockfish	*S. saxicola*	Speckled rockfish	*S. ovalis*
Swordspine rockfish	*S. ensifer*	Squarespot rockfish	*S. hopkinsi*
Tiger rockfish	*S. nigrocinctus*	Starry rockfish	*S. constellatus*
Vermilion rockfish	*S. miniatus*	Stripetail rockfish	*S. saxicola*
Widow rockfish	*S. entomelas*	Swordspine rockfish	*S. ensifer*
Yelloweye rockfish	*S. ruberrimus*	Tiger rockfish	*S. nigrocinctus*
Yellowtail rockfish	*S. flavidus*	**Vermilion rockfish**	*S. miniatus*
		Widow rockfish	*S. entomelas*
		Yelloweye rockfish	*S. ruberrimus*
		Yellowtail rockfish	*S. flavidus*
Slope rockfish			
Aurora rockfish	*S. aurora*	Aurora rockfish	*S. aurora*
Bank rockfish	*S. rufus*	Bank rockfish	*S. rufus*
Blackgill rockfish	*S. melanostomus*	Blackgill rockfish	*S. melanostomus*
Darkblotched rockfish	*S. crameri*	Darkblotched rockfish	*S. crameri*
Redbanded rockfish	*S. babcocki*	Pacific ocean perch	*S. alutus*
Sharpchin rockfish	*S. zacentrus*	Redbanded rockfish	*S. babcocki*
Splitnose rockfish	*S. diploproa*	Rougheye rockfish	*S. aleutianus*
		Sharpchin rockfish	*S. zacentrus*
		Splitnose rockfish	*S. diploproa*

rockfish in the south; blue, bocaccio, yellowtail, canary, and chilipepper in the north) and estimated species-specific fractions of total catch by block. For the remaining species, we grouped the species into the appropriate assemblages (nearshore shallow, nearshore deep, minor shelf, and minor slope rockfish) and estimated the fraction of the total catch for each assemblage and block. Species assemblage assignments are shown in Table 2. We then applied the species composition for groups of blocks that represented different regions of the coast (e.g., 400s, 500s). For the central California region, we equally weighted the proportion of any given assemblage by species between the 1978-1984 CCRS survey and the 1987-1998 CPFV onboard observer survey (Figure 15a and 15b). Although the latter survey is more data rich, data from the former effort would be likely to more accurately reflect the appropriate time period and reduce, but not eliminate, the consequences of temporal changes in species composition as a



Figures 15a and 15b: Fraction of each species in the various assemblages for the two data sources used to estimate the species composition in central and nouthern California.

result of fishing or changing ocean conditions. However, we acknowledge that weighting these data by the number of sampled fish could be more appropriate.

As there were very few data for northern California, we pooled the species compositions from the 100 and 200 blocks together. For the 600 blocks, which span Point Conception and represented the boundaries of the various sampling programs, distinguishing blocks 600-642 (Morro Bay, Avila Beach region) from blocks 643-700 (Santa Barbara, northern Channel Islands Region). The southern California regions were pooled into six "superblock" regions, as defined by the inshore and offshore regions of 643-699, 700 and 800 blocks together. Figure 16 shows an example of some of the latitudinal trends seen in some of the species from the assemblages (shown as a percentage of that assemblage over space). This approach allowed us to capture these major trends while minimizing the considerable variability in the catches of minor species from poorly sampled blocks and regions. A more focused delineation of the regions and areas used for grouping CDFG blocks might be based on biogeographical boundaries or a statistical evaluation of the species assemblages in different regions (for example, a cluster analysis of the more data-rich blocks could be useful in delineating more appropriate groupings).

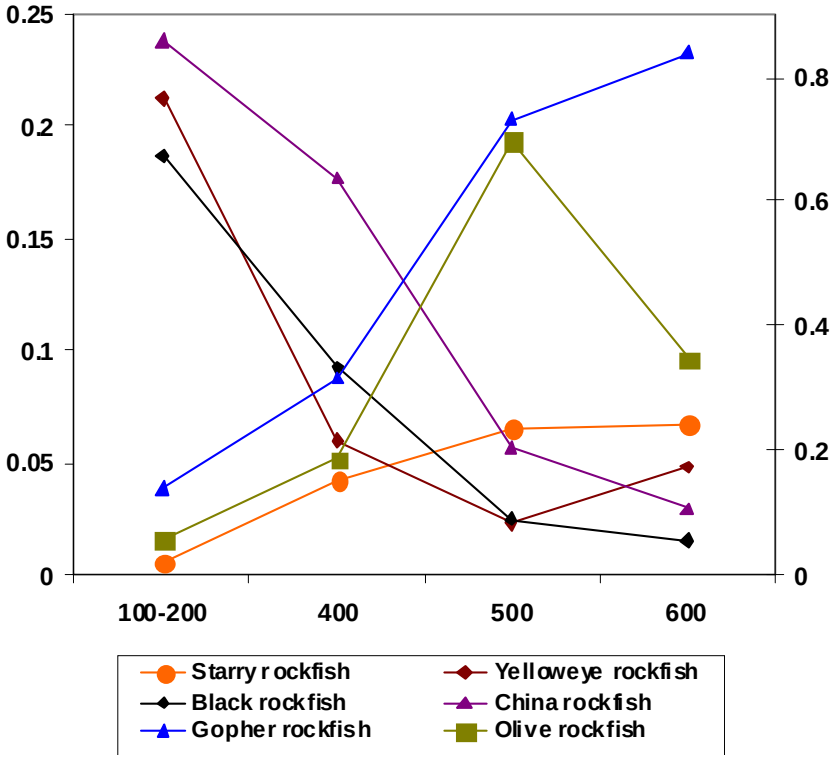


Figure 16: Fraction of catch (within their respective assemblage) for several species of rockfish in the central and northern California region across latitude (via fishing block areas), illustrating some of the changes in relative abundance over space.

Finally, we compared the resulting species composition of the CPFV fleet estimated by this method to the independent species composition of the CPFV fleet estimated by Miller and Gotshall (1965). As Miller and Gotshall based their assumptions of the total CPFV catch on logbook records, we used the unadjusted (for compliance) logbook estimates for this comparison. The results are shown as a bar chart of the relative species composition (Figure 17). Although the relationships are imperfect in general, the total catches of most species are reasonably well correlated. One of the greatest outliers, chilipepper, might be explained by the sporadic nature of large year classes that briefly pulse through these fisheries (a particularly strong 1984 year class resulted in the high catches of chilipepper estimated in the 1987-1998 CPFV onboard observer data set). Although catches of chilipepper were minimal in the Miller and Gotshall (1965) study, they were shown to be high for several years (from 1962-1964) in the species composition studies of the Monterey Bay region recreational fisheries described earlier. These results might also suggest that an equally plausible approach to generating the historical catch reconstructions for this regions may be to interpolate the species compositions of the catch reported in Miller and Gotshall (1965) to those based on either (or both) CCRS and RecFin in the 1980s, particularly if the discrepancies reflect a shift from more vulnerable to more productive species.

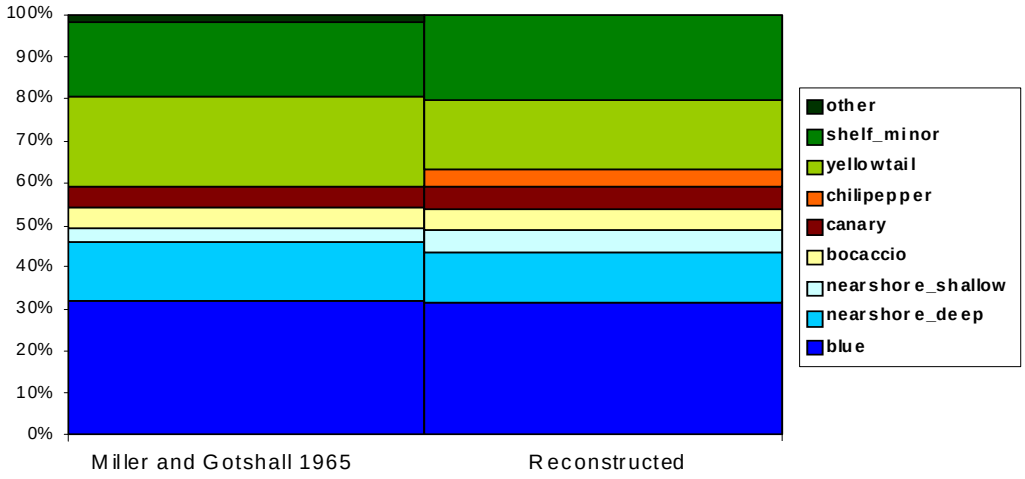


Figure 17 : A comparison of the species composition of the estimated CPFV catch (averaged across the 1958-1961 period) as estimated by Miller and Gotshall (1965) and by this method.

Part III: Species composition of skiff- and shore-mode catches

Unlike the CPFV fishery, there are very few estimates of skiff- and shore-mode total rockfish catches prior to the RecFIN era. The best available information is from Miller and Gotshall (1965) who estimated rockfish catches (by species) by skiff (private or rental boat), pier, shore, and skindiving modes throughout central and northern California between 1958 and 1961. Estimated annual catches of rockfish during that period were just under 12,000 rockfish for the pier mode, just under 10,000 for skindiving mode, just over 35,000 for shore mode and just under 180,000 for skiff mode. The total estimated annual catch of skiff and shore modes was 236,785 rockfish for this period; representing 25.8% of the total rockfish catch in this region and period. Blue and black rockfish were by far the most important species across these modes, although bocaccio (typically encountered only as young-of-year during strong recruitment years) was the most commonly caught species in the pier mode, and brown rockfish was the third-most important (after black, and before blue rockfish) in the pier mode. Grass and black-and-yellow rockfish were also important elements of the shore mode, while copper, brown, canary and gopher rockfish were other important components of the skiff catch.

No estimates of total rockfish catch or of species composition exist between this short study and the RecFIN (post-1980) era.[2] Consequently, we took the following approach for estimating catches in these groups. First, noticing that the approximate proportions of rockfish catches in the different fishing modes (skiff, pier and shore) had changed little between the early study and the RecFIN era, we pooled all "skiff and shore" modes into a single pool to facilitate the reconstruction. A more careful evaluation of the shore mode would be warranted in future analyses. Second, we explicitly linked the trend in skiff- and shore-mode total-rockfish catches to the trend in CPFV catches as reflected in the CPFV logbooks, under the assumption that the year to year shifts in rockfish catches in the logbook programs represented (at least in part) changes in the availability of more desirable target species (e.g., salmon, California halibut, striped bass). This was done both as a projection to the 1980 (RecFIN) era, as well as retrospectively based on a constant fraction of the CPFV catch prior to the period covered by this study. However, this method led to a significant underestimation of the skiff and shore mode catches by the 1980s as estimated in RecFIN, as by the early 1980s, skiff and shore modes accounted for 43% of the total central and northern California rockfish catch, up from 25% in the 1958-1961 study.

Consequently, we used a linear ramp between 1962 and 1980, with an incremental increase in skiff and shore mode recreational catches each year, such that the projected catches from our method for the early 1980s (years that we do not actually "use") was equal to the average RecFIN catches over that period. Furthermore, this ramp-up was species-specific for the top five species in each region (Table 2), and assemblage-specific for the remaining species, to

[2] Although there are limited data on the species composition of recreational catches currently available from 1962-1972 from the previously mentioned skiff and CPFV monitoring programs in Monterey Bay (and potentially additional information for the San Francisco region that could be keypunched from paper records and utilized), we have not yet incorporated these data into our reconstruction efforts.

capture relative changes in the species composition of these catches. Although there are few data with which to justify this simple approach, the method is reasonably consistent with a nearly linear increase in the sale of sportfishing and hunting licenses from the late 1930s through the mid-1970s, during which period the number of licenses sold grew from 0.4 million to nearly 2.2 million per year (Figure 18; P. Reilly, CDFG, pers. com.). Similarly, Miller and Odemar (1968) document a significant increase in skiff effort relative to CPFV effort between their 1958-1960 study and their 1966 study. For Monterey, Santa Cruz, San Mateo and San Francisco sport fisheries, they estimated an annual average of ~39,000 angler days on CPFV vessels and 38,000 on skiff/private boats for the 1958-1960 period. In 1966 they estimated a comparable number (38,000; a 2.1% decline) of CPFV fishing days but nearly double (60,000; a 58.7% increase) the number of skiff/private vessel fishing days.

For southern-California skiff- and shore-mode fisheries, there is considerably less information. Pinkas et al. (1968) report on skiff- and shore-mode fisheries for the 1965-1966 period, for which they estimated skiff and private-boat catches of 51,500 rockfish per year, pier and jetty catches of just under 4,000 per year, and shore mode catches of just over 1,000 per year. This represented less than 10% of the total estimated rockfish recreational catch of 660,000 fish per year, thus more than 90% of the catch came

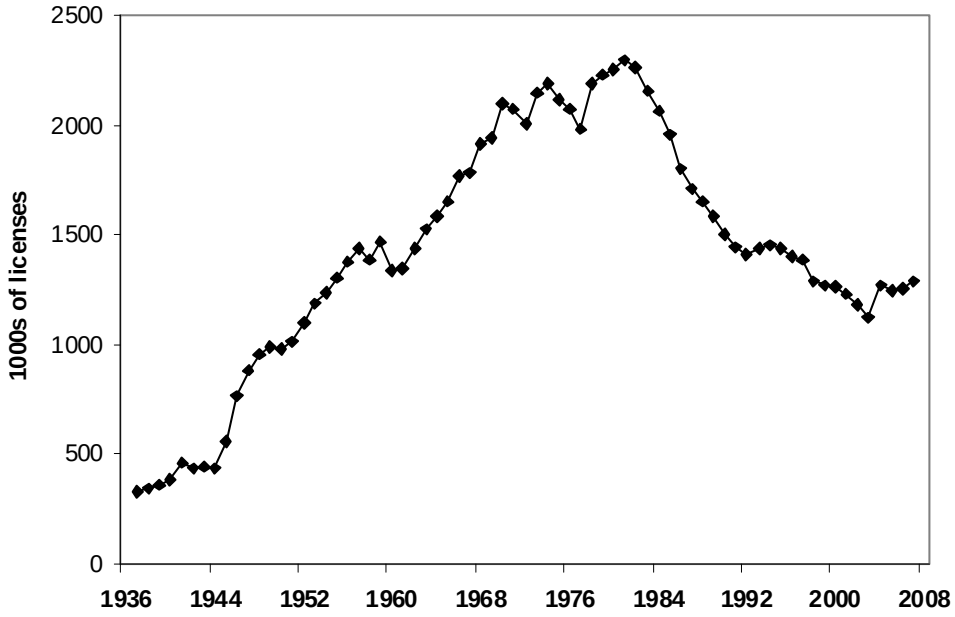


Figure 18: Total number of California sportfishing and hunting licenses issued from the late 1930s through 2007 (P. Reilly, CDFG, pers. com.)

from the CPFV fleet. By contrast, by the early 1980s, RecFIN estimates of skiff and shore mode catches averaged 1.8 million fish per year, representing 44.7% of the total recreational rockfish catch in the southern California region (note: we exclude the 1980 RecFIN catch estimates from this analysis, as the estimate for this year is double the estimate for any of the following years

and has often been considered highly questionable). As with the central- and northern-California total-catch numbers, we linked the trend in skiff- and shore-mode catches to the trend in CPFV catches, and subsequently included a linear ramp-up in order to equal the 1981-1985 average skiff- and shore-mode rockfish catch. Unfortunately, only the shoreline catches in the Pinkas et al. (1968) study included species information (with grass, olive and kelp rockfish as the most important species respectively); such that virtually no information on the species composition of the catch is available prior to 1980. Consequently, we used the species composition for skiff and shore modes from the first five years of the RecFIN program to estimate the historical species composition of the skiff- and shore-mode fisheries.

Part IV: Total Biomass of Catches

Thus far, all reconstructions have been done in numbers of fish, rather than weights. As size information is even more sparse than species composition information for most historical periods, there are few data available to evaluate trends in size over time in the pre-RecFIN era (although see Mason 1998, which was specific to Monterey Bay). As the current stock assessment modeling framework used for most west coast groundfish assessments (Stock Synthesis, version 3) is capable of using either numbers of fish or total catch biomass for estimating removals, numbers of fish are likely to be the most reasonable currency for historical (and perhaps contemporary) recreational catches. However, given that many assessments may need to pool recreational catches with commercial catches, particularly when the recreational component is minor (e.g., widow rockfish), we produced estimates of catches by species in both numbers and biomass.

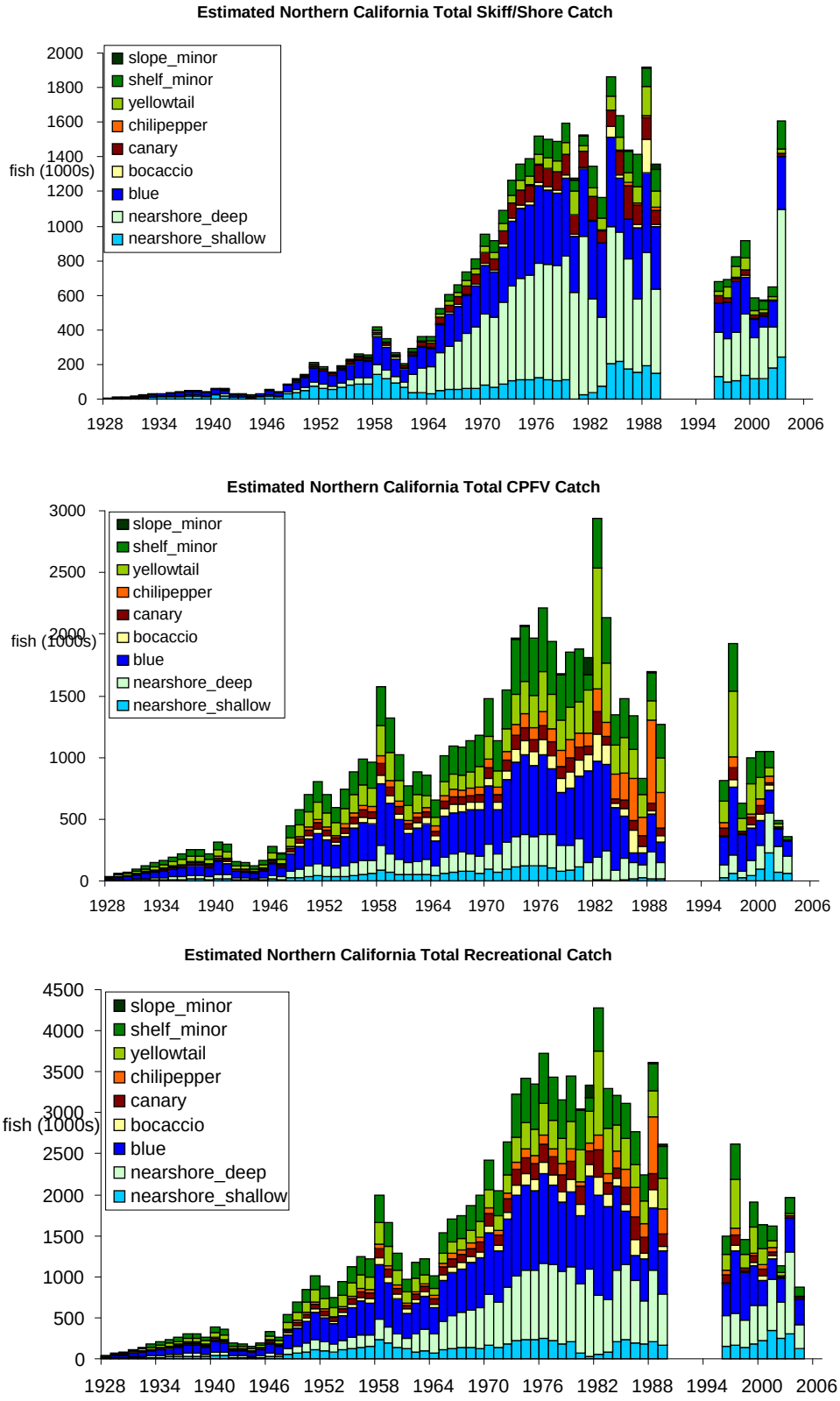
To estimate the biomass of catches in central and northern California, we simply interpolated between the mean weights reported in Miller and Gotshall (1965) and the average weight by species from the first five years of RecFIN data. In most instances there was a modest to significant decline in average weight, for example 0.59 to 0.51 kg mean weight for blue rockfish, 1.2 to 0.8 kg mean weight for chilipepper rockfish, 1.1 to 0.6 kg mean weight for brown rockfish. There was little or no change for bocaccio, olive, canary or yellowtail rockfish and modest increases in average size for cowcod, copper and quillback rockfish. For southern California species, we used length information from the 1975-1978 CPFV onboard observer data to estimate weights (using weight/length relationships from assessments when available or Love et al. 2002 otherwise) for species that either are being assessed in this stock assessment cycle or have been assessed in recent cycles; including blue, bocaccio, chilipepper, canary, cowcod, bronzespotted, gopher, greenspotted, greenstriped, widow and yelloweye. For all other species we used average RecFIN weights for the 1980-1984 period when available by species, and mean weights of *Sebastes* for species with little or no data in the RecFIN database. This inconsistency was due to time constraints, although a comparison of the mid-70s average sizes with early 1980s average sizes did not indicate drastic differences by method. For several of the smaller or dwarf species (e.g., honeycomb, pygmy, shortbelly, splitnose) we used the mean weights of rosy rockfish, rather than the mean weights of all rockfish, as proxies. As with other aspects of the reconstruction efforts, the approach for estimating the biomass of catches would benefit by a more rigorous investigation, which might include a comparison of trends and variability in

predicted average weight from the raw data relative to that predicted internally in models that utilize catch in numbers of fish (and convert these numbers to mass internally).

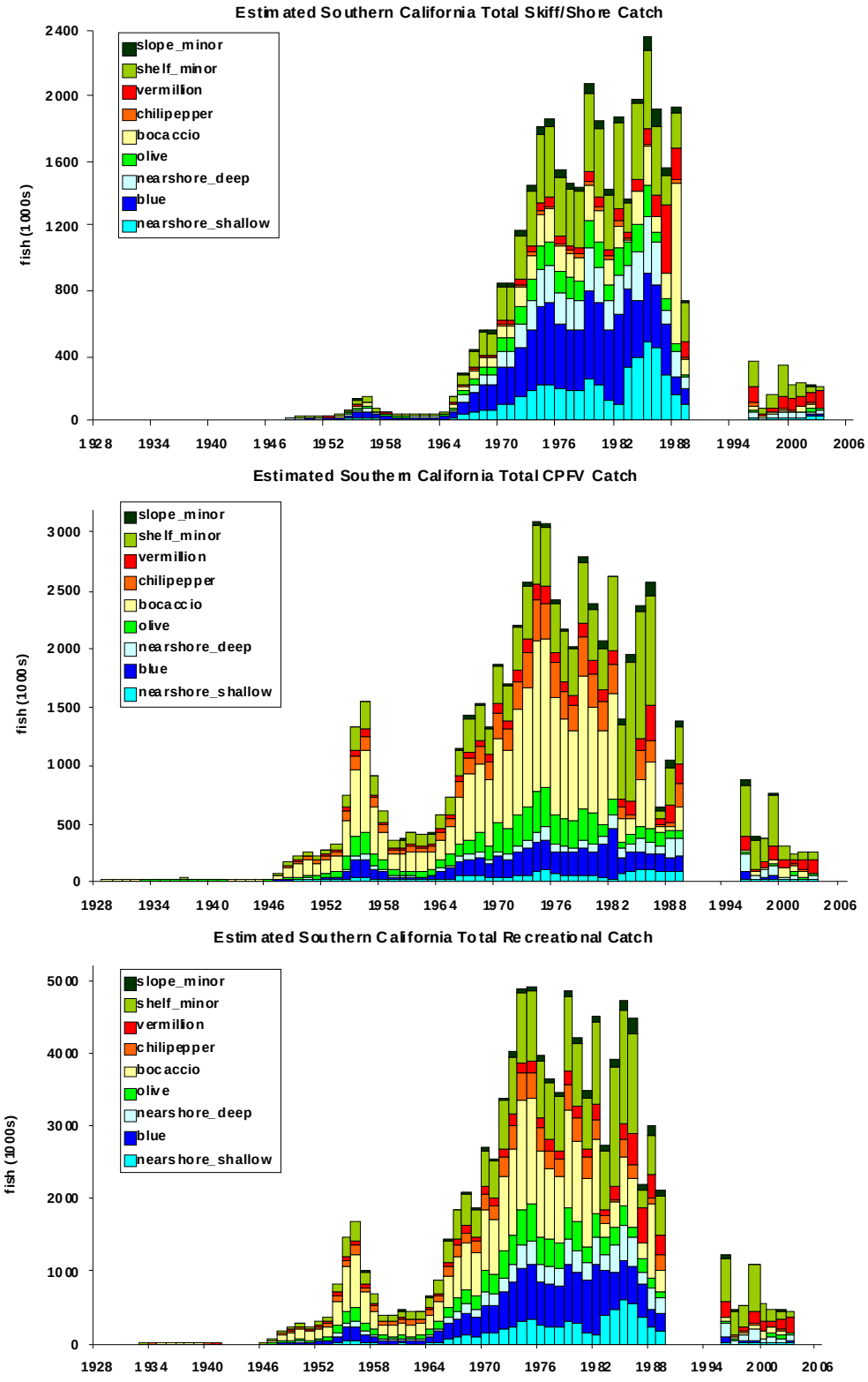
Results

The resulting estimates of CPFV, skiff and shore modes, and total recreational catch for northern and central California Fisheries for the 1928-1980 period are summarized in Appendix F and are available in digital form upon request to J. Field (John.Field@noaa.gov) or M. Key (mkey@dfg.ca.gov). These results are also shown in Figures 19a, 19b and 19c which reflect the different fisheries (CPFV versus skiff and shore modes) as well as the total catch, for the five most common (CPFV) species and the remaining assemblages (Figures include RecFIN estimates for 1981 to 2003 for the purposes of scale, excluding the period of incomplete RecFIN sampling from 1990-1995). Between 1928 and 1980, we estimate that over 60 million rockfish were caught in recreational fisheries in this region, with an estimated total weight of 47,800 metric tons. Nearly a third of the total catch (in numbers) were blue rockfish, with black, yellowtail, copper, canary, rosy and olive rockfish being (sequentially) the next most important species. Catches increased from an annual average of 0.25 million fish (approximately 200 tons) in the late 1930s, were estimated (perhaps unfairly) to be 0 during the war era, and grew to an average of 1.3 million fish (1,000 tons) per year in the late 1950s, to 1.7 million fish (1,400 tons per year) in the late 1960s and to 3.2 million fish (2,500 tons per year) in the late 1970s.

Comparable estimates for southern California recreational catches are also shown in Figures 20a, 20b and 20c, which reflect CPFV, skiff/shore and total catches respectively. Interestingly, both the total number of estimated rockfish caught (62.8 million) and the total weight (48,200 metric tons) are very similar to the estimates in the central and northern California region. Bocaccio were estimated as the most frequently caught species, accounting for 23% of the total catch (by number) between 1928 and 1980, with blue rockfish a close second at 18.5% (by number), followed by olive, chilipepper, greenspotted, copper and vermilion rockfish. Although the CPFV fishery initially developed in southern California, rockfish catches were minimal into the late 1930s, with an average of 35,000 fish caught per year (versus nearly ten times that amount in the north in the same period). There was a significant pulse of effort in the mid-1950s, with rockfish catches increasing from less than half a million fish in 1953 to 1.8 million fish in 1956, although catches dropped back to below half a million fish by 1959. This pulse may have been associated with declines in warm water species in response to changing ocean conditions (MacCall 1996). Average annual catches increased again by the late 1960s to an average of 1.8 million fish, and grew to over 4 million fish per year by 1973, and fluctuated between 4 and 5 million fish per year from the early 1970s through the 1980s.



Figures 19a, 19b and 19c: Estimated total catches (by number) for CPFV (top), skiff/shore (center) and all modes combined (bottom) for the northern California region, 1928-2003.



Figures 20a, 20b and 20c: Estimated total catches (by number) for skiff/shore (top), CPFV (center) and all modes combined for the southern California region, 1928-2003.

Discussion and Direction of Future Efforts for the Recreational Reconstruction

As stated at the beginning of this section, we consider this to be an interim product that will continue to undergo further refinement and analysis. In our opinion, the results are an improvement over most of the *ad hoc* methods used in the past to generate historical catches of rockfish by species, and should represent reasonable approximations of historical catches in the absence of conflicting evidence to the contrary for specific species. However, we readily acknowledge that the catch estimates for some species may benefit from greater scrutiny, and we are ready and willing to revisit elements of the estimation or undertake additional focused sensitivity analysis at the request of assessment authors. A great many possibilities for additional efforts have already been entertained or contemplated (see below) and will be evaluated further in future efforts. Several of the most important outstanding issues and remaining uncertainties (in our collective opinions) are highlighted below:

- Reconciling the difference between CPFV logbook numbers and RecFIN catch estimates is the key issue; at this point we base our estimates on what seems to be a reasonable estimate of compliance rates, but it is unlikely that this rate can be estimated with greater precision, or that it has been constant over time. This will likely remain as one of the greatest sources of uncertainty in estimating historical catches.

- Finding the means to relocate and keypunch the additional species composition data collected for central California recreational fisheries from 1961-1972 would be immensely valuable, using these data for these regions is likely to be superior than the current block/species composition approach currently used, particularly for some key "boom/bust" species that reflect strong year classes moving through fishery (e.g., bocaccio and chilipepper).

- Re-evaluating the species composition data by block for southern California using the 1980s CPFV onboard observer data is a key priority, and can be done reasonably rapidly based on the recent analysis by CDFG to assign fishing locations to blocks (with the recognition that many such areas span multiple blocks and will require some fractionation of the catch to blocks in a reasonable fashion). In both southern and central/northern areas, it might be useful to consider factor or cluster analysis methods that might facilitate an improved grouping of blocks or regions.

- Alternative approaches might compare simply hindcasting the observed MRFSS species composition of the catch backwards in time to the approach using the block-specific data. It may be that some form of model averaging of several approaches like this would be a useful product, or might allow us to assess confidence at some gross level. We have explored this to a limited degree in southern California, where differences are not major for the most commonly encountered species.

- Catch estimates could and should be reported (or made available) over finer spatial scales, particularly for the regions North and South of Cape Mendocino. Data from

southern Oregon could potentially be incorporated to a more focused effort for this region, and the availability of any such data for the early period should be explored.

- We have not yet made any effort to address or estimate discards historically; our default recommendation would be for assessment authors to use a constant rate based on RecFIN estimates or the rates reported in the CPFV onboard observer databases.

Similarly, we have made no efforts to develop catch estimates from the recreational fishery for non-rockfish species. The primary rationale for this was that the rockfish are the most difficult group to deal with, and that once a satisfactory approach for addressing rockfish could be developed, the same methods could be applied somewhat easily to other (non-*Sebastes*) groundfish encountered in CPFV and other recreational fisheries.

Data Access

The catch reconstruction data resides in the SQL Server CATCH_RECONSTRUCTION database on the PINNIGER server. In addition, the final commercial landings are duplicated in the CALCOM database on the PORICHTHYS server. These databases can be accessed through ODBC connections. The final catch reconstruction data can be accessed through the California Cooperative Groundfish Survey website (calcomfish.ucsc.edu). Due to rules governing confidentiality, some data are not available to offsite users including landing receipts and vessel-specific sample data.

ODBC connections are a simple way of connecting various software packages to relational databases. Software like Excel, ACCESS, SAS, R, etc... can easily access the database. ODBC drivers are typically installed by default on all Windows machines. On Apple computers, ODBC drivers must be purchased (about $40 per seat). Drivers for other operating systems are available and can be found on the internet. The following describes how to make connections from Windows. Some of the information is relevant to other operating systems including driver (SQL Server), Server Name (128.114.3.187), and protocol (TCP/IP). Setting up ODBC connections is a simple process. To access the PORICHTHYS server, no VPN is required. To access the PINNIGER server from outside the NOAA Wide-Area Network (WAN), a VPN connection is required (contact Don Pearson for more information). The first step in the process is to obtain a database login from Don Pearson. The next step is to make the ODBC connection using the following steps:

START->SETTINGS->CONTROL PANEL->ADMINISTRATIVE TOOLS->ODBC

Under the User DSN tab:
Press ADD
On the driver list scroll down to SQL Server and press FINISH
Give it a name (any name will work, for example CALCOM)
under Server, type 128.114.3.187
Press NEXT

Choose “With SQL Server authentication” ...
Enter the Login ID provided to you - not case sensitive
Enter the Password provided to you - case sensitive
Under CLIENT CONFIGURATION
    select TCP/IP
    unselect Dynamically Determine Port and enter 1433 for
        the port number
    Press OKAY
Press NEXT
Press NEXT
Press FINISH
Press TEST DATA SOURCE
    It should respond Tests Completed Successfully
Press OKAY
Press OKAY
Press OKAY - this closes it and you are ready to go

If you have problems, please contact D. Pearson for assistance (Don.Pearson@noaa.gov).

Acknowledgments

We would like to thank Steve Crooke, Frank Henry, Tom Jow, Dick Nitsos, Dave Ono, Joe Penisi, Tom Ghio, and Mike McCorkle for their invaluable contributions at the experts meeting. Paul Reilly and Deb Wilson-Vandenberg also participated and assisted with that discussion. We express our appreciation to Kevin O’Connor for his outstanding work on the literature search and data entry. Also, Jan Mason also kindly shared information that assisted our effort. Lastly, Gina Schmidt’s (CDFG) assistance with GIS issues is greatly appreciated.

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Appendix A – Members of the California Catch Reconstruction Working Group

The working group responsible for the development and review of the material presented in this document was composed of the following individuals, which included four NOAA Fisheries employees and three California Department of Fish and Game employees.

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Appendix B – Table Structures

RECON_COM_LANDS

COLUMN NAME	DATA TYPE	NULLS	COMMENTS
YEAR	INTEGER	N	
SPECIES	VARCHAR(5)	N	
REGION_CAUGHT	INTEGER	N	
GEAR	VARCHAR(5)	N	
POUNDS	REAL	N	
SOURCE	VARCHAR(25)	N	

Notes:
Year: 1916-1968 for rockfish, 1931-1968 for non-rockfish
Region_caught: 2=Crescent City, Eureka, Fort Bragg; 3=Inside San Francisco Bay, 4=Bodega Bay, San Francisco, Half Moon Bay, 5=Monterey, 6=Morro Bay, Santa Barbara, 7=Los Angeles, 8=San Diego
Gear: TWL=trawl (rockfish only), OTH=non-trawl (rockfish only), UNK=unknown (rockfish only), ALL (non-rockfish only)
Source: Don Interp=Interpolated values for 1938, non-rockfish based on values in 1937 and 1939, Don Block=landings of non-rockfish based on block-summary data, RECON1=reconstructed rockfish landings (done by Steve Ralston)

RECON_REC_LANDS

COLUMN NAME	DATA TYPE	NULLS	COMMENTS
YEAR	INTEGER	N	
AREA	VARCHAR(10)	N	
SPECIES	VARCHAR(5)	N	
POUNDS	INTEGER	N	
FREQ	INTEGER	N	

Notes:
Area: North=North of Pt. Conception, S=South of Pt. Conception
Freq: Count of the number of fish

BLOCK_SUMMARY

COLUMN NAME	DATA TYPE	NULLS	COMMENTS
REGION	INTEGER	Y	
YEAR	INTEGER	Y	
MARK_CAT	INTEGER	Y	
MONTH	INTEGER	Y	
BLOCK	INTEGER	Y	
POUNDS	NUMERIC	Y	
AREA	VARCHAR(25)	Y	
IMPORTED	CHAR(1)	Y	
REGION_CAUGHT	INTEGER	Y	

Notes:
Region: 1=northern, 2=Eureka/Fort Bragg, 3=San Francisco Bay and Delta, 4=San Francisco Ocean, 5=Monterey, 6=Morro Bay/Santa Barbara, 7=San Pedro, 8=San Diego
Block: CDFG block number
Area: Area caught (Landed in California); northern California, central California, southern California, central America, central Pacific, Hawaii, Mexico, Oregon, SF Bay, South America, South of U.S., Unknown, Washington, Western Pacific
Imported: Imported fish are not included in this table
Region_Caught: Based on the file the data were in or block number

ALL_CA_LRCPTS

COLUMN NAME	DATA TYPE	NULLS	COMMENTS
TICKET	VARCHAR(8)	N	
YEAR	INTEGER	N	
MONTH	INTEGER	Y	
DAY	INTEGER	Y	
BOAT_NO	VARCHAR(8)	Y	
PORT	INTEGER	Y	
MCAT	INTEGER	Y	
GEAR	INTEGER	Y	
LBS	NUMERIC	Y	
GEAR_GRP	CHAR(4)	Y	
PORT_COMPLEX	CHAR(4)	Y	
PPP	VARCHAR(15)	Y	
COMMENTS	VARCHAR(50)	Y	
MOD_TICKET	VARCHAR(15)	Y	
YEAR_STR	CHAR(4)	Y	
REVISED_GEAR_GRP	VARCHAR(4)	Y	
CDFG_BLOCK	NCHAR(10)	Y	

Notes:
Ticket: Ticket number
Port: CDFG port code
Mcat: Market Category
Gear: CDFG gear code
Gear_grp: assigned gear group eg..TWL, HKL, ...
Port_complex: assigned port complex eg..ERK, MNT,...
PPP: Price per pound
Mod_Ticket: internal use
Year_str: internal use
Revised_gear_grp: internal use
CDFG_block: block number

CDFG_TRAWL_EFFORT

COLUMN NAME	DATA TYPE	NULLS	COMMENTS
YEAR	INTEGER	Y	
MONTH	INTEGER	Y	
BLOCK	INTEGER	Y	
NO_DRAGS	INTEGER	Y	
MINUTES_FISHED	INTEGER	Y	

CDFG_TRAWL_LOG_SUMMARY

COLUMN NAME	DATA TYPE	NULLS	COMMENTS
YEAR	INTEGER	N	
MARK_CAT	INTEGER	N	
BLOCK	INTEGER	Y	
LBS	NUMERIC	Y	
REGION_CAUGHT	INTEGER	Y	
AREA	VARCHAR(25)	Y	

Notes:
Region_caught: based on file, CDFG region code where fish were caught (not necessarily landed).

COM_LANDS

COLUMN NAME	DATA TYPE	NULLS	COMMENTS
YEAR	CHAR(4)	N	
QUARTER	CHAR(1)	N	
LIVE	CHAR(1)	N	
MARK_CAT	INTEGER	N	
GEAR_GRP	CHAR(3)	N	
PORT_COMPLEX	CHAR(3)	N	
SPECIES	VARCHAR(4)	N	
POUNDS	NUMERIC	N	
SOURCE	VARCHAR(20)	N	

Notes:
Quarter: quarterly interval during year (1-4)
Live: Landed live or not (Y or N)
Source: method used to estimate landing - refer to CALCOM documentation

FISHERY_STATS_FINAL

COLUMN NAME	DATA TYPE	NULLS	COMMENTS
YEAR	FLOAT	Y	
AREA	VARCHAR(25)	Y	
REGION	FLOAT	Y	
GEAR_GRP	VARCHAR(25)	Y	
SPECIES	VARCHAR(25)	Y	
MCAT	FLOAT	Y	
POUNDS	FLOAT	Y	

RECON_COMM_ALL_SPECIES

COLUMN NAME	DATA TYPE	NULLS	COMMENTS
SPECIES	VARCHAR(5)	N	
YEAR	INTEGER	N	
REGION	INTEGER	N	
GEAR	VARCHAR(5)	Y	
POUNDS	NUMERIC	Y	

NOTES:
Species: Rockfish landings are from 1916-1968 and are from Steve Ralston's reconstruction. Non-rockfish are summarized from the block_summary table and are from 1931-1968 (excluding 1938).
Region: For rockfish, regions 1 and 2 are combined, for non-rockfish, regions 1-8 are separate.

Gear: For rockfish, types are TWL=Trawl, OTH=non-trawl, UNK=Unknown. For non-rockfish, all gears are listed as Unknown.

REC_SAMPLES

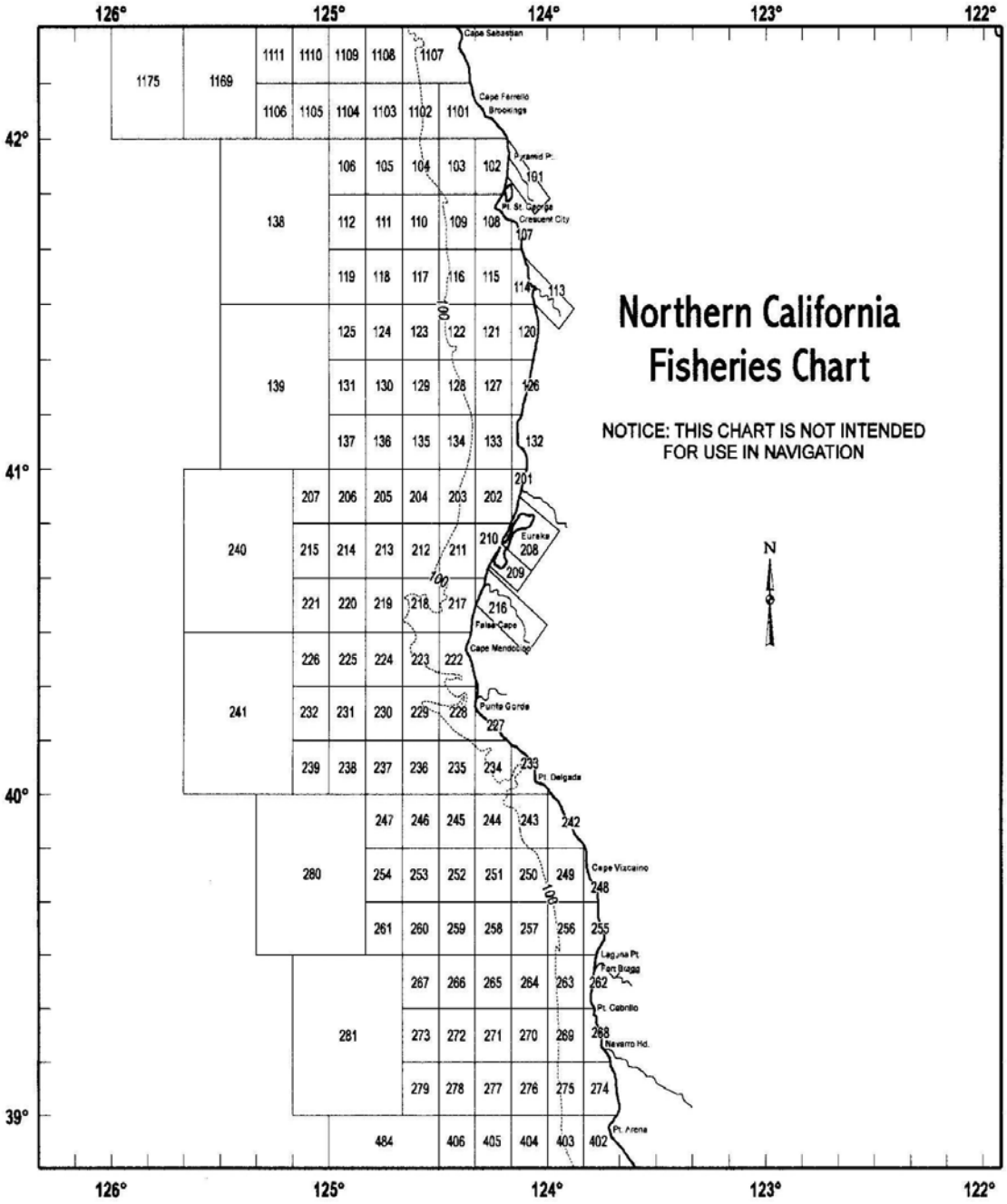
COLUMN NAME	DATA TYPE	NULLS	COMMENTS
SAMPLE_NO	VARCHAR(11)	N	
SAMPLE_DATE	DATE	N	
CAL_PORT	VARCHAR(15)	N	
TRIP_NO	NUMERIC	Y	
SAMPLER	VARCHAR(4)	Y	
BOAT_NO	VARCHAR(7)	Y	
MIN_DEPTH	NUMERIC	Y	
MAX_DEPTH	NUMERIC	Y	
CDFG_BLOCK	NUMERIC	Y	

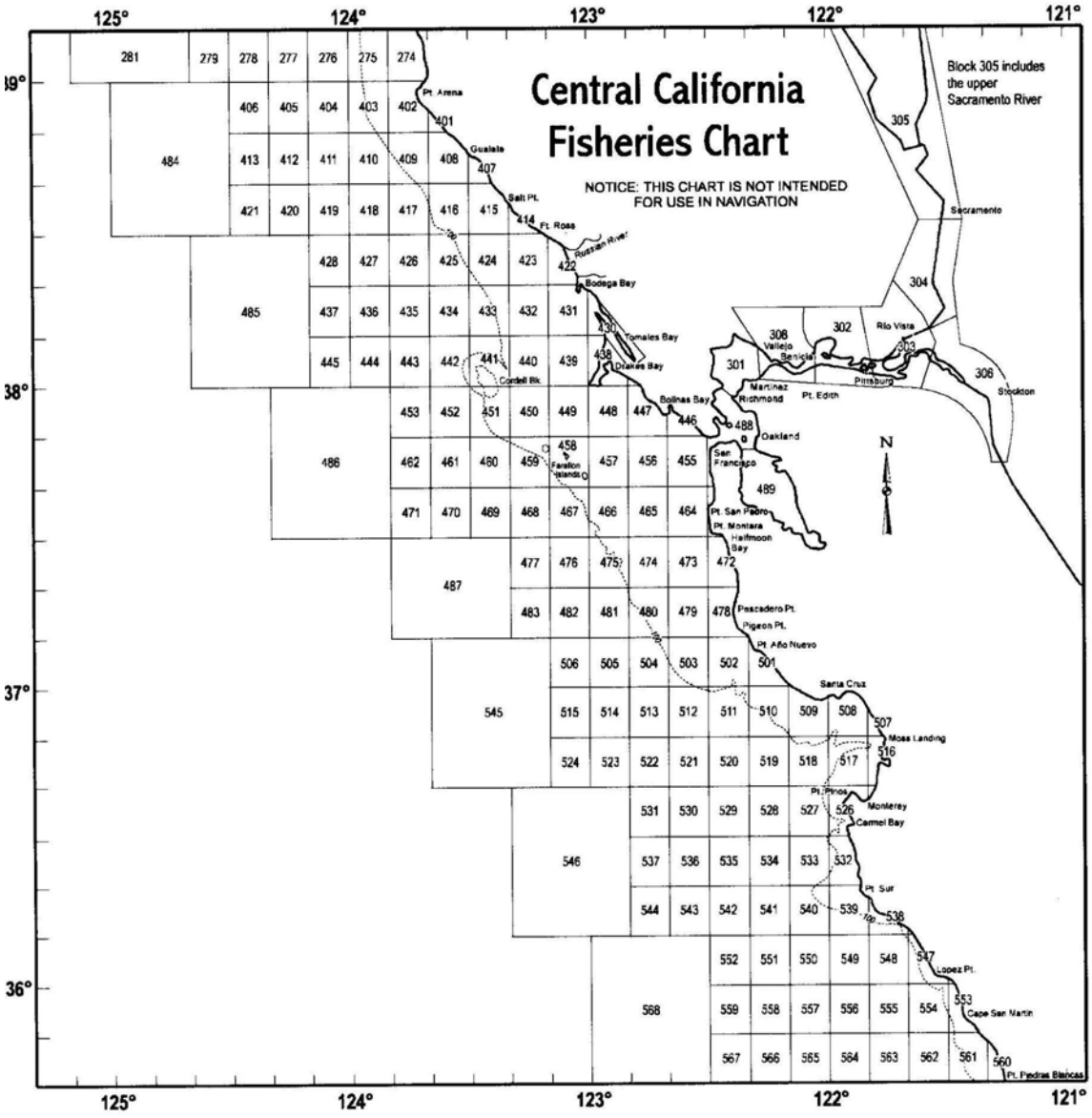
REC_SAMPLES

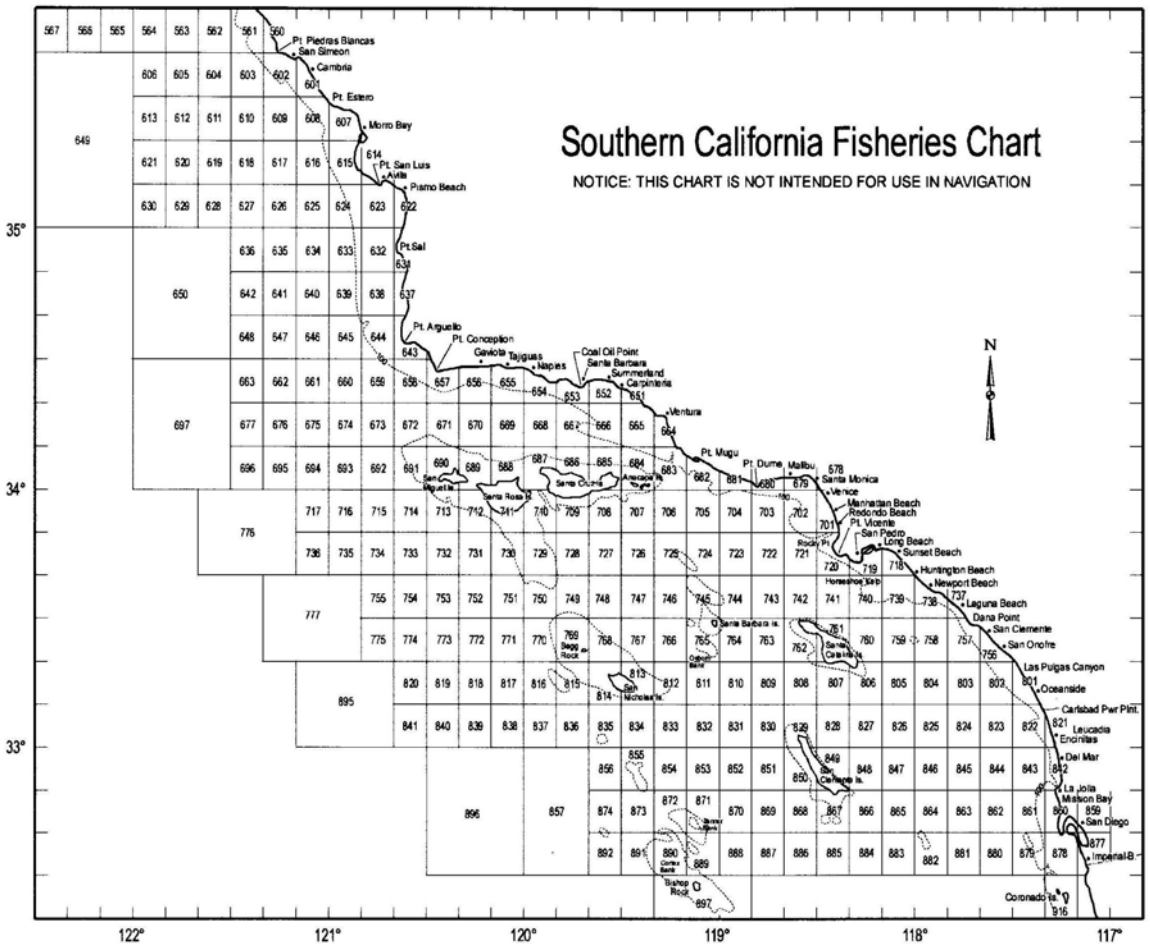
COLUMN NAME	DATA TYPE	NULLS	COMMENTS
SAMPLE_NO	VARCHAR(11)	N	
FISH_NO	NUMERIC	N	
SPECIES	VARCHAR(4)	N	
SEX	NUMERIC	N	
FLENGTH	NUMERIC	Y	
MATURITY	NUMERIC	Y	UNRELIABLE
WEIGHT	NUMERIC	Y	RARE
AGE	NUMERIC	Y	

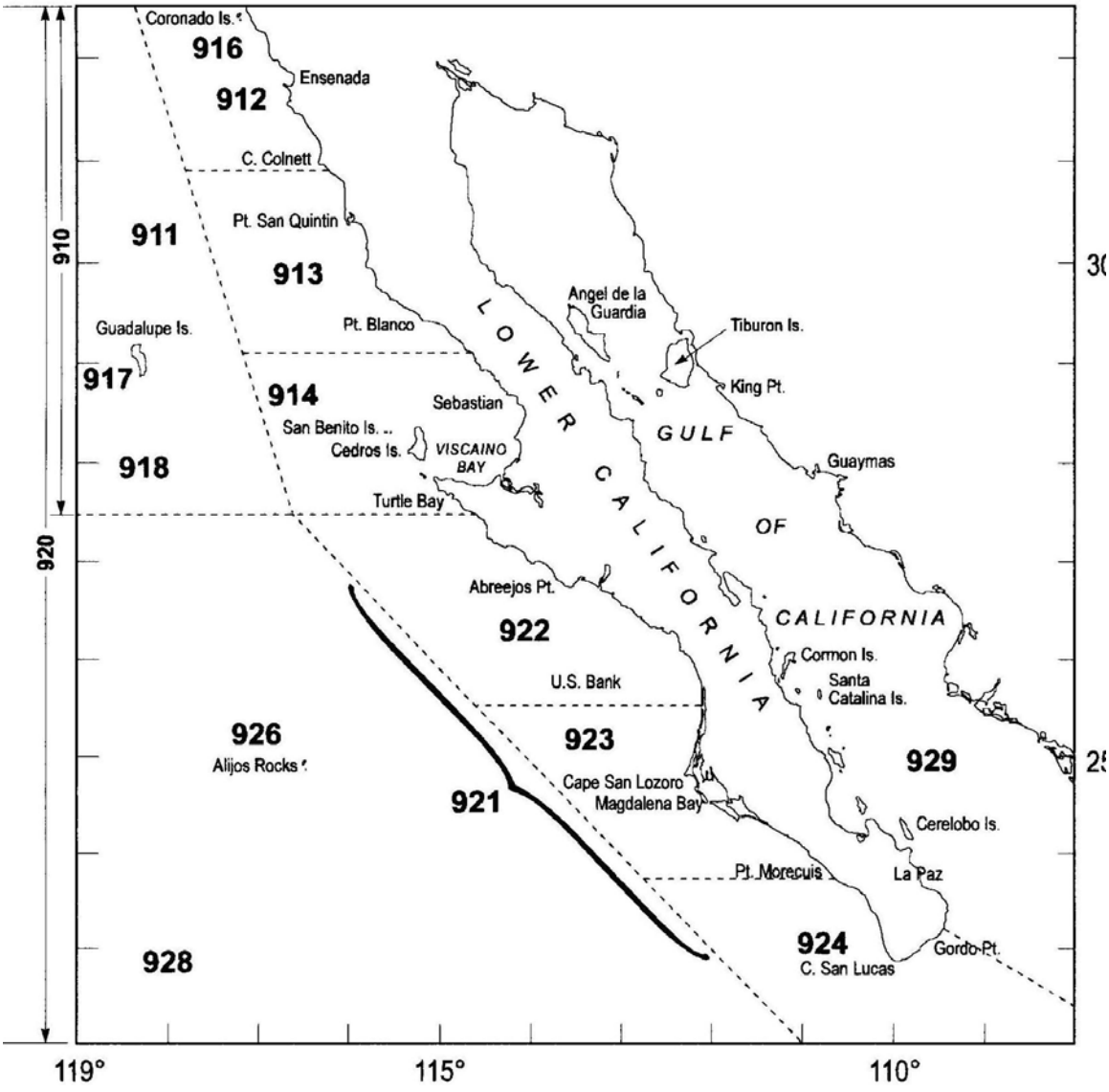
[do we include a description of the CPFV logbook or Recreational Block Summary tables????]

Appendix C – California Department of Fish and Game Block Charts




Central California
Fisheries Chart
NOTICE: THIS CHART IS NOT INTENDED
FOR USE IN NAVIGATION
Block 305 includes
the upper
Sacramento River
125°
124°
123°
122°
121°
39°
38°
37°
36°
Pt. Arena
Gualala
Salt Pt.
Ft. Ross
Russian River
Bodega Bay
Tomales Bay
Drakes Bay
Cordell Bk
Bolinas Bay
Farallon Islands
Oakland
San Francisco
Pt. San Pedro
Pt. Montara
Halfmoon Bay
Pescadero Pt.
Pigeon Pt.
Pt. Año Nuevo
Santa Cruz
Moss Landing
Pt. Pinos
Monterey
Carmel Bay
Pt. Sur
Lopez Pt.
Cape San Martin
Pt. Piedras Blancas
Sacramento
Rio Vista
Vallejo
Benicia
Martinez
Richmond
Pt. Edith
Pittsburg
Stockton
N


Southern California Fisheries Chart
NOTICE: THIS CHART IS NOT INTENDED FOR USE IN NAVIGATION
N
Pt. Piedras Blancas
San Simeon
Cambria
Pt. Estero
Morro Bay
Pt. San Luis
Avila
Pismo Beach
Pt.Sal
Pt. Arguello
Pt. Conception
Gaviota
Tajiguas
Naples
Coal Oil Point
Santa Barbara
Summerland
Carpinteria
Ventura
Pt. Mugu
Pt. Dume
Malibu
Santa Monica
Venice
Manhattan Beach
Redondo Beach
Pt. Vicente
San Pedro
Long Beach
Sunset Beach
Huntington Beach
Newport Beach
Laguna Beach
Dana Point
San Clemente
San Onofre
Las Pulgas Canyon
Oceanside
Carlsbad Pwr Plnt.
Leucadia
Encinitas
Del Mar
La Jolla
Mission Bay
San Diego
Imperial B
Coronado Is.
Santa Barbara Is.
Santa Cruz Is.
San Nicholas Is.
Bishop Rock
Begg Rock
Santa Rosa Is.
Santa Cruz Is.
Anacapa Is.
San Miguel Is.
Rocky Pt.
Horseshoe Kelp
Cortes Bank
Osborn Bank
Tanner Bank
35°
34°
33°
122°
121°
120°
119°
118°
117°


Coronado Is.
916
Ensenada
912
C. Colnett
911
Pt. San Quintin
913
910
Guadalupe Is.
Pt. Blanco
917
914
Sebastian
San Benito Is.
Cedros Is.
VISCAINO BAY
918
Turtle Bay
920
Abreejos Pt.
922
U.S. Bank
926
Alijos Rocks
923
921
Cape San Lozoro
Magdalena Bay
929
Cerelobo Is.
Pt. Morecuis
La Paz
928
924
C. San Lucas
Gordo Pt.
Angel de la Guardia
Tiburon Is.
King Pt.
Guaymas
LOWER CALIFORNIA
GULF OF CALIFORNIA
Cormon Is.
Santa Catalina Is.
119°
115°
110°

Appendix D – Listing of "Rockfish" Market Categories in the CALCOM Database

Market Category	Description	Nominal Species
245	Rockfish, cowcod	CWCD
246	Rockfish, copper (whitebelly)	COPP
247	Rockfish, canary	CNRY
248	Yelloweye rockfish	YEYE
249	Rockfish, vermilion	VRML
250	Rockfish, unspecified	URCK
251	Rockfish, black-and-yellow	BYEL
252	Rockfish, black	BLCK
253	Rockfish, bocaccio	BCAC
254	Rockfish, chilipepper	CLPR
255	Rockfish, greenspotted	GSPT
256	Rockfish, starry	STAR
257	Rockfish, darkblotched	DBRK
258	Rockfish, China	CHNA
259	Rockfish, yellowtail	YTRK
260	Scorpionfish	SCOR
262	Thornyheads	THDS
263	Rockfish, gopher	GPHR
264	Rockfish, pinkrose	PRRK
265	Rockfish, yelloweye	YEYE
266	large red rockfish	URCK
267	Rockfish, brown	BRWN
268	Rockfish, rosy	ROSY
269	Rockfish, widow	WDOW
270	Rockfish, splitnose	SNOS
271	Rockfish, Pacific ocean perch	POP
285	Rockfish, pelican (China)	URCK
651	Rockfish, olive	OLVE
652	Rockfish, grass	GRAS
653	Rockfish, pink	PNKR
654	Rockfish, greenstriped	GSRK
655	Rockfish, copper	COPP
657	Rockfish, flag	FLAG
658	Rockfish, treefish	TREE
659	Rockfish, kelp	KLPR
660	Rockfish, honeycomb	HNYC
661	Rockfish, greenblotched	GBLC
662	Rockfish, bronzespotted	BRNZ
663	Rockfish, bank	BANK

664	Rockfish, rosethorn	RSTN
665	Rockfish, blue	BLUR
666	Rockfish, squarespot	SQRS
667	Rockfish, blackgill	BLGL
668	Rockfish, stripetail	STRK
669	Rockfish, speckled	SPKL
670	Rockfish, swordspine	SWSP
671	Rockfish, calico	CLCO
672	Rockfish, shortbelly	SBLY
673	Rockfish, chameleon	CMEL
674	Rockfish, aurora	ARRA
675	Rockfish, redbanded	RDBD
676	Rockfish, Mexican	MXRF
678	Thornyhead, longspine	LSPN
679	Thornyhead, shortspine	SSPN
956	Rockfish, group bocaccio/chili	URCK
957	Rockfish, group bolina	USHR
958	Rockfish, group deepwater reds	RCK3
959	Rockfish, group red	URCK
960	Rockfish, group small	URCK
961	Rockfish, group rosefish	RCK6
962	Rockfish, group gopher	URCK
963	Rockfish, large red	URCK
970	Rockfish, quillback	QLBK
971	Rockfish, group canary/vermili	RCK8
972	Rockfish, group black/blue	RCK9
973	Nearshore Rockfish	USHR
974	Shelf Rockfish	USLF
975	Slope Rockfish	USLP
976	Deep Nearshore Rockfish	UDNR
977	all rf mcats - ratio	URCK
998	Rockfish, Live-well mix	URCK

Appendix E – Programs Used in Commercial Rockfish Landings Reconstructions

RECON-01.SAS: Take raw Access block-summary data and create a SAS database (*blksum0*) that includes the key stratification variables: year, market category, area, and mtons. Some market categories and areas are redefined. Season can be included later when the trawl block summary monthly data are available.

RECON-02.SAS: Uses that Heimann-Carlisle data and the FB-105 data to extend the block-summary data to fill in the 1916-1930 period, as well as the missing year of data (1938). This is done by calculating the proportion of the total rockfish catch by area from 1916-30 and 1938 from FB-105 data and applying the proportions to the total catch data from Heimann & Carlisle, yielding direct estimates of rockfish catch by area. The rockfish catch by area data are further decomposed into market categories using the proportional distribution of market category catches by area obtained from the 1931-32 and 1937+1939 block-summary data. The estimated data are labeled with a TYPE=H label, whereas the original block-summary data are labeled TYPE=B. The new database is named *blksum1*.

RECON-03.SAS: Takes the raw Access trawl block-summary data and creates a SAS database (*twlsum0*) that includes the key stratification variables: year, market category, area, and mtons. Some market categories are redefined. Season can be included later when the monthly data have been keypunched.

RECON-04.SAS: Calculates the proportion of all landings that were trawl in 1925-26 and applies those proportions to all landings from 1916-1924 to estimate trawl landings. The extended trawl landing data set is *twlsum1*.

RECON-05.SAS: Determines the proportion trawl catch out of the total catch using the 1960, 1965, and fish-ticket data. Exported to an Excel spreadsheet 'p_trawl_recpt.xls'. The data are stratified by year, region, and rockfish market category.

RECON-06.SAS: Determines the proportion trawl catch out of the total catch using the 1956 block summary and trawl block-summary data. Exported to an Excel spreadsheet 'p_trawl_recpt.xls'. The data are stratified by year, region, and rockfish market category.

P_TRAWL_RECPT.XLS: This Excel spreadsheet actually sparses the results from Recon-5.sas and Recon-6.sas and interpolates the proportion of the total catch taken in trawl fisheries for all rockfish market categories from 1957 - 1968. The interpolated values are exported in the file '*p_trawl_interp.prn*' for use in Recon-07.sas

RECON-07.SAS: Reads the interpolated proportion trawl values from 1957-68 and applies them to the block-summary data, stratified by market category, year, and region. The resulting estimates of trawl landings are appended to the trawl block-summary data, creating a continuous time series from 1916-68. The new extended trawl landing data set is twlsum2. None of the original trawl block-summary data from 1957 are utilized. A variable TYPE is created with a

value of 'I' for the interpolated estimates (1957-68) and a value of 'T' for the original trawl block-summary data.

RECON-08.SAS: Retrieve the complete block summary and trawl block-summary data sets. Correct for an apparent deficit of trawl catches during the period 1944-47 by forming a ratio estimator of sum_trawl ÷ sum_total, based on the 6 years on either side of this period. Apply the estimator to the block-summary data for the years in question and update the trawl block-summary data set. Combine the block-summary data (blksum1) and the trawl block-summary data (twlsum2) and compute the non-trawl catch by difference according to year, market category, and area strata. Using the 1955 fish tickets, correct for odd behavior in area 2 during 1955, where some trawl catches exceeded total catches (a discontinued code for group red was used). Use the trawl and non-trawl catches to create a new stratification variable = gear and create a final, complete SAS database with the result (complete).

RECON-09.SAS: Estimate the species composition of rockfish market categories by gear and area from the 1978-84 time period. The composition for MC-250 in area 2 (Eureka) is modified to exclude the high widow catches that initiated the great widow rockfish hunt. Catches of nominal market categories are set aside. Species compositions are then sparsed over the entire 1916-68 time period and merged with the catch data. Species-specific catches are estimated for sampled strata (market category-area-gear) and catches without samples are set aside. The compositions are collapsed over the gear stratum leaving samples by market category-area and these are applied where possible. The compositions are collapsed over area and are applied to the remaining strata with no samples. The various types of estimates are reassembled and summarized.

RECON-01.SAS

```
options pagesize=max linesize=80;
libname save "c:\historical catch";
* THIS SECTION CREATES A LOOKUP OF ALL OF THE 'ROCKFISH' MARKET CATEGORIES;
proc import out=work.marketcats datatable="dbo_market_categories" dbms=access2000 replace;
  database="c:\historical catch\calcom.mdb";
data marketcats;
  set marketcats;
  if species_group='ROCK';
  keep market_category nominal_species species_group;
  rename market_category=mark_cat;
proc sort data=marketcats;  by mark_cat;
* THIS SECTION ASSEMBLES THE BLOCK-SUMMARY DATA INTO PROPER STRATA, INCLUDING
  REGION, GEAR, MARKET CATEGORY, AND YEAR.  THE DATA ARE SPLIT INTO TWO
  COMPONENTS (UNSPECIFIED ROCKFISH AND NOMINAL ROCKFISH), WHICH ARE TREATED SEPARATELY;
proc import out=work.blocksum datatable="dbo_block_summary" dbms=access2000 replace;
  database="c:\historical catch\calcom.mdb";
data blocksum;
  set blocksum;
  if mark_cat=285 then mark_cat=258;          *reassigns pelican rockfish (unspecified) to china rockfish;
  if mark_cat=963 then mark_cat=959;          *reassigns 'rockfish, large red' to 'rockfish, group red';
  if mark_cat=998 then delete;                *drops 'rockfish, live-well mix' (called bait priot to 1968);
  if (region_caught ge 1) and (region_caught le 8);
  if region_caught=1 then region_caught=2;    *assign Crescent City catches to Eureka/Ft Bragg;
  if region_caught=3 then region_caught=4;    *assign delta catches to San Francisco;
  totl_mt=pounds/2204.6;
  keep year mark_cat totl_mt region_caught;
proc sort data=blocksum;
  by mark_cat;
data blocksum;
  merge blocksum marketcats;
  by mark_cat;
  if species_group='ROCK';                     *includes the rockfish nominal species names for clarity;
  if totl_mt=. then delete;                    *deletes valid rockfish market categories with no catch;
proc sort data=blocksum;
  by mark_cat year region_caught;
```

```
proc means data=blocksum noprint;
  var totl_mt;
  by mark_cat year region_caught;
  id nominal_species;
  output out=stratot sum=totl_mt;
data save.blksum;
  set stratot;
  drop _type_ _freq_;
proc print data=save.blksum;
run;
```

RECON-02.SAS

```
options pagesize=max linesize=80;
libname save "c:\historical catch";
data heimann;
  infile "c:\historical catch\heimann.dat";
  input year rockctch;
data fb105;
  infile "c:\historical catch\fb105.dat" firstobs=2;
  input year p_socal p_cencal p_norcal;
data byarea;
  merge heimann fb105;
  by year;
  s_catch = rockctch*p_socal;
  c_catch = rockctch*p_cencal;
  n_catch = rockctch*p_norcal;
  drop rockctch p_socal p_cencal p_norcal;
proc transpose data=byarea out=region;
  by year;
data region;
  set region;
  if _name_='s_catch' then region='S';
  if _name_='c_catch' then region='C';
  if _name_='n_catch' then region='N';
  drop _name_;
  rename col1=regnctch;
proc sort data=region;
  by year region;
data extend;
  set save.blksum0;
  if (year le 1932) or year=1937 or year=1939;
  if year le 1932 then period=1;
    else period=2;
  if region_caught=2 then region='N';
  if region_caught=4 or region_caught=5 then region='C';
  if region_caught ge 6 then region='S';
  drop mark_cat nominal_species;
proc sort data=extend;
  by period region;
proc freq data=extend;
  tables region_caught / noprint out=regprop;
  by period region;
  weight totl_mt;
data regprop;
  set regprop;
  prop = percent/100;
  if period=1 then do;
    do year=1916 to 1930;
      output;
      end;
    end;
  if period=2 then do;
    year=1938;
      output;
    end;
  drop count percent;
proc sort data=regprop;
  by year region;
data regctch;
  merge regprop region;
  by year region;
  catch = prop*regnctch;
  drop prop regnctch region;
proc sort data=regctch;
  by year region_caught;
data extend;
  set save.blksum0;
  if (year le 1932) or year=1937 or year=1939;
```

```
  if year le 1932 then period=1;
    else period=2;
proc sort data=extend;
  by period region_caught;
proc freq data=extend;
  tables mark_cat / noprint out=mc_gprop;
  by period region_caught;
  weight totl_mt;
data mc_gprop1 mc_gprop2;
  set mc_gprop;
  prop = percent/100;
  if period=1 then output mc_gprop1;
  if period=2 then output mc_gprop2;
  drop count percent;
data mc_gprop1;
  set mc_gprop1;
  do year=1916 to 1930;
    output;
        end;
data mc_gprop2;
  set mc_gprop2;
  year=1938;
data periods;
  set mc_gprop1 mc_gprop2;
proc sort data=periods;
  by year region_caught;
data estimates;
  merge regctch periods;
  by year region_caught;
  totl_mt = prop*catch;
  type = 'H';
  drop prop catch period;
data save.blksum1;
  set save.blksum0 estimates;
  if type='' then type='B';
proc sort data=save.blksum1;
  by mark_cat year region_caught;
proc print;
run;
```

RECON-03.SAS

```
options pagesize=max linesize=80;
* THIS SECTION CREATES A LOOKUP OF ALL OF THE 'ROCKFISH' MARKET CATEGORIES;
proc import out=work.marketcats datatable="dbo_market_categories" dbms=access2000 replace;
  database="c:\historical catch\calcom.mdb";
data marketcats;
  set marketcats;
  if species_group='ROCK';
  keep market_category nominal_species species_group;
  rename market_category=mark_cat;
proc sort data=marketcats;  by mark_cat;
* THIS SECTION BRINGS IN THE TRAWL BLOCK-SUMMARY DATA AND PREPARES IT FOR USE;
libname save 'c:\historical catch\trawl quarterly';
proc import out=work.trawlsum datatable="dbo_cdfg_trawl_log_summary" dbms=access2000 replace;
  database="c:\Historical Catch\calcom.mdb";
data trawlsum;
  set trawlsum;
  if mark_cat=285 then mark_cat=258;   *reassigns pelican rockfish (unspecified) to china rockfish;
  if mark_cat=963 then mark_cat=959;   *reassigns 'rockfish, large red' to 'rockfish, group red';
  if mark_cat=998 then delete;         *drops 'rockfish, live-well mix' (called bait priot to 1968);
  if (region_caught ge 1) and (region_caught le 8);
  if region_caught=1 then region_caught=2;    *assign Crescent City catches to Eureka/Ft Bragg;
  if region_caught=3 then region_caught=4;    *assign delta catches to San Francisco;
  trwl_mt = lbs/2204.6;
  keep year mark_cat trwl_mt region_caught;
proc sort data=trawlsum;  by mark_cat;
data trawlsum;
  merge trawlsum marketcats;
  by mark_cat;
  if species_group='ROCK';             *only allows rockfish market categories;
  if trwl_mt=. then delete;            *removes unobserved market categories;
proc sort data=trawlsum;
  by mark_cat year region_caught;
proc means data=trawlsum noprint;
  var trwl_mt;
  by mark_cat year region_caught;
  id nominal_species species_group;
  output out=stratwl sum=trwl_mt;
data stratwl;
```

```
  set stratwl;
  drop _type_ _freq_;
run;
```

RECON-04.SAS

```
options pagesize=max linesize=80;
libname save "c:\historical catch";
data trawl2526;
  set save.twlsum0;
  if year=1925 or year=1926;
proc sort data=trawl2526;
  by mark_cat region_caught;
proc means data=trawl2526 noprint;
  var trwl_mt;
  by mark_cat region_caught;
  output out=sumtrwl sum=;
data block2526;
  set save.blksum1;
  if year=1925 or year=1926;
proc sort data=block2526;
  by mark_cat region_caught;
proc means data=block2526 noprint;
  var totl_mt;
  by mark_cat region_caught;
  output out=sumtotl sum=;
data combine;
  merge sumtotl sumtrwl;
  by mark_cat region_caught;
  if trwl_mt=. then trwl_mt=0;
  p_trwl = trwl_mt/totl_mt;
  keep mark_cat region_caught p_trwl;
data catch;
  set save.blksum1;
  if year lt 1925;
  drop type nominal_species;
proc sort data=catch;
  by mark_cat region_caught;
data estimate;
  merge catch combine;
  by mark_cat region_caught;
  trwl_mt = p_trwl*totl_mt;
  if trwl_mt=0 then delete;
  drop p_trwl totl_mt;
data save.twlsum1;
  set estimate save.twlsum0;
proc print data=save.twlsum1;
run;
```

RECON-05.SAS

```
options pagesize=max linesize=80;
* IMPORT THE 1960 FISH TICKETS;
*proc import out=work.fishtick datatable="dbo_ca_1960_lrcpt_data" dbms=access2000 replace;
*  database="c:\historical catch\fishtick60.mdb";
* IMPORT THE 1965 FISH TICKETS;
*proc import out=work.fishtick datatable="dbo_ca_1965_lrcpt_data" dbms=access2000 replace;
*  database="c:\historical catch\fishtick65.mdb";
* THIS DATA STEP WORKS FOR THE 1960 AND 1965 TABLES, A SEPARATE ONE IS NEEDED FOR THE 1969 RECEIPTS;
*data fishtick;
*  set fishtick;
*  qtr = int((mon-1)/3)+1;
*  keep yr mark_cat lbs port gear qtr;
* IMPORT THE 1969 FISH TICKETS;
*proc import out=work.fishtick datatable="dbo_all_ca_lrcpts" dbms=access2000 replace;
*  database="c:\historical catch\fishtick69.mdb";
* USE THIS DATA STEP FOR THE 1969 RECEIPTS ONLY;
*data fishtick;
*  set fishtick;
*  qtr = int((month-1)/3)+1;
*  keep year mcat lbs port gear qtr;
*  rename year=yr mcat=mark_cat;
* THIS SECTION CREATES A LOOKUP OF ALL OF THE 'ROCKFISH' MARKET CATEGORIES AND SUBSETS THE DATA;
proc import out=work.marketcats datatable="dbo_market_categories" dbms=access2000 replace;
  database="c:\historical catch\calcom.mdb";
data marketcats;
  set marketcats;
  if species_group='ROCK';
  keep market_category nominal_species species_group;
  rename market_category=mark_cat;
```

```
proc sort data=marketcats;
  by mark_cat;
proc sort data=fishtick;
  by mark_cat;
data fishtick;
  merge fishtick marketcats;
  by mark_cat;
  if species_group='ROCK';                    *includes the rockfish nominal species names for clarity;
  if lbs=. then delete;
proc sort data=fishtick;
  by gear;
* THIS SECTION CREATES A LOOKUP OF TRAWL VS. NON-TRAWL GEAR CODES;
proc import out=work.gears datatable="dbo_gear_codes" dbms=access2000 replace;
  database="c:\historical catch\calcom.mdb";
data gears;
  set gears;
  if (gear_grp='TWL' or gear_grp='MDT') then type='T';
     else type='N';
  keep cdfg_code type;
  rename cdfg_code=gear;
proc sort data=gears;
  by gear;
data fishtick;
  merge fishtick gears;
  by gear;
  if lbs=. then delete;                          *drops gears with no positive catch;
  if type='' then type='N';                      *3 records of gear=45, which is undefined (38 lbs total);
  drop gear species_group nominal_species;
  rename type=gear;
* THIS SECTION CREATES A LOOKUP OF PORT CODES;
proc import out=work.ports datatable="dbo_port_codes" dbms=access2000 replace;
  database="c:\historical catch\calcom.mdb";
data ports;
  set ports;
  if port_complex='BDG' then region_caught=4;
  if port_complex='BRG' then region_caught=2;
  if port_complex='CRS' then region_caught=2;
  if port_complex='ERK' then region_caught=2;
  if port_complex='MNT' then region_caught=5;
  if port_complex='MRO' then region_caught=6;
  if port_complex='OCA' then region_caught=.;
  if port_complex='OLA' then region_caught=7;
  if port_complex='OSB' then region_caught=6;
  if port_complex='OSD' then region_caught=8;
  if port_complex='OSF' then region_caught=4;
  keep cdfg_code port_complex region_caught;
  rename cdfg_code=port;
proc sort data=ports;
  by port;
proc sort data=fishtick;
  by port;
data fishtick;
  merge fishtick ports;
  by port;
  if lbs=. then delete;                          *drops ports with no positive catch;
  if port=753 or port=766 then region_caught=7;  *accounts for two LA ports not in the market category table;
  if port=894 then region_caught=8;              *accounts for one SD port not in the market category table;
  if port=77 or port=55056 or port=77078 then delete;    *1965 receipts with bogus port codes (38 lbs total);
  drop port port_complex;
proc sort data=fishtick;
  by mark_cat region_caught gear;
* ACCUMULATE THE CATCH BY MARKET CATEGORY, REGION, AND GEAR AND CALCULATE THE PROPORTION TRAWL;
proc means data=fishtick noprint;
  var lbs;
  by mark_cat region_caught gear;
  output out=sumdata sum=sumlbs;
proc transpose data=sumdata out=proptrwl;
  by mark_cat region_caught;
  id gear;
data proptrwl;
  set proptrwl;
  if _name_='sumlbs';
  if n=. then n=0;
  if t=. then t=0;
  totlbs = n + t;
  p_trwl = t/totlbs;
  keep mark_cat region_caught p_trwl;
proc print data=proptrwl noobs;
  format p_trwl 10.8;
```

```
run;
```

RECON-06.SAS

```
options pagesize=max linesize=80;
* THIS SECTION CREATES A LOOKUP OF ALL OF THE 'ROCKFISH' MARKET CATEGORIES;
proc import out=work.marketcats datatable="dbo_market_categories" dbms=access2000 replace;
  database="c:\historical catch\calcom.mdb";
data marketcats;
  set marketcats;
  if species_group='ROCK';
  keep market_category nominal_species species_group;
  rename market_category=mark_cat;
proc sort data=marketcats;  by mark_cat;
* THIS SECTION ASSEMBLES THE BLOCK-SUMMARY DATA INTO PROPER STRATA, INCLUDING
  REGION, GEAR, MARKET CATEGORY, AND YEAR.  THE DATA ARE SPLIT INTO TWO
  COMPONENTS (UNSPECIFIED ROCKFISH AND NOMINAL ROCKFISH), WHICH ARE TREATED SEPARATELY;
proc import out=work.blocksum datatable="dbo_block_summary" dbms=access2000 replace;
  database="c:\historical catch\calcom.mdb";
data blocksum;
  set blocksum;
  if mark_cat=285 then mark_cat=258;   *reassigns pelican rockfish (unspecified) to china rockfish;
  if mark_cat=963 then mark_cat=959;   *reassigns 'rockfish, large red' to 'rockfish, group red';
  if mark_cat=998 then delete;         *drops 'rockfish, live-well mix' (called bait priot to 1968);
  if (region_caught ge 1) and (region_caught le 8);
  if region_caught=1 then region_caught=2;    *assign Crescent City catches to Eureka/Ft Bragg;
  if region_caught=3 then region_caught=4;    *assign delta catches to San Francisco;
       *we use region_caught because region is often missing,
        when region is missing we assign region_caught based on block number;
  totl_mt=pounds/2204.6;
  keep year mark_cat totl_mt region_caught;
proc sort data=blocksum;
  by mark_cat;
data blocksum;
  merge blocksum marketcats;
  by mark_cat;
  if year=1956;
  if species_group='ROCK';
  if totl_mt=. then delete;
proc sort data=blocksum;
  by mark_cat year region_caught;
proc means data=blocksum noprint;
  var totl_mt;
  by mark_cat year region_caught;
  output out=stratot sum=totl_mt;
data stratot;
  set stratot;
  drop _type_ _freq_;
proc sort data=stratot;
  by year mark_cat region_caught;
* THIS SECTION BRINGS IN THE TRAWL BLOCK-SUMMARY DATA AND PREPARES IT FOR USE;
libname save 'c:\historical catch\trawl quarterly';
proc import out=work.trawlsum datatable="dbo_cdfg_trawl_log_summary" dbms=access2000 replace;
  database="c:\Historical Catch\calcom.mdb";
data trawlsum;
  set trawlsum;
  if mark_cat=285 then mark_cat=258;   *reassigns pelican rockfish (unspecified) to china rockfish;
  if mark_cat=963 then mark_cat=959;   *reassigns 'rockfish, large red' to 'rockfish, group red';
  if mark_cat=998 then delete;         *drops 'rockfish, live-well mix' (called bait priot to 1968);
  if (region_caught ge 1) and (region_caught le 8);
  if region_caught=1 then region_caught=2;    *assign Crescent City catches to Eureka/Ft Bragg;
  if region_caught=3 then region_caught=4;    *assign delta catches to San Francisco;
  trwl_mt = lbs/2204.6;
  keep year mark_cat trwl_mt region_caught;
proc sort data=trawlsum;  by mark_cat;
data trawlsum;
  merge trawlsum marketcats;
  by mark_cat;
  if year=1956;
  if species_group='ROCK';             *only allows rockfish market categories;
  if trwl_mt=. then delete;            *removes unobserved market categories;
proc sort data=trawlsum;
  by mark_cat year region_caught;
proc means data=trawlsum noprint;
  var trwl_mt;
  by mark_cat year region_caught;
  output out=stratwl sum=trwl_mt;
data stratwl;
  set stratwl;
  drop _type_ _freq_;
```

```
proc sort data=stratwl;
  by year mark_cat region_caught;
* COMBINE THE BLOCK-SUMMARY DATA AND THE TRAWL BLOCK-SUMMARY DATA AND CALCULATE THE PROPORTION TRAWL;
data proptrwl;
  merge stratot stratwl;
  by year mark_cat region_caught;
  if trwl_mt=. then trwl_mt=0;
  p_trwl = trwl_mt/totl_mt;
proc print;
  var year mark_cat region_caught p_trwl;
run;
```

RECON-07.SAS

```
options pagesize=max linesize=80;
libname save "c:\historical catch";
* READ IN THE INTERPOLATED PROPORTION TRAWL FOR EACH YEAR, MARKET CATEGORY, AND AREA FROM 1957-68;
data interp;
  infile "c:\historical catch\p_trawl_interp.prn" firstobs=2;
  input mark_cat region_caught year p_trawl;
proc sort data=interp;
  by year mark_cat region_caught;
* EXTRACT THE TOTAL ROCKFISH LANDINGS FROM 1957-68 FROM THE BLOCK-SUMMARY DATA;
data blksum5768;
  set save.blksum1;
  if year ge 1957;
  keep year mark_cat region_caught totl_mt;
proc sort data=blksum5768;
  by year mark_cat region_caught;
*CALCULATE THE TRAWL LANDINGS BY YEAR, MARKET CATEGORY, AND YEAR FROM 1957-68;
data twlsum5768;
  merge blksum5768 interp;
  by year mark_cat region_caught;
  if totl_mt=. then totl_mt=0;
  if p_trawl=. then p_trawl=0;
  trwl_mt = p_trawl*totl_mt;
  type = 'I';
  drop totl_mt p_trawl;
* DELETE THE BOGUS 1957 DATA FROM THE ORIGINAL TRAWL LANDINGS DATA;
data twlsum2;
  set save.twlsum1;
  if year le 1956;
  type = 'T';
  drop nominal_species;
* APPEND THE NEW 1957-68 ESTIMATES TO THE ORIGINAL 1925-56 DATA;
data save.twlsum2;
  set twlsum2 twlsum5768;
proc print data=save.twlsum2;
run;
```

RECON-08.SAS

```
options pagesize=max linesize=80;
libname save "c:\historical catch";
*RETRIEVE THE BLOCK SUMMARY AND THE TRAWL BLOCK-SUMMARY DATA FOR USE;
data blksum;
  set save.blksum1;
  drop nominal_species type;
proc sort data=blksum;
  by mark_cat region_caught year;
data twlsum;
  set save.twlsum2;
  drop type;
proc sort data=twlsum;
  by mark_cat region_caught year;
*THIS SECTION CALCULATES THE NUMERATOR PORTION OF A RATIO ESTIMATOR
 TO CORRECT LOW TRAWL CATCHES DURING THE WAR YEARS;
data interp1;
  set twlsum;
  if year ge 1941 and year le 1950;
  if year ge 1944 and year le 1947 then delete;
proc sort data=interp1;
  by mark_cat region_caught;
proc means data=interp1 noprint;
  var trwl_mt;
  by mark_cat region_caught;
  output out=ratio1 sum=num;
*THIS SECTION CALCULATES THE DENOMINATOR PORTION OF A RATIO ESTIMATOR
 TO CORRECT LOW TRAWL CATCHES DURING THE WAR YEARS;
data interp2;
```

```
  set save.blksum1;
  if year ge 1941 and year le 1950;
  if year ge 1944 and year le 1947 then delete;
proc sort data=interp2;
  by mark_cat region_caught;
proc means data=interp2 noprint;
  var totl_mt;
  by mark_cat region_caught;
  output out=ratio2 sum=den;
*THIS SECTION FORMS THE RATIO ESTIMATOR;
data ratio;
  merge ratio1 ratio2;
  by mark_cat region_caught;
  if num=. then num=0;
  if den=. then den=num;
  prop_twl = num/den;
  keep mark_cat region_caught prop_twl;
*THIS SECTION SUBSETS THE BLOCK SUMMARY STRATA DURING THE WAR YEARS;
data blk_base;
  set save.blksum1;
  if year ge 1944 and year le 1947;
proc sort data=blk_base;
  by mark_cat region_caught year;
proc means data=blk_base noprint;
  var totl_mt;
  by mark_cat region_caught year;
  output out=blk_base sum=;
*THIS SECTION CALCULATES THE TRAWL CATCH BY STRATUM DURING THE WAR YEARS USING THE RATIO ESTIMATOR;
data twl44_47;
  merge blk_base ratio;
  by mark_cat region_caught;
  if year=. then delete;          *strata caught in 1941, 1942, 1943, 1948, 1949, or 1950 but not from 1944-47;
  if prop_twl=. then prop_twl=0;  *stratum caught from 1944-47 (MC=255, region 2, 0.64 mt) but not base years;
  trwl_mt = totl_mt*prop_twl;
  drop _type_ _freq_ totl_mt prop_twl;
data twlsum;
  set twlsum;
  if year ge 1944 and year le 1947 then delete;     *delete bad years from the complete trawl data set;
data twlsum;
  set twlsum twl44_47;                    *adds in the estimated values for 1944-47 to the complete data set;
proc sort data=twlsum;
  by mark_cat region_caught year;
*COMBINE THE BLOCK SUMMARY AND TRAWL BLOCK-SUMMARY DATA SETS AND DETERMINE THE NON-TRAWL CATCH BY DIFFERENCE;
data combine;
  merge blksum twlsum;
  by mark_cat region_caught year;
* THIS SECTION CORRECTS AN ERROR THAT WAS DETECTED IN THE TRAWL BLOCK-SUMMARY DATA AFTER EXAMINING THE 1955
FISH TICKETS.  SPECIFICALLY, THERE WAS A SIGNIFICANT DEFICIT IN THE GROUP RED (265=959)CATCH.  FIX BY USING THE
FISH TICKET TRAWL CATCHES INSTEAD OF THE TRAWL BLOCK SUMMARY CATCHES (SEE '1955 DISCREPANCIES' IN
'SCHEME.XLS');
  if year=1955 and region_caught=2 and mark_cat=250 then trwl_mt=178.2;
  if year=1955 and region_caught=2 and mark_cat=252 then trwl_mt=151.2;
  if year=1955 and region_caught=2 and mark_cat=253 then trwl_mt=105.7;
  if year=1955 and region_caught=2 and mark_cat=254 then trwl_mt=  3.9;
  if year=1955 and region_caught=2 and mark_cat=270 then trwl_mt= 60.3;
  if year=1955 and region_caught=2 and mark_cat=271 then trwl_mt= 17.7;
  if year=1955 and region_caught=2 and mark_cat=959 then trwl_mt=660.6;
  if year=1955 and region_caught=2 and mark_cat=960 then trwl_mt=  0.0;
  if totl_mt=. then totl_mt=0;
  if trwl_mt=. then trwl_mt=0;
  nont_mt = totl_mt - trwl_mt;                  *NON-TRAWL CATCH = TOTAL CATCH - TRAWL CATCH;
* IF THERE IS A MINOR DISCREPANCY (I.E., TRAWL CATCH TOO HIGH) THEN REDUCE THE TRAWL
  CATCH TO EQUAL THE TOTAL CATCH AND SET THE NON-TRAWL CATCH TO ZERO;
  if nont_mt lt 0 then do;
    trwl_mt=totl_mt;
    nont_mt=0;
       end;
  drop totl_mt;
*THIS SECTION SUBSETS TO THE NON-TRAWL DATA AND DEFINES A GEAR VARIABLE;
data nont;
  set combine;
  gear='N';
  rename nont_mt=catch;
  drop trwl_mt;
*THIS SECTION SUBSETS TO THE TRAWL DATA AND DEFINES A GEAR VARIABLE;
data trwl;
  set combine;
  gear='T';
  rename trwl_mt=catch;
```

```
  drop nont_mt;
*THE TRAWL AND NON-TRAWL DATA ARE CONCATENATED;
data save.complete;
  set nont trwl;
proc sort data=save.complete;
  by mark_cat year region_caught gear;
proc print data=save.complete;
run;
```

RECON-09.SAS

```
options pagesize=max linesize=80;
libname save "c:\historical catch";
* THIS SECTION CREATES A LOOKUP OF ALL OF THE 'ROCKFISH' MARKET CATEGORIES;
proc import out=work.marketcats datatable="dbo_market_categories" dbms=access2000 replace;
  database="c:\historical catch\calcom.mdb";
data marketcats;
  set marketcats;
  if species_group='ROCK';
  keep market_category nominal_species species_group;
  rename market_category=mark_cat;
proc sort data=marketcats;
  by mark_cat;

* SEPARATE THE DATA INTO NOMINAL AND UNSPECIFIED COMPONENTS;
proc sort data=save.complete;
  by mark_cat;
data nominal unspecified;
  merge save.complete marketcats;
  by mark_cat;
  if year=. then delete;                                    *removes unobserved market categories;
  if mark_cat=250 or mark_cat=253 or mark_cat=254 or
     mark_cat=959 or mark_cat=960 then output unspecified;
          else output nominal;
*THIS SECTION CALCULATES SPECIES COMPOSITION OF MARKET CATEGORIES BY SAMPLED STRATA (REGION AND GEAR);
proc import out=work.comlands datatable="dbo_com_lands" dbms=access2000 replace;
  database="c:\historical catch\calcom.mdb";
data speccomp;
  set comlands;
  if (year ge 1978) and (year le 1984);                     *set the time period for catch composition;
  if source='ACTUAL';                                       *use only actual samples;
  if mark_cat=250 or mark_cat=253 or mark_cat=254 or
     mark_cat=959 or mark_cat=960;                          *subset to unspecified market categories;
  if port_complex='CRS' then region_caught=2;
  if port_complex='ERK' then region_caught=2;
  if port_complex='BRG' then region_caught=2;
  if port_complex='BDG' then region_caught=4;
  if port_complex='OSF' then region_caught=4;
  if port_complex='MNT' then region_caught=5;
  if port_complex='MRO' then region_caught=6;
  if port_complex='OSB' then region_caught=6;
  if port_complex='OLA' then region_caught=7;
  if port_complex='OSD' then region_caught=8;
  if (gear_grp='TWL' or gear_grp='MDT') then gear='T';  else gear='N';
  drop source gear_grp quarter live port_complex;
proc sort data=speccomp;
  by region_caught gear mark_cat species;
proc means data=speccomp noprint;
  var pounds;
  by region_caught gear mark_cat species;
  output out=compdata sum=totlbs;
proc freq data=compdata;
  tables species / noprint out=comps;
  by region_caught gear mark_cat;
  weight totlbs;
* THIS SECTION CORRECTS FOR THE 'WIDOW PROBLEM' IN MARKET CATEGORY 250, TRAWL, AT EUREKA.  THE SPECIES COMP
  FOR THAT STRATUM IS ADJUSTED SO THAT THE PROPORTION WIDOW DROPS FROM 48% TO 15% (SEE 'COMPARE COMPS.XLS');
data comps;
  set comps;
  if region_caught=2 and mark_cat=250 and gear='T' then delete;
  p = percent/100;
  drop count percent;
data correction;
  infile "c:\historical catch\eur_twl_250.prn" firstobs=2 missover;
  input species $ p;
  region_caught=2;
  mark_cat=250;
  gear='T';
data comps;
  set comps correction;
```

```
proc sort data=comps;
  by region_caught gear mark_cat;
* THIS SECTION CORRECTS THE INCORRECT SPECIES CATCHES FOR EUREKA-TRAWL-250 BACK TO THE ORIGINAL 'SPECCOMP' DATA
SET.
  THIS IS NECESSARY BECAUSE THE SPECCOMP DATA SET IS USED REPETIVELY AS STRATA ARE COLLAPSED;
data adjdata;
  set compdata;
  keep region_caught gear mark_cat totlbs;
proc means data=adjdata noprint;
  var totlbs;
  by region_caught gear mark_cat;
  output out=stratot sum=;
data stratot;  set stratot;  drop _type_ _freq_;
data speccomp;
  merge comps stratot;
  by region_caught gear mark_cat;
  lbs = p*totlbs;
  drop totlbs p;
  rename lbs=totlbs;
* SPARSE THE COMPOSITIONAL DATA FOR LATER MERGING WITH THE HISTORICAL BLOCK & TRAWL SUMMARY DATA;
data comps;
  set comps;
  do year=1916 to 1968;
    output;
        end;
proc sort data=comps;
  by region_caught gear mark_cat year species;
proc sort data=unspecified;
  by region_caught gear mark_cat year;
* THE COMPOSITIONAL INFORMATION IS MERGED WITH THE BLOCK-SUMMARY DATA
  AND SPECIES-SPECIFIC CATCHES CALCULATED.  DATA WITH NO COMPOSITIONAL
  INFORMATION ARE SET ASIDE FOR FURTHER ANALYSIS.  THESE CATCHES WILL
  BE DESIGNATED AS TYPE='sample3' BECAUSE THERE ARE THREE STRATA IN THE
  CALCULATION (REGION, GEAR, AND MARKET CATEGORY);
data reconstruct nosamples;
  merge comps unspecified;
  by region_caught gear mark_cat year;
  if p=. then output nosamples;
    else output reconstruct;                *set aside catches with no fully stratified species comp;
data reconstruct;
  set reconstruct;
  if catch=. then delete;                   *deletes (year x region x gear) strata with no catch;
  sp_catch = p*catch;
  type = 'sample3';
  keep region_caught gear species sp_catch year type;
* THIS SECTION STANDARDIZES THE NOMINAL CATCH RECORDS, CONCATENATES THEM
  WITH THE RECONSTRUCTED DATA, AND SUMS OVER REGIONS AND GEARS;
data nominal;
  set nominal;
  type = 'nominal';
  keep region_caught gear nominal_species catch year type;
  rename nominal_species=species catch=sp_catch;
*proc print data=nominal;
data all;
  set reconstruct nominal;
proc sort data=all;
  by species year;
*proc print data=all (obs=10);
* THIS SECTION CALCULATES SPECIES COMPS BY REGION & MARKET CATEGORY (COLLAPSES GEAR)
  FOR THE PURPOSE OF ASSIGNING SOME OF THE 'NOSAMPLE' DATA, I.E., DROP GEAR FROM
  THE STRATIFICATION.  THESE CATCHES WILL BE DESIGNATED AS TYPE='sample2' BECAUSE THERE
  ARE TWO STRATA IN THE CALCULATION (REGION AND MARKET CATEGORY);
proc sort data=speccomp;
  by region_caught mark_cat species;
proc means data=speccomp noprint;
  var totlbs;
  by region_caught mark_cat species;
  output out=compdata2 sum=totlbs;
proc freq data=compdata2;
  tables species / noprint out=comps2;
  by region_caught mark_cat;
  weight totlbs;
data comps2;
  set comps2;
  p = percent/100;
  drop count percent;
data comps2;
  set comps2;
  do year=1916 to 1968;             *sparse the compositional data for later merging;
```

```
    output;
         end;
proc sort data=comps2;
  by region_caught mark_cat year species;
*proc print data=comps2 (obs=100);
proc sort data=nosamples;
  by region_caught mark_cat year;
proc means data=nosamples noprint;
  var catch;
  by region_caught mark_cat year;
  output out=sample2 sum=totcatch;
data sample2;  set sample2;  drop _type_ _freq_;
data sample2 sample1;
  merge sample2 comps2;
  by region_caught mark_cat year;
  if totcatch=. then delete;        *deletes strata with no catch;
  if p=. then output sample1;       *sets aside records with no site x markcat composition;
    else output sample2;
data sample2;
  set sample2;
  sp_catch = p*totcatch;
  type = 'sample2';
  gear='';
  keep region_caught species sp_catch year type gear;
*proc print data=sample2 (obs=20);
* THIS SECTION CALCULATES SPECIES COMPS BY MARKET CATEGORY ONLY (COLLAPSES BOTH REGION AND
  GEAR) FOR THE PURPOSE OF ASSIGNING THE REMAINING 'NOSAMPLE' DATA, I.E., DROP GEAR
  AND REGION_CAUGHT FROM THE STRATIFICATION.  THESE CATCHES WILL BE DESIGNATED AS
  TYPE='sample1' BECAUSE THERE IS ONLY ONE STRATUM IN THE CALCULATION (MARKET CATEGORY);
proc sort data=speccomp;
  by mark_cat species;
proc means data=speccomp noprint;
  var totlbs;
  by mark_cat species;
  output out=compdata1 sum=totlbs;
proc freq data=compdata1;
  tables species / noprint out=comps1;
  by mark_cat;
  weight totlbs;
data comps1;
  set comps1;
  p = percent/100;
  drop count percent;
*proc print data=comps1;
data comps1;
  set comps1;
  do year=1916 to 1968;             *sparse the compositional data for later merging;
    output;
         end;
proc sort data=comps1;
  by mark_cat year species;
*proc print data=comps1 (obs=10);
proc sort data=sample1;
  by mark_cat year;
proc means data=sample1 noprint;
  var totcatch;
  by mark_cat year;
  output out=sample_1 sum=totcatch;
data sample_1;  set sample_1;  drop _type_ _freq_;
*proc print data=sample_1 (obs=10);
data sample_1 residual;
  merge sample_1 comps1;
  by mark_cat year;
  if totcatch=. then delete;        *deletes strata with no catch;
  if p=. then output residual;      *there are residual data with no species comps;
    else output sample_1;
data sample_1;
  set sample_1;
  sp_catch = p*totcatch;
  gear='';
  region_caught=.;
  type='sample1';
  drop p totcatch mark_cat;
*proc print data=sample_1 (obs=20);
* HERE IS THE RESIDUAL MARKET CATEGORY DATA THAT IS COMPLETELY UNALLOCATED TO SPECIES;
data residual;
  set residual;
  drop species p;
proc print data=residual;
```

```
* HERE ALL THE DATA ARE COMBINED (TYPE=NOMINAL, SAMPLE1, SAMPLE2, AND SAMPLE3) AND
  VARIOUS SUMMARIES CAN BE CONDUCTED;
data all;
  set all sample2 sample_1;
proc sort data=all;
  by species year;
*proc contents data=all;
proc freq data=all;
  tables type;
  weight sp_catch;
proc sort data=all;
  by species year region_caught gear;
proc means data=all noprint;
  var sp_catch;
  by species year region_caught gear;
  output out=summary sum=catch;
proc print data=summary (obs=200);
run;
```

Appendix F – Total recreational catch estimates for key species and assemblages in numbers and pounds, 1928-1980, for areas north and south of Point Conception

Table F1: Total recreational catch (1000s of fish) for fisheries north of Point Conception

	blue	bocaccio	canary	chili-pepper	nearshore deep	nearshore shallow	shelf minor	slope minor	yellowtail
1928	12.3	1.6	2.1	1.2	4.6	3.8	6.8	0.0	5.5
1929	24.5	3.1	4.2	2.4	9.2	7.6	13.6	0.0	11.0
1930	28.2	3.6	4.9	2.8	10.5	8.8	15.6	0.0	12.6
1931	37.6	4.8	6.5	3.7	14.0	11.7	20.8	0.0	16.8
1932	47.0	6.0	8.1	4.7	17.6	14.6	26.0	0.1	21.0
1933	56.4	7.1	9.7	5.6	21.1	17.6	31.2	0.1	25.2
1934	65.8	8.3	11.3	6.6	24.6	20.5	36.4	0.1	29.5
1935	75.2	9.5	13.0	7.5	28.1	23.4	41.6	0.1	33.7
1936	84.6	10.7	14.6	8.4	31.6	26.3	46.8	0.1	37.9
1937	100.3	12.7	17.3	10.0	37.5	31.2	55.5	0.1	44.9
1938	98.7	12.5	17.0	9.8	36.8	30.7	54.6	0.1	44.1
1939	86.3	10.9	14.9	8.6	32.2	26.9	47.7	0.1	38.6
1940	124.2	15.7	21.4	12.4	46.4	38.7	68.7	0.2	55.6
1941	114.8	14.5	19.8	11.4	42.9	35.7	63.5	0.1	51.4
1942	61.0	7.7	10.5	6.1	22.8	19.0	33.7	0.1	27.3
1943	58.3	7.4	10.1	5.8	21.8	18.2	32.3	0.1	26.1
1944	47.9	6.1	8.3	4.8	17.9	14.9	26.5	0.1	21.4
1945	63.9	8.1	11.0	6.4	23.9	19.9	35.3	0.1	28.6
1946	109.9	13.9	19.0	10.9	41.1	34.2	60.8	0.1	49.2
1947	87.0	11.0	15.0	8.7	32.5	27.1	48.1	0.1	38.9
1948	173.5	22.0	29.9	17.3	64.8	54.0	96.0	0.2	77.7
1949	224.9	28.5	38.8	22.4	84.0	70.0	124.4	0.3	100.7
1950	274.1	34.7	47.3	27.3	102.4	85.3	151.6	0.3	122.7
1951	332.0	41.0	56.2	31.2	123.9	114.4	175.4	0.4	141.1
1952	288.9	35.6	48.9	27.1	107.8	99.6	152.6	0.3	122.7
1953	246.0	30.4	41.6	23.1	91.8	84.8	130.0	0.3	104.5
1954	305.8	37.7	51.7	28.7	114.1	105.4	161.6	0.4	129.9
1955	364.6	45.0	61.7	34.2	136.0	125.6	192.7	0.4	154.9
1956	407.1	50.2	68.9	38.2	151.9	140.3	215.1	0.5	173.0
1957	398.2	49.8	65.7	44.1	140.8	145.7	220.5	0.6	149.3
1958	659.4	80.1	113.8	60.2	254.8	231.6	334.9	0.7	258.7
1959	544.3	66.6	92.1	47.4	197.7	188.2	294.3	0.6	235.7
1960	422.7	52.7	71.5	43.4	163.1	145.1	216.7	0.6	175.1
1961	314.5	44.4	49.7	26.5	120.8	123.2	164.9	0.4	131.1
1962	373.9	52.2	61.2	37.9	212.1	86.4	198.9	0.4	153.5
1963	408.9	57.6	65.7	32.0	262.6	92.4	194.5	0.4	106.6
1964	312.9	48.8	59.6	43.3	235.0	73.6	162.9	0.5	81.0
1965	495.3	69.4	91.1	42.0	352.1	110.0	245.8	0.5	133.8
1966	523.7	77.1	96.5	62.5	402.4	122.3	268.6	0.9	144.0
1967	526.4	72.7	99.1	58.1	432.9	138.2	270.1	0.7	142.4
1968	580.5	67.9	105.0	62.7	456.6	138.2	298.1	1.0	159.3
1969	618.3	72.3	118.1	57.6	490.1	127.0	314.0	0.7	195.8
1970	753.8	77.2	146.4	68.5	617.3	172.0	370.7	0.7	222.5
1971	623.7	68.4	126.5	58.8	556.7	135.9	309.2	0.5	172.9
1972	824.7	80.7	166.7	66.5	696.4	182.4	392.5	0.8	230.2
1973	983.6	122.2	193.4	91.1	791.3	218.7	532.4	1.1	295.8
1974	1050.1	132.1	200.2	110.3	840.5	233.9	537.9	1.4	318.6
1975	979.7	131.8	193.2	103.3	846.3	228.6	556.3	1.0	316.0
1976	1095.0	142.1	222.8	114.4	913.7	243.6	615.4	1.1	382.2
1977	966.5	127.7	214.2	107.2	933.3	219.2	534.6	0.9	336.7
1978	844.1	129.1	206.9	131.1	883.1	182.8	479.1	1.0	304.7
1979	917.2	152.1	222.6	156.3	911.9	203.9	556.1	1.5	328.1
1980	976.0	142.5	225.8	122.3	972.1	234.2	542.3	1.7	323.2

Table F2: Total recreational catch (1000s of pounds) for fisheries north of Point Conception

	blue	bocaccio	canary	chili-pepper	nearshore deep	nearshore shallow	shelf minor	slope minor	yellowtail
1928	16.1	5.3	3.5	3.2	14.6	3.5	11.9	0.0	9.5
1929	32.2	10.6	7.0	6.4	29.2	7.1	23.8	0.1	19.0
1930	37.0	12.2	8.0	7.4	33.5	8.1	27.4	0.1	21.8
1931	49.3	16.2	10.7	9.8	44.7	10.8	36.5	0.1	29.1
1932	61.6	20.3	13.4	12.3	55.8	13.6	45.6	0.1	36.4
1933	73.9	24.3	16.1	14.7	67.0	16.3	54.8	0.1	43.7
1934	86.2	28.4	18.7	17.2	78.2	19.0	63.9	0.1	51.0
1935	98.5	32.4	21.4	19.6	89.3	21.7	73.0	0.2	58.2
1936	110.8	36.5	24.1	22.1	100.5	24.4	82.1	0.2	65.5
1937	131.4	43.2	28.5	26.2	119.1	28.9	97.4	0.2	77.7
1938	129.2	42.5	28.1	25.7	117.2	28.5	95.8	0.2	76.4
1939	113.0	37.2	24.5	22.5	102.5	24.9	83.7	0.2	66.8
1940	162.8	53.5	35.3	32.4	147.6	35.8	120.6	0.3	96.2
1941	150.4	49.5	32.7	30.0	136.4	33.1	111.5	0.3	88.9
1942	79.9	26.3	17.4	15.9	72.5	17.6	59.2	0.1	47.2
1943	76.4	25.1	16.6	15.2	69.3	16.8	56.6	0.1	45.2
1944	62.7	20.6	13.6	12.5	56.9	13.8	46.5	0.1	37.1
1945	83.7	27.5	18.2	16.7	75.9	18.4	62.0	0.1	49.4
1946	144.0	47.3	31.3	28.7	130.6	31.7	106.7	0.2	85.1
1947	113.9	37.5	24.7	22.7	103.3	25.1	84.4	0.2	67.3
1948	227.3	74.8	49.4	45.3	206.1	50.1	168.5	0.4	134.4
1949	294.6	96.9	64.0	58.7	267.2	64.9	218.3	0.5	174.1
1950	359.1	118.1	78.0	71.5	325.6	79.1	266.1	0.6	212.2
1951	434.9	139.3	92.7	81.7	417.3	100.5	309.9	0.7	244.0
1952	378.4	121.2	80.6	71.1	363.1	87.4	269.6	0.6	212.3
1953	322.3	103.2	68.7	60.5	309.2	74.4	229.6	0.5	180.8
1954	400.6	128.3	85.4	75.2	384.4	92.5	285.4	0.7	224.8
1955	477.6	153.0	101.8	89.7	458.3	110.3	340.3	0.8	268.0
1956	533.3	170.8	113.6	100.1	511.7	123.2	379.9	0.9	299.2
1957	521.6	169.3	108.4	115.6	482.7	131.0	395.6	1.1	258.2
1958	863.8	272.3	187.7	157.7	850.1	206.2	596.7	1.3	447.5
1959	713.1	226.5	151.9	124.2	671.2	164.9	525.2	1.0	407.8
1960	553.7	179.2	118.0	113.7	544.3	127.7	377.4	1.0	303.0
1961	412.0	151.0	82.0	69.5	404.3	113.7	287.7	0.7	226.8
1962	485.9	177.2	100.5	97.2	528.3	16.1	16.1	0.7	265.3
1963	527.0	195.6	107.4	80.5	656.4	16.1	16.1	0.7	184.1
1964	399.9	165.3	97.1	106.5	586.9	16.1	16.1	0.8	139.6
1965	627.8	234.9	147.6	101.2	871.2	16.1	16.1	0.9	230.5
1966	658.3	260.6	155.7	147.1	986.1	16.1	16.1	1.6	247.8
1967	656.1	245.7	159.2	133.7	1050.7	16.1	16.1	1.2	244.9
1968	717.4	229.1	167.8	140.9	1102.8	16.1	16.1	1.7	273.5
1969	757.5	243.7	187.9	126.5	1175.8	16.1	16.1	1.2	335.9
1970	915.5	259.9	232.0	146.7	1457.3	16.1	16.1	1.4	381.2
1971	750.9	230.3	199.4	122.7	1311.0	16.1	16.1	1.0	296.0
1972	984.1	271.3	261.7	135.4	1619.6	16.1	16.1	1.5	393.6
1973	1163.3	410.3	302.2	180.5	1818.0	16.1	16.1	1.9	505.3
1974	1230.9	442.9	311.3	212.7	1912.8	16.1	16.1	2.5	543.6
1975	1137.9	441.6	299.0	193.8	1908.3	16.1	16.1	1.8	538.5
1976	1260.2	475.6	343.2	208.4	2040.3	16.1	16.1	1.9	650.7
1977	1102.0	426.8	328.4	189.7	2060.6	16.1	16.1	1.7	572.6
1978	953.6	431.3	315.8	225.1	1936.4	16.1	16.1	1.9	517.6
1979	1026.4	507.6	338.0	259.9	1982.5	16.1	16.1	2.8	556.8
1980	1056.1	582.1	329.6	142.0	1991.0	16.1	16.1	3.4	470.9

Table F3: Total recreational catch (in 1000s of fish) for fisheries south of Point Conception

	blue	bocaccio	chili-pepper	nearshore deep	nearshore shallow	shelf minor	slope minor	vermillion	olive
1928	0.3	1.6	0.3	0.1	0.1	0.5	0.0	0.1	0.4
1929	0.7	3.1	0.6	0.2	0.2	1.1	0.0	0.2	0.9
1930	1.0	4.7	0.9	0.3	0.3	1.6	0.1	0.3	1.3
1931	1.4	6.2	1.2	0.4	0.4	2.1	0.1	0.4	1.8
1932	1.7	7.8	1.5	0.5	0.5	2.7	0.1	0.6	2.2
1933	2.0	9.4	1.8	0.6	0.6	3.2	0.1	0.7	2.6
1934	2.4	10.9	2.2	0.7	0.7	3.7	0.2	0.8	3.1
1935	2.7	12.5	2.5	0.8	0.8	4.3	0.2	0.9	3.5
1936	2.7	12.5	2.5	0.8	0.8	4.3	0.2	0.9	3.5
1937	3.2	21.5	5.0	0.8	0.8	6.3	0.3	1.4	3.5
1938	3.6	17.3	4.2	1.0	1.0	6.1	0.3	1.5	3.8
1939	3.2	15.3	3.6	1.0	0.9	5.0	0.2	1.1	3.7
1940	2.5	11.0	2.4	0.6	0.6	4.0	0.2	0.9	3.0
1941	2.3	10.2	2.2	0.6	0.6	3.7	0.2	0.8	2.7
1942	1.2	5.4	1.2	0.3	0.3	2.0	0.1	0.4	1.5
1943	1.2	5.2	1.1	0.3	0.3	1.9	0.1	0.4	1.4
1944	1.0	4.2	0.9	0.2	0.2	1.5	0.1	0.3	1.1
1945	1.3	5.6	1.2	0.3	0.3	2.0	0.1	0.5	1.5
1946	2.2	9.7	2.1	0.6	0.6	3.5	0.2	0.8	2.6
1947	11.0	29.1	7.7	2.7	2.7	12.1	0.5	2.2	11.2
1948	17.4	79.7	22.5	6.0	5.9	29.7	1.3	7.1	19.6
1949	21.2	103.7	29.1	7.4	7.3	34.2	1.5	10.0	23.3
1950	30.8	122.4	25.0	9.9	9.8	44.6	3.1	10.3	30.4
1951	24.3	106.0	21.0	8.3	8.2	38.1	3.2	8.0	27.5
1952	36.9	118.4	33.3	9.7	9.6	53.2	2.3	12.7	32.7
1953	39.4	133.7	36.0	13.0	12.8	62.4	3.3	16.5	48.4
1954	89.8	320.7	74.5	31.0	30.7	128.8	7.0	31.6	113.4
1955	178.2	593.8	111.1	54.6	54.0	232.1	8.5	54.3	175.6
1956	187.9	716.0	130.8	59.7	59.0	274.8	10.5	64.3	202.1
1957	113.3	413.7	86.6	31.9	31.5	162.0	7.0	39.7	110.0
1958	89.4	235.1	65.3	26.8	26.5	111.5	4.2	34.2	78.5
1959	44.6	138.7	41.8	16.0	15.8	68.1	3.4	19.2	45.8
1960	40.5	144.5	50.9	17.5	17.3	73.7	10.2	15.7	35.7
1961	45.1	165.4	56.7	20.0	19.9	92.4	9.4	17.1	38.1
1962	40.2	159.6	56.3	15.6	15.4	99.0	5.7	16.9	40.8
1963	51.3	151.8	48.4	17.4	17.2	94.4	8.4	16.4	50.1
1964	85.7	190.8	63.3	29.3	29.0	138.7	9.3	27.1	67.7
1965	137.8	249.2	78.7	41.3	40.6	185.7	15.0	35.9	103.3
1966	182.1	440.6	129.8	95.7	94.3	284.7	29.5	61.5	124.4
1967	246.9	601.3	148.0	108.5	106.5	384.1	37.1	69.4	159.7
1968	297.6	649.7	154.2	128.2	125.7	427.3	35.7	83.4	196.0
1969	259.9	612.9	167.2	106.7	104.1	355.2	26.4	74.1	175.0
1970	385.1	811.5	237.0	157.0	153.1	506.2	38.2	101.4	320.5
1971	363.8	754.9	202.8	156.2	152.2	498.3	35.7	96.5	286.7
1972	503.4	1021.8	248.1	207.8	202.3	649.7	55.1	127.2	375.5
1973	619.0	1179.4	312.3	245.9	239.2	793.5	67.6	149.3	408.0
1974	731.6	1477.6	379.6	316.6	308.2	939.6	75.4	168.1	504.8
1975	755.4	1456.3	345.2	335.4	326.8	944.5	74.9	177.8	508.3
1976	589.7	1162.5	310.0	265.3	258.2	795.1	67.9	138.0	387.1
1977	582.3	987.7	265.2	244.5	237.7	775.7	64.7	132.2	363.8
1978	570.3	916.6	235.6	237.0	230.3	734.3	60.3	131.2	351.1
1979	783.0	1338.1	367.6	327.2	317.6	1008.8	99.0	178.0	443.0
1980	697.6	1101.1	306.8	295.4	286.9	879.4	89.7	153.3	414.8

Table F4: Total recreational catch (in 1000s of pounds) for fisheries south of Point Conception

	blue	bocaccio	chili-pepper	nearshore deep	nearshore shallow	shelf minor	slope minor	vermillion	olive
1928	0.2	4.4	0.6	0.0	0.0	0.0	0.0	0.3	0.5
1929	0.5	8.8	1.2	0.0	0.0	0.0	0.0	0.6	0.9
1930	0.7	13.2	1.8	0.3	0.4	1.9	0.2	0.9	1.4
1931	1.0	17.6	2.4	0.4	0.5	2.6	0.2	1.2	1.9
1932	1.2	22.0	3.0	0.5	0.6	3.2	0.3	1.6	2.3
1933	1.5	26.4	3.6	0.6	0.8	3.9	0.3	1.9	2.8
1934	1.7	30.8	4.3	0.7	0.9	4.5	0.4	2.2	3.3
1935	1.9	35.2	4.9	0.9	1.0	5.2	0.5	2.5	3.7
1936	1.9	35.2	4.9	0.9	1.0	5.2	0.5	2.5	3.7
1937	2.3	60.7	9.8	0.9	1.1	7.7	0.8	3.9	3.7
1938	2.6	48.9	8.4	1.1	1.3	7.4	0.7	4.1	4.1
1939	2.3	43.3	7.2	1.0	1.2	6.0	0.5	3.2	3.9
1940	1.8	31.0	4.7	0.7	0.8	4.8	0.4	2.5	3.1
1941	1.6	28.7	4.3	0.6	0.8	4.4	0.4	2.3	2.9
1942	0.9	15.2	2.3	0.3	0.4	2.4	0.2	1.2	1.5
1943	0.8	14.6	2.2	0.3	0.4	2.3	0.2	1.2	1.5
1944	0.7	12.0	1.8	0.3	0.3	1.9	0.2	1.0	1.2
1945	0.9	16.0	2.4	0.4	0.4	2.5	0.2	1.3	1.6
1946	1.6	27.5	4.1	0.6	0.7	4.2	0.4	2.2	2.8
1947	7.9	82.3	15.2	2.8	3.4	15.2	1.2	6.3	11.9
1948	12.5	225.1	44.5	6.3	7.8	37.6	2.9	19.7	20.7
1949	15.2	292.8	57.6	7.7	9.6	43.5	3.5	27.8	24.6
1950	22.1	345.7	49.4	10.3	13.0	57.2	7.1	28.7	32.1
1951	17.4	299.3	41.6	8.6	10.4	47.7	7.2	22.3	29.0
1952	26.4	334.3	66.0	9.9	12.6	68.4	5.3	35.5	34.5
1953	28.2	377.5	71.3	13.0	16.2	80.0	7.6	46.1	51.1
1954	64.3	905.5	147.4	32.1	38.9	162.8	15.9	88.0	119.8
1955	127.5	1676.8	219.9	56.0	72.0	293.3	19.2	151.5	185.4
1956	134.5	2022.0	258.9	59.6	77.1	344.5	23.9	179.2	213.3
1957	81.1	1168.2	171.6	31.5	42.1	208.0	15.8	110.6	116.1
1958	64.0	663.9	129.3	25.2	36.7	150.0	9.4	95.4	82.9
1959	31.9	391.6	82.7	15.2	20.9	89.6	7.8	53.4	48.3
1960	29.0	408.2	100.7	16.7	23.2	97.4	23.4	43.7	37.7
1961	32.3	467.1	112.3	19.3	27.3	123.5	21.6	47.7	40.3
1962	28.8	450.8	111.5	15.3	20.8	133.2	13.2	47.1	43.0
1963	36.7	428.6	95.9	17.0	23.2	127.8	19.4	45.6	52.9
1964	61.4	538.7	125.3	27.6	41.1	191.3	21.3	75.5	71.5
1965	98.7	703.6	155.8	39.5	58.0	250.4	34.3	100.1	109.1
1966	130.3	1244.1	257.0	89.7	144.2	379.8	67.3	171.5	131.3
1967	176.7	1698.0	293.1	103.7	164.2	513.2	84.4	193.6	168.6
1968	213.0	1834.7	305.4	122.7	195.0	563.8	80.9	232.6	206.9
1969	186.0	1730.6	331.1	103.8	160.0	452.1	59.3	206.6	184.7
1970	275.6	2291.5	469.2	152.4	236.2	636.7	85.8	282.9	338.4
1971	260.3	2131.8	401.7	152.9	231.2	623.4	80.0	268.9	302.7
1972	360.2	2885.2	491.2	204.1	313.9	811.3	123.7	354.8	396.3
1973	443.0	3330.4	618.3	241.3	375.6	1000.3	151.9	416.4	430.7
1974	523.6	4172.5	751.7	312.1	477.2	1162.9	168.9	468.6	532.9
1975	540.6	4112.1	683.6	332.7	502.2	1177.0	167.5	495.8	536.6
1976	422.0	3282.8	614.0	261.6	401.7	994.9	152.3	384.9	408.7
1977	416.7	2789.1	525.1	240.2	370.9	976.6	145.2	368.7	384.0
1978	408.1	2588.3	466.6	233.4	361.8	928.2	134.9	365.8	370.6
1979	560.4	3778.6	727.9	322.5	501.1	1269.8	222.5	496.4	467.7
1980	623.9	2078.8	422.1	375.5	476.1	1009.4	171.7	428.6	370.6

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