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ABSTRACT

In this study we examined the reliability of California's commercial groundfish landing estimates from 1969-2006. To determine the reliability of the estimates, we examined potential problems including: species misidentification, landing receipt errors, and unusual patterns in landings. We found that landing estimates for most species were at least generally reliable; however, there were some problems which could not be adequately resolved. In many cases where there were potential problems, we were confident that total landings were probably small. In other cases, we found that recent landing estimates were reliable; however, early landing estimates were questionable. We also found that for northern California, we will need to modify our landing estimation method for the years 1969 through 1977. In some cases, end users could improve landing estimates with more detailed analyses.

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INTRODUCTION

California's commercial fishing industry is complex and dynamic. More than 1,000 species are landed at numerous ports throughout the state. Many types of gears are used to harvest the resource. The nature of the fisheries has changed over time as a result of market demands and regulatory actions. Participants in the commercial fishery range from a single person using a fishing pole from the beach to large tuna vessels operating in international waters. Attempting to monitor and regulate the diverse fisheries is a difficult task at best. California's fisheries are regulated by the California Department of Fish and Game, the National Marine Fisheries Service, and the Pacific Fishery Management Council.

Groundfish are an important component of California's commercial fisheries. In 2005, the estimated total market value of groundfish in California was $13,751,146 (PacFIN, 2006). Groundfish can generally be divided into four groups: elasmobranchs, flatfish, rockfish, and other species (roundfish) (PFMC, 2006). Total annual groundfish landings between 1969 and 2006 have ranged from a high of 55,000 metric tons (mt) in 1982 down to about 13,000 mt in 2006 (Figure 1) with flatfish and rockfish accounting for the majority of landings (Figure 2). Since 1969, trawl gears have always been responsible for the largest fraction of the landings (Figure 3). The northern region (Crescent City, Eureka, and Fort Bragg) have typically had the highest landings, followed by the central region (Bodega Bay, San Francisco, Monterey, and Morro Bay) (Figure 4). Landings in the southern region (Santa Barbara, Los Angeles, and San Diego) have typically constituted only a small fraction of total groundfish landings.

Under the federal Groundfish Fisheries Management Plan (GFMP), the list of species considered as groundfish is more restrictive than we use in this document. In Table 1, we list the species included in this document and whether they are listed as groundfish in the GFMP. We have included the extra species since these are frequently landed with other groundfish species, or are similar in other respects, for example, turbots are not listed in the GFMP but are closely associated with other flatfish.

We have limited the time interval included in this paper to 1969 through 2006 because, at this writing, only those years are included in the groundfish landing estimates in the CALCOM database (CALCOM, 2006). The CALCOM database is the repository for commercial groundfish market sample data managed by the California Cooperative Groundfish Survey (CCGS). In the near future, landing estimates from earlier years will be included in CALCOM. Inclusion of earlier years will be based on the current landing estimates and therefore the reliability of the estimates for the earlier years will depend on the reliability of the current estimates.
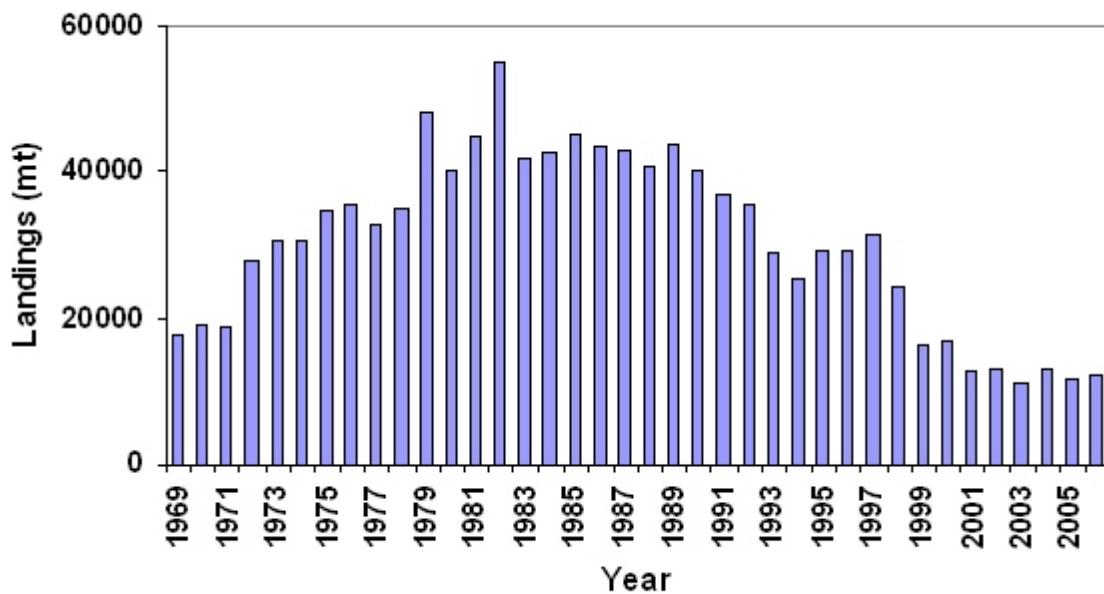
Figure 1. Estimated total commercial groundfish landings (metric tons)
for California, 1969-2006.
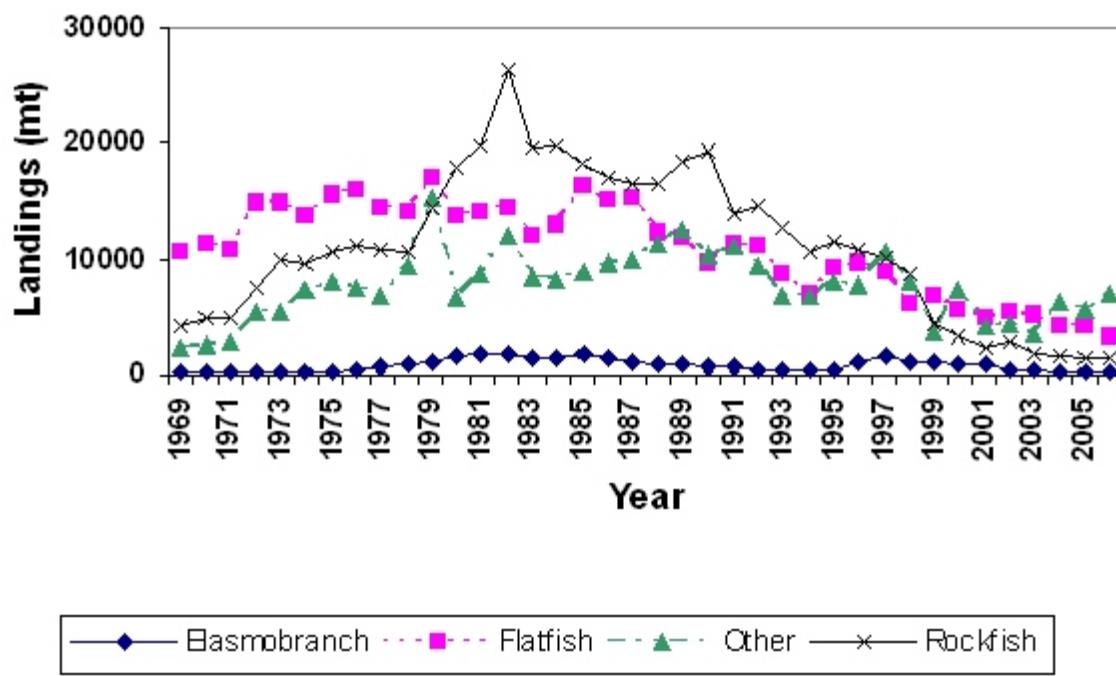
Figure 2. Estimated total commercial groundfish landings (metric tons)
for California by species group, 1969-2006.

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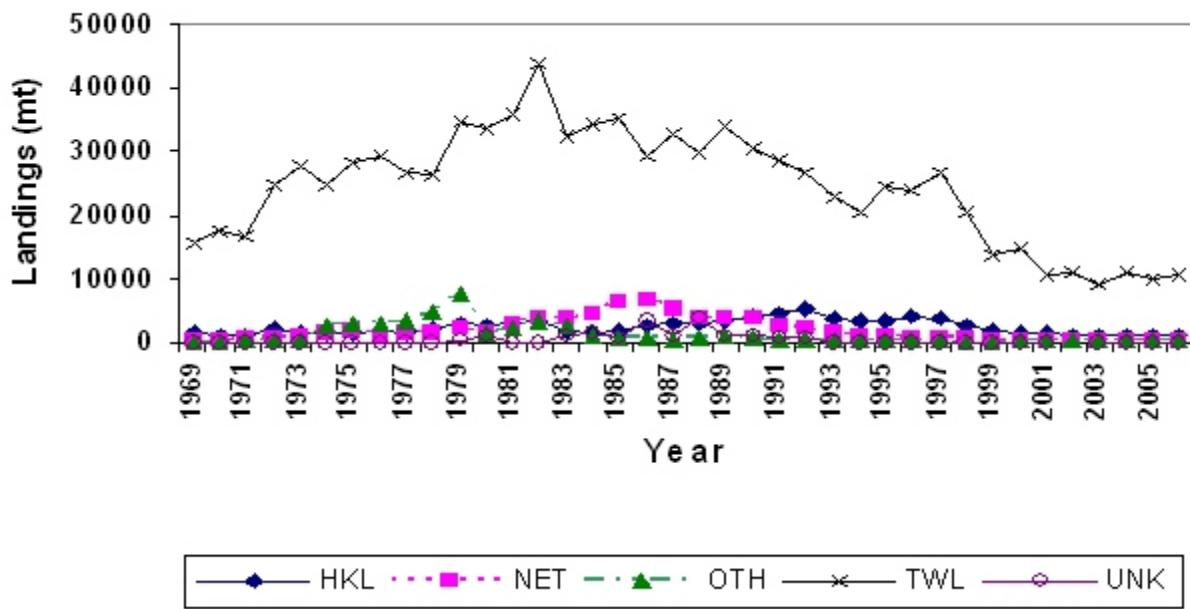
Figure 3. Estimated total commercial groundfish landings (metric
tons) for California by gear group, 1969-2006. HKL=hook and line,
OTH=Other, TWL=trawl, NET=gill net.
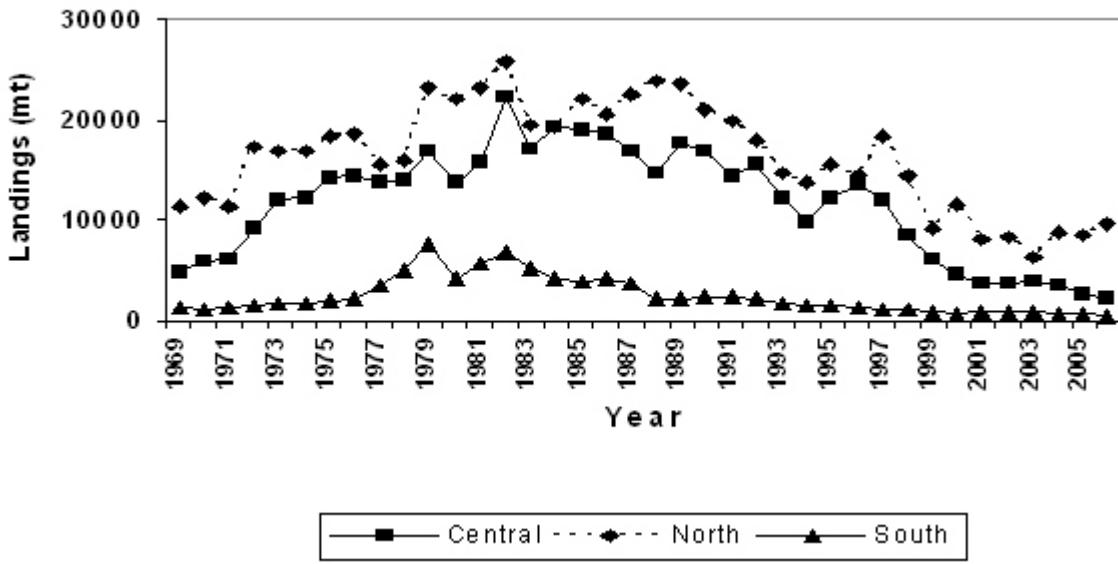
 Figure 4. Estimated total commercial groundfish landings (metric tons)
for California by region, 1969-2006. NORTH=Crescent City, Eureka, and
Fort Bragg; Central=Bodega Bay, San Francisco, Monterey, and Morro
Bay; South=Santa Barbara, Los Angeles, and San Diego.

Table 1. List of species included in this report and whether they are listed in the federal Groundfish Fisheries Management Plan. Species are listed by common name and using the groupings used in this paper.

GROUP	COMMON NAME	SCIENTIFIC NAME	GFMP
Elasmobranchs	Angel shark	*Squatina californica*	N
	Big skate	*Raja binoculata*	Y
	California skate	*R. inornata*	Y
	Leopard shark	*Triakis semifasciata*	Y
	Longnose skate	*R. rhina*	Y
	Soupfin shark	*Galeorhinus zyopterus*	Y
	Spiny dogfish	*Squalus acanthias*	Y
	Spotted ratfish	*Hydrolagus colliei*	Y
	Thresher shark	*Alopias* spp	N
Other Species	Finescale codling	*Antimora microlepis*	Y
	Pacific rattail	*Coryphaenoides acrolepis*	Y
	Cabezon	*Scorpaenichthys marmoratus*	Y
	California sheephead	*Semicossphus pulcher*	N
	Kelp greenling	*Hexagrammos decagrammus*	Y
	Lingcod	*Ophiodon elongatus*	Y
	Pacific cod	*Gadus macrocephalus*	Y
	Pacific whiting	*Merluccius productus*	Y
	Sablefish	*Anoplopoma fimbria*	Y
	California scorpionfish	*Scorpaena guttata*	Y
Flatfish	Arrowtooth flounder	*Atheresthes stomias*	Y
	Butter sole	*Isopsetta isolepis*	Y
	California halibut	*Paralichthys californicus*	N
	Curlfin sole	*Pleuronichthys decurrens*	Y
	Dover sole	*Microstomus pacificus*	Y
	English sole	*Parophrys vetulus*	Y
	Flathead sole	*Hippoglossoides elassodon*	Y
	Longfin sanddab	*Citharichthys xanthostigma*	N
	Pacific halibut	*Hippoglossus stenolepis*	N
	Pacific sanddab	*Citharichthys sordidus*	Y
	Petrale sole	*Eopsetta jordani*	Y
	Rex sole	*Glyptocephalus zachirus*	Y
	Rock sole	*Lepidopsetta bilineata*	Y
	Sand sole	*Psettichthys melanostictus*	Y
	Speckled sanddab	*Citharichthys stigmaeus*	N
	Starry flounder	*Platichthys stellatus*	Y
	Turbots, various		N
Rockfish	Rockfish, all	*Sebastes* spp.	Y
	Longspine thornyhead	*Sebastolobus altivelis*	Y
	Shortspine thornyhead	*Sebastolobus alascanus*	Y

Estimation of species-specific landings is essential to managing the groundfish fishery. Landing estimates are based on landing receipts; however, the estimation is complicated by the way in which fish are sorted into what are known as market categories. A market category is a sort group. Currently there are 421 defined market categories (including groundfish and non-groundfish) in California. Market categories come in two types: single species categories and group categories.

Historically, single species market categories are most commonly used for non-rockfish species. A single-species market category supposedly contains one species; however, in practice this is often not the case. In fact, we have observed landings where the majority of fish are not the species for which the market category they were sorted into was named.

Group market categories historically have been the most common approach to sorting rockfish in California. However, in recent years, rockfish are increasingly being sorted into single species categories due to increased species-specific regulations. For example, after the 1991 regulatory requirement to sort bocaccio, the chilipepper market category (254) which often was a mixed species group, became largely a single species market category. This occurred because chilipepper rockfish and bocaccio were often landed together.

Sorting into market categories is done for two reasons: regulatory requirement and dealer preference. When management measures such as trip limits are applied to a species or group of species, the fishermen are required to sort the species into a separate market category to facilitate monitoring of the landings. More often, dealers have the species sorted into market categories to meet their needs. Dealer based sorting can be based on size, quality, species, price, or some combination of these. What is important to recognize is that species and market category are not synonymous: species is not recorded on the landing receipt, only market category, and this is often a source of confusion to users of the data.

The term "market category" is often used interchangeably with species code, but this is very misleading. Treating a market category as a species code can lead to serious errors in estimating species-specific landings. At this time, California has 114 groundfish market categories. Since 1969, landings were made in 61 different groundfish market categories, with 53 groundfish market categories never being used. New market categories were added over time and their usage often fluctuates among years, and ports.

In order to obtain more reliable estimates of species-specific landings, a commercial market sampling program called the California Cooperative Groundfish Survey (CCGS) was implemented in 1978. This program was designed primarily to collect species composition data for rockfish and secondarily to collect biological information such as length, sex, maturity, and age data to help manage the fishery. Over time this program grew to include other groups of groundfish including flatfish, roundfish, and non-groundfish such as California sheephead. The CCGS is conducted jointly by the California Department of Fish and Game (CDFG), the Pacific States Marine Fisheries Commission (PSMFC), and the National Marine Fisheries Service (NMFS). Using the sampling scheme designed by Sen (1984), port samplers collect data from the landings at each of the ten defined port complexes (Appendix A). The data are entered into the CALCOM database managed by NMFS. At the end of the year, port sample data are applied to landing receipts to

obtain the final estimates of species-specific landings for the state.
In addition, the landing estimates are applied to the age and length
data from the port samples to estimate age and length compositions of
the commercial landings. The annual landing estimates are then
provided to the Pacific Information Network (PacFIN) for inclusion in
their system.

    Port sampling is stratified by year, market category, port
complex (Appendix A), gear group (Appendix B), quarter (1-4), and
condition (live or dead). Currently there are more than 25,000
possible groundfish strata that can be landed in any given year. In
practice, there has never been a year in which landings were made in
all strata. Nonetheless, the number of strata which need to be
sampled can be quite large (Figure 5). Since the number of port
samplers for the entire state varies between six and 12 individuals,
it is not feasible to adequately sample all strata with landings.
This complicates the process of estimating species-specific landings.
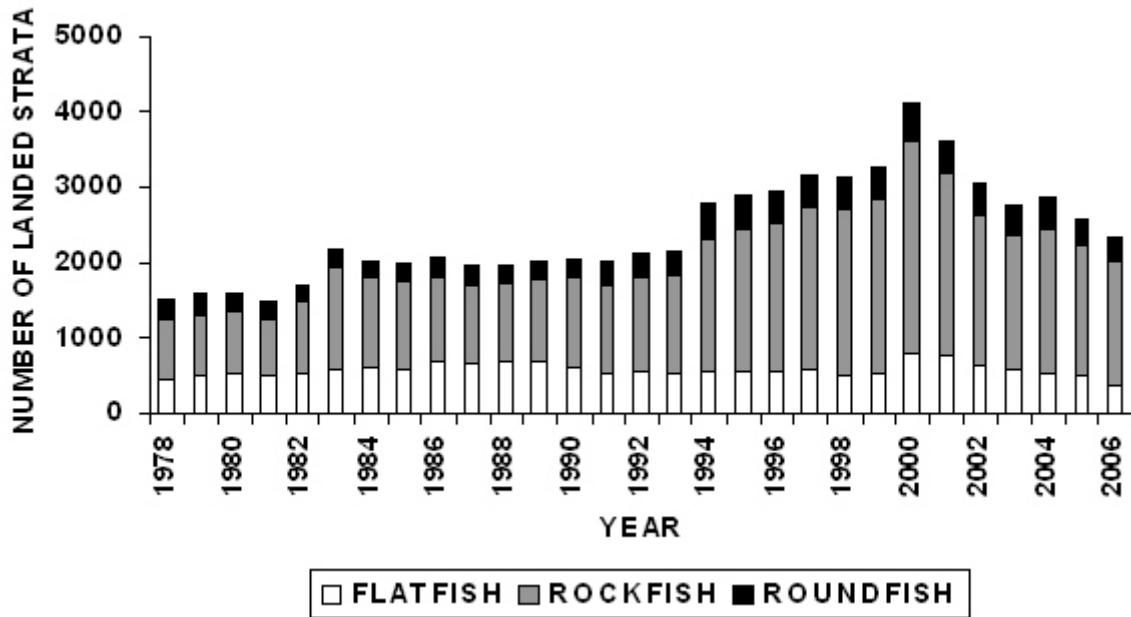
Figure 5. Number of groundfish strata (port complex, gear group,
market category, condition, and quarters) landed in California from
1978-2006 by year and major species group.

    A brief example of the expansion process is provided in Appendix
C. Descriptions of the sampling program can be found in Erwin et al.,
(1997); Pearson and Erwin (1997); and, Pearson and Almany (1995).
Sampling methodology has remained relatively constant since 1978 with
few modifications made to the actual sampling procedures. A full, up
to date description of the port sampling program and expansion process
can be obtained from the California Cooperative Groundfish Survey

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Manual[1]. A summary of the number of samples taken over time is
provided in Appendix D.

It is not possible to fully determine how accurate the port
sample data are. Even though every effort is made to check the data
for errors, it is not possible to verify cluster (sub-sample) weights,
species codes, or counts with complete certainty. We are forced to
rely on training and our ability to identify possible outliers in the
data. In addition, by checking the data monthly, we have the
opportunity to identify and correct errors by checking with port
samplers.

Every time a commercial landing is made in California, a landing
receipt is required to be completed and submitted to CDFG. These
receipts form the basis of estimating California's commercial
landings. Each receipt contains at least the following information:
date of landing, port where the landing was made, vessel number,
market category(ies), pounds landed (by market category), landing
receipt number, condition code (live or dead), and gear used.

While the full process of expanding samples to landings is beyond
the scope of this paper, what is important to this analysis is what
occurs with unsampled strata. When a quarter (three month interval)
has not been sampled for a year, port, gear, condition, and market
category, the expansion program automatically seeks other quarters to
use following a specific search sequence. If the expansion program
finds a quarter with samples, it will automatically use it (referred
to as Borrowing). Borrowing across quarters is not recorded. For all
other cases, the stratum is considered unsampled. Between 1985 and
2006, between eight and 32% of the rockfish landings were made in
unsampled strata. If the expansion process only relied on expanding
actual sampled strata, all unsampled rockfish strata would be treated
as unspecified rockfish. This would be unacceptable since it would
result in underestimation of species-specific landings. In some cases
the effect would be quite large. Any scheme to estimate the species
composition of unsampled strata will have errors, possibly very
significant ones.

To address the problem of unsampled strata, the CCGS uses four
approaches: 1) borrowing species compositions from sampled strata, 2)
treating some unsampled strata as Nominal (i.e... assuming the entire
stratum was composed of a single species), 3) leaving the unsampled
stratum as unspecified for the group (e.g.. unspecified rockfish), or
4) using an overall species composition for the port/gear strata
derived from a later time interval (referred to as the ratio method).
The method used to estimate landings in an unsampled stratum is
identified in the database by a source code. This source code can be
used to help determine the reliability of the landing estimate.

1. Available from Donald Pearson at NMFS, 110 Shaffer Rd, Santa Cruz,
CA 95060 (831)420-3944

Borrowing is done in two ways. The simplest form of borrowing uses a species composition from an adjacent port complex. The next level of borrowing uses the species composition from two port complexes away. In practice, borrowing from two port complexes away is seldom done and is probably less reliable than borrowing from an adjacent port complex.

The second approach to estimating unsampled stratum is to treat the entire stratum as a single species. In this case, the source code for the stratum is set to "Nominal". There are two cases where this approach is considered to be very reliable: 1) the widow rockfish market category (269) after 1983 and 2) the bocaccio market category (253) after 1991. In both cases, sorting is required by regulation. Samples from these strata verify they are "pure" or nearly so. In other cases, usually when the landing for the stratum is less than one metric ton, we automatically assign the stratum as nominal. In some situations, where we have information from port samplers or port biologists, we treat strata with larger landings as "Nominal".

The third approach is to treat the entire strata as an unspecified group. This is done for multi-species market categories when we have no information to support using the first two approaches. Most often this is used for unsampled gears (diving, trap, or other), which constitute a small fraction of the landings. When this approach is used, the source code is set to "Nominal" and the species code is set to an unspecified group (for example: unspecified flatfish).

The fourth approach, referred to as the "Ratio Estimator Method", uses species compositions from a different time interval. This approach is only applied to rockfish market categories in years and port complexes where no samples were taken and borrowing from an adjacent port complex could not be done. No species composition samples were collected anywhere prior to 1978. No samples were taken from southern California (Santa Barbara, Los Angeles, and San Diego) prior to 1983. Since there are landing receipts going back to 1969, and since some estimate of species-specific landings was needed, port samples from a later time interval were used to estimate the landings for the earlier years. For this method we first determined the earliest three year interval for each port complex that was sampled. Next we determined the species compositions from all rockfish market categories combined for each port/gear strata of the three year interval, weighted by total rockfish pounds by year. We then applied these compositions to the rockfish landings (from the receipts) for each year/port/gear group in the unsampled time interval. This approach collapsed market category as a stratum, and since there was no live fish fishery prior to 1990, there was no need to include condition as a classification variable. Landings expanded by this method are given a source code of "Ratio".

Landing estimates are integral to managing the fishery. While it is not possible to know with certainty how reliable the estimates are, we wanted to provide an estimate of reliability to end users. We

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undertook this study to evaluate how reliable our estimates of California's groundfish landings are. We used both qualitative and quantitative methods to estimate the reliability for all species. We hope our findings will allow users to incorporate our estimates of reliability in their analyses.

In this study we first examined landing receipts for possible errors. Next we examined the distribution of landings into market categories in an attempt to identify anomalies that may indicate errors or changes in sorting practices. Finally, we examined the actual landing estimates for each groundfish species in an effort to estimate the reliability of the estimates.

One issue that cannot be addressed is missing landing receipts. Although by law, a landing receipt must be submitted for every landing, it is known that this does not always occur. There is no way to determine how many landings occurred for which either no receipt was filled out or was not entered into the system. Anecdotal evidence suggests that as much as 25% of the landings for some gears, in some ports, were unreported; however, there is no way to confirm this.

METHODS

Landing Receipts

To identify potential errors in the landing receipt data, we examined all possible values of market category, port, gear, and vessel identifiers. We compared all values from the database to the official code lists to look for irregularities. We also examined the code lists to check for ambiguous or duplicate codes. For this examination, we looked at all receipts including those for non-groundfish market categories since it was possible that some groundfish market categories had been misrecorded.

In the next phase we compared the gear codes against the market categories since it was unlikely that certain gears would catch significant quantities of certain species. For example: gill nets are not permitted to land salmonids. We also plotted the frequency of landings by different gears over time to see if there were any readily apparent issues associated with miscoding of gear.

Market Categories

To identify possible errors in recording of market categories in the landing receipt data we plotted frequency of landings in market categories against year, port, and gear. We looked for any obvious irregularities such as unusual spikes in reported landings. When a possible error was detected, we examined the actual landing receipts to see if other data on the receipts could explain the discrepancy. This is possible because landings of some species usually do not co-occur; for example: squid are almost never landed with salmon.

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Port Sampling

To determine how well port samples reflected the landings, we plotted the natural log of mean landed weights for sampled strata versus bins of the natural log of mean landed weights for all landed strata. For the plots we used median, 25th percentile, and 75th percentile. We over-layed a line of equality (1:1) to determine how the median values from the port samples compared to the actual landing distribution.

Species-specific Landings

The final phase of this analysis examined estimated landings for all species. For non-rockfish, we examined the landings and trends in market categories to identify possible errors. We also evaluated possible problems that may have affected the results, such as misidentification and the effect of sorting on the estimates. With rockfish we had to be more comprehensive, since species composition sampling is essential in obtaining the final species-specific landing estimates.

To evaluate the reliability of rockfish landing estimates, we examined the literature, market category distribution, and estimated landings. Then we created a sampled-strata index which was used to develop a landing estimate score. We conclude each species account with a summary. The summary is typically divided into two parts: 1983 to present, and 1969 through 1982. This was done because port sampling was not conducted in southern California prior to 1983. In addition, no sampling was conducted anywhere prior to 1978. However, CALCOM provides landing estimates back to 1969 using the ratio estimator approach.

SAMPLED-STRATA INDEX

Since any species of rockfish has the potential to be sorted into almost any market category, and since there are many possible strata that need to be sampled, it is very difficult to determine how reliable our estimates of species-specific landings are. In order to get some idea of how well the strata were sampled for each species, we developed a sampled-strata index. The idea behind this index was to determine which strata were likely to contain a substantial fraction of the landings for each species and how well those strata were sampled. We created this index only for rockfishes since non-rockfish species have not relied on port sampling to estimate species-specific landings.

To create the index, we first defined a stratum as a unique port complex, gear group, and market category. Then we examined the raw landing data for all years and determined which strata had landings greater than 1,000 lbs. Using this list of strata, we then determined the mean number of fish, per sample, for each species in the port

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samples. Strata with an average of more than one fish per sample of
the target species were considered to be the likely strata for that
species. In addition, we included any single-species market category,
defined as the target species, as a likely stratum. The net result
was a list of likely strata which needed to be sampled for each
species, in each year, at each port, by each gear.

     To create the actual Sampled-Strata Index for all years combined,
we first created annual indexes (I_a) using the following formula:
     $I_a = E_a(S_a/M_a)$
     Where:
          E_a = total annual estimated landing weight of the species
               (from the expansions) from all likely strata
          S_a = total weight of all landings from trips which were
               sampled from all likely strata
          M_a = total weight of all landings from all likely
                    strata

There were two problems with the annual indices: 1) when the estimated
weight of the species (E_a) was 0 and yet the likely strata (S_a) were
sampled, and 2) when no samples were taken from the likely strata (S_a)
and landings were made in the likely strata (M_a). In the first case
where $E_a=0$ and $S_a>0$ we set $I_a=S_a$. In the second case, where $S_a=0$ and
$M_a>0$ we set $I_a=0$.

     To create the final index, we used the following formula:
          $I = E_a/ M_a$
     Where:
           E_a = the sum of all estimated landings weights for the
          species from all years
           M_a = the sum of all weights from all landings from all
          years for the likely strata

This resulted in an annual sampled-strata index for each species. The
range of values for this index falls between 0 and 1 (inclusive).

     Another issue that needed to be considered when creating the
indices was regulatory-induced sorting. Prior to a requirement to
sort a given species, the species could be sorted into almost any
rockfish market category. After the regulation was implemented, the
regulated species had to be sorted into a single, relatively "pure",
market category. This meant that after the regulation was
implemented, there were fewer likely strata that had to be sampled.
The first thing we decided was to allow a three year "grace period" to
allow the regulation to be phased in. After three years, we
restricted the likely market categories to the single species market
category required by the regulation, and to the unspecified rockfish
market category (250). This adjustment affected two species: widow
rockfish in 1983 and bocaccio in 1991. In the late 1990's two other
species, black rockfish and canary rockfish were required to be sorted
as a result of trip limits. To a large extent, these were already
sorted into nominal market categories before the regulations went into

effect. Shortly after these sort requirements took place, heavy restrictions were placed on landings for these two species. Therefore, we feel the sort requirements did not substantially affect the Sampled Strata Index for either canary or black rockfish.

The sampled-strata index by itself does not have a lot of meaning: it must be evaluated in relation to the estimated expanded landings of the species. If the index is high, the reliability is considered good if most of the landings are based on actual port samples. If the index is high, but a large fraction of the landings are estimated from either NOMINAL or BORROWED type expansions, then the index is not as useful. If the index is low, it indicates the estimates could be unreliable; however, it could also mean that the sorting into market categories changed over time and that some of the strata were not as important in some years. It is for this reason that we report the indices as part of an overall Landing Estimate Score which includes other factors.

LANDING ESTIMATE SCORE

The final process for examining the reliability of the landing estimates was to create a landing estimate score for each species of rockfish. This score was based on the sampled-strata index, the possibility of misidentification, sorting requirements, percent of landings based on actual port samples, market category anomalies, landing anomalies, reliability of classification as Nominal, and the relative abundance of the species. While the score is largely subjective, it does provide a simple estimate of relative reliability.

The sampled-strata index (previously described) has value because it takes into account the sample distribution across likely strata. The index was scored as follows:
    1 - lowest 20th percentile of all indexes
    2 - 20th - 40th percentile
    3 - 40th - 60th percentile
    4 - 60th - 80th percentile
    5 - highest 20th percentile of all indexes

The possibility of misidentification was scored on a scale of 1-5. The following score definitions were used:
    1 - very easy to misidentify, one or more very similar
            species
    2 - easy to misidentify, possibly because it is rare
    3 - possible to misidentify, one or more somewhat similar
            species
    4 - unlikely to be misidentified, probably common or has
            distinctive characteristics
    5 - virtually impossible to misidentify, no similar species,
        common in the landings

The requirement for sorting was used in the score because it reduces the number of likely strata the species should be present in. The sorting requirement was scored as follows:
    1 - no mandatory sorting, no evidence of voluntary sorting
    2 - no mandatory sorting, some evidence of voluntary sorting
    3 - mandatory sorting within the last 5 years
    4 - mandatory sorting for more than 50% of sampled years
    5 - mandatory sorting for more than 75% of sampled years

Percent of landings based on actual port samples was used because it is a direct measure of our sampling coverage. Percent based on actual samples was determined by summing the pounds landed for the species by source code (ACTUAL, BORROWED, or NOMINAL) from the CALCOM landing estimates. Percent of landings was scored as follows:
    1 - <10% of landings based on actual port samples on average per
         year
    2 - 10-40% of landings based on actual port samples on average
          per
         year
    3 - 40-60% of landings based on actual port samples on average
          per
         year
    4 - 60-90% of landings based on actual port samples on average
          per
         year
    5 - >90% of landings based on actual port samples on average per
         year

Market category anomalies are highly subjective. For this part of the score we were interested in how stable the landings are in the most important market categories for the species (the ones used in the Sampled-Strata Indices previously described). The market category anomalies were examined on a statewide basis. Market category anomalies were scored as follows:
    1 - many anomalies, changes of greater than 50% among
        adjacent years
    2 - changes of >25% among adjacent years with no ready
        explanation
    3 - some spikes in probable market categories, with only
            about 50% of spikes having a ready explanation
    4 - some spikes in the market categories, most can be fully
            explained
    5 - few if any spikes, or if spikes are present, they can
            all be readily explained

Landing anomalies are similar to market category anomalies in that we were interested in how regular the patterns of estimated landings from the expansions were. We scored this in the same way as for market category anomalies.

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Reliability of assigning landings as Nominal was important because landing estimates often rely on assigning unsampled single species market categories as Nominal. If the assumption that the market category is composed entirely (or nearly entirely), of the target species is incorrect, then the reliability of the estimate will be low, particularly if a large fraction of the landings rely on the Nominal estimation method. Nominal reliability was scored as follows:

1 - known to be unreliable in most years
2 - no way to evaluate, possibly because it has never been sampled
3 - poorly sampled therefore reliability is uncertain
4 - between 60-85% of fish by weight in the port samples are the target species
5 - Highly reliable in most years, voluntary or mandatory sorting is typical

Relative abundance was included in the score because the more common a species is, the more likely it is to be correctly identified and to be present in multiple port samples. This is true even if there are similar species. The best example of this is with longspine and shortspine thornyheads. The two species are very similar. They are also very common. Therefore because of their high abundance, port samplers can readily tell the difference between the two species. To examine relative abundance, we summed the number of fish observed in all samples over all years and then ranked then in ascending order. Relative abundance was scored as follows:

1 - bottom 20th percentile in actual number of observed fish
2 - 20 - 40th percentile
3 - 40 - 60th percentile
4 - 60 - 80th percentile
5 - top 80th percentile

For each rockfish species, a final reliability score was tabulated as a simple sum of the eight ranking factors. A summary discussion for each species is provided so that users of the landing estimates can evaluate the reliability of the data. Although we feel that the final score is valuable, we also feel that users of the landing estimates should consider each of the ranking elements separately since each has value. For example, if most of the landing estimates are based on actual samples, this alone suggests the landings are more likely to be reliable.

RESULTS

Landing Receipts

Our examination of landing receipts found numerous errors, including bad port codes, multiple codes for unknown gear, undefined or poorly defined gear codes, and invalid market categories; however, very few errors were related to groundfish. Most of these errors occurred prior to 1980 and affected coastal pelagics, invertebrates,

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highly migratory species and certain nearshore, non-groundfish species like perch and smelt.

Market Category Analysis

Although market categories are discussed in more detail in the species accounts section later in this document, we detected two market category problems while examining the landing receipts that need to be covered in more detail here. The first problem was the redefinition of market category 265 in 1981. The second problem is the apparent recoding of all landings previously listed as market category 253 (bocaccio), to market category 956 (group chilipepper/bocaccio) in 1979.

Currently market category 265 is defined as yelloweye rockfish. Examination of the landing distributions of this market category between 1969 and 2006 shows a dramatic reduction in the landings after 1981 (Figure 6). Since yelloweye rockfish is a relatively minor species, the high landings of this market category prior to 1982 warranted concern. As we examined the distribution of the landings, it became clear this market category had been redefined. Port samples taken prior to 1982 from market category 265 had very few yelloweye rockfish, while samples taken after 1981 were composed almost entirely of yelloweye rockfish. In fact, the species compositions of port samples prior to 1982 more nearly matched the species composition of market category 959 (group red), which did not appear on landing receipts until 1980. We examined a CDFG catch report for 1968 where market category 265 was described as red rockfish, not yelloweye. To resolve this issue, we developed the ratio estimation method (previously described) to eliminate the effect of the redefinition of market categories in unsampled years. It is not clear why this market category was redefined, since we could not find any documentation.

When we examined the market category distribution, we noted that prior to 1979, market category 956 (group chilipepper/ bocaccio) had never been used (Figure 7). In 1980, there were no landings reported for this market category and very few in 1981. After 1981, the market category was used frequently. Additionally, we found that market category 253 (bocaccio), which was heavily used prior to 1979, was virtually absent in 1979. Market category 253 was then used again after 1979 until it disappeared in the mid 1980s and then reappeared in 1991 as a result of a regulatory requirement forcing sorting of bocaccio. When we looked into this situation in more detail, we found 62 port samples taken in 1979 listed as having been taken from market category 253. When we matched the port samples to the landing receipts, we found that in every case, the landing receipts showed market category 956. This occurred at four different port complexes. Since port samplers are supposed to record the market category shown on the landing receipt at the time they take the sample, it was clear the market category had been changed on the receipt after the sample had been taken. It was also clear that this had been done only in 1979. As a result, port samples taken for market category 253 in 1979

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were not used in the expansion process since there were no landings to expand to. Moreover, landings reported as 956 could not be expanded since there were no port samples taken for this market category. It should be noted that the species composition of market category 253 prior to 1982 contained a large amount of species other than bocaccio. This situation had a large effect on landings for 1979. The problem was of sufficient magnitude to require us to re-expand the 1979 landings after recoding the market category 956 landings to market category 253. This resulted in an increase of the bocaccio and chilipepper rockfish landing estimates, while reducing the landings of widow rockfish. These three species are major components of California's rockfish landings. It is not known why or by whom the landing receipts were altered.
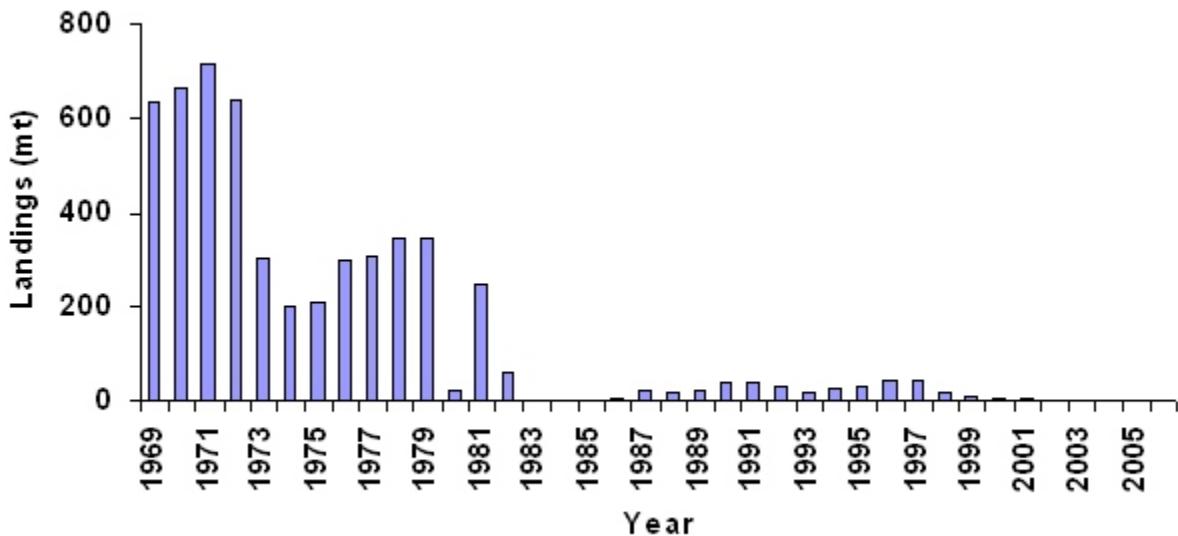

Figure 6. California landings of market category 265 (currently defined as yelloweye rockfish) in metric tons from 1969-2006.

Port Sampling

We examined how well sampling was conducted by comparing sampled landing sizes to the actual landing size distribution, and found that our port samples were fairly representative of the landings (Figure 8). The plot in Figure 8 shows that the median of the sampled landing weights are close to a 1:1 ratio with the overall mean landings weights per trip. A strong deviation from this pattern would have suggested a bias in the way samples were taken.

16
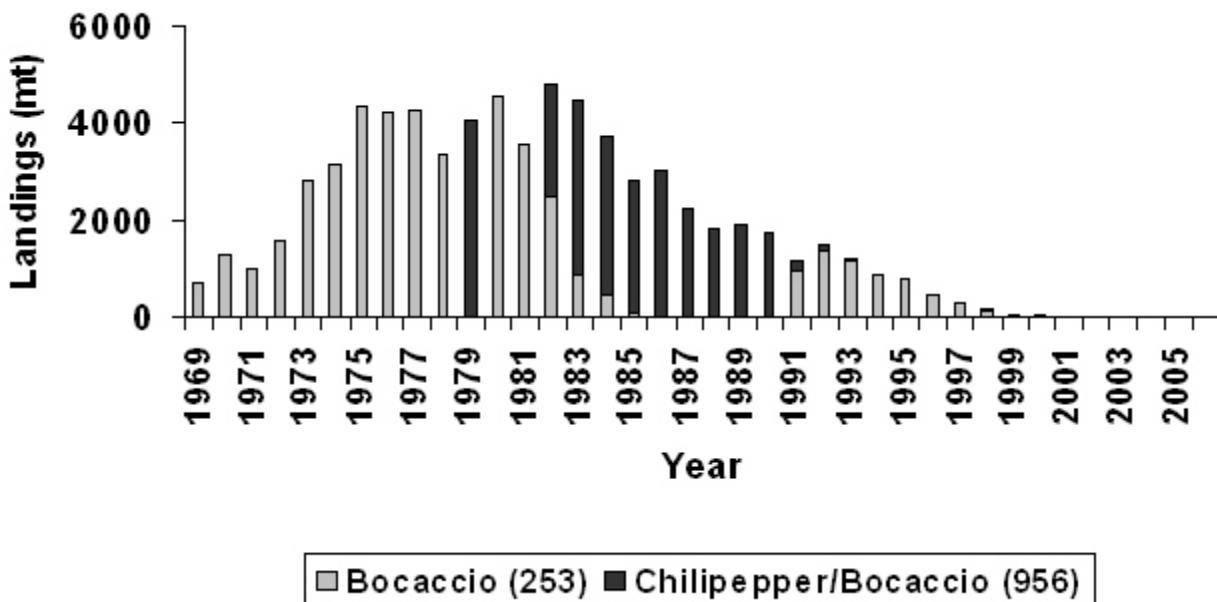
Figure 7. California Landings of market categories 253 (bocaccio rockfish) and 956 (chilipepper/bocaccio) (metric tons) from 1969-2006.
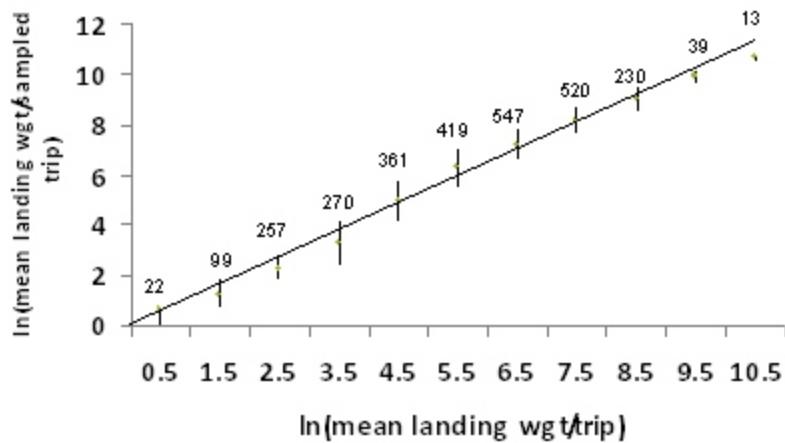
Figure 8. Plot of the natural log of mean landing weight per trip for sampled trips versus bins of the natural log of mean landing weight per trip for all landings. The dot represents the median value and the range bars are for the 25th and 75th percentiles. A line of equality is shown as well as the number of samples for each bin.

Species Accounts (By Group and Scientific Name)

SHARKS AND SKATES

Thresher Shark: Common, Bigeye, and Pelagic
Scientific Names: *Alopias vulpinus* (common), *A. superciliosus* (bigeye), *A. pelagicus* (pelagic)
Principal Gear(s) used: gill net
Principal Area(s): southern California
Market Category(ies): 97 - Bigeye, 98 - Pelagic, 155 - Thresher unspecified, and possibly 150 - unspecified shark

General Information:
     Three species of thresher shark are caught in California, with the pelagic thresher being far less abundant than the other two species (common and bigeye). These three species were heavily targeted in the late 1970s through the mid 1980s in southern California (Figure 9) (Ebert, 2003). Most landings were made using gill net; however, there is a large quantity in the early 1980s with unknown gear type. It is assumed that most of the unknown gear was gill net.

     Most thresher shark landings occur in the general thresher shark market category, making it impossible to obtain reliable estimates of the landings of each of the three species. There is also a large quantity of unspecified shark landings which occurred in southern California using gill nets at the same time that the thresher shark fishery was taking place (Figure 10). It is therefore considered possible that at least some of the unspecified shark was in fact thresher shark which means that the landing estimates for this species are low, possibly by as much as 50% in some years. Since we could not find any species composition data from the unspecified shark market category, we cannot confirm what species were actually being landed. Overall we feel the landing estimates for this species are generally unreliable.

Soupfin shark
Scientific Name: *Galeorhinus galeus*
Principal Gear(s) used: trawl and gill net
Principal Area(s): southern and central California
Market Category(ies): 159 - soupfin shark

General Information:
     This species was the target of a large fishery in the 1930s and 1940s (Ebert, 2003). Since it is highly prized, it is likely that most of the landings are reported in the soupfin shark market category with little being reported in the unspecified shark market category; therefore landing estimates are considered to be generally reliable (Figure 11).

18
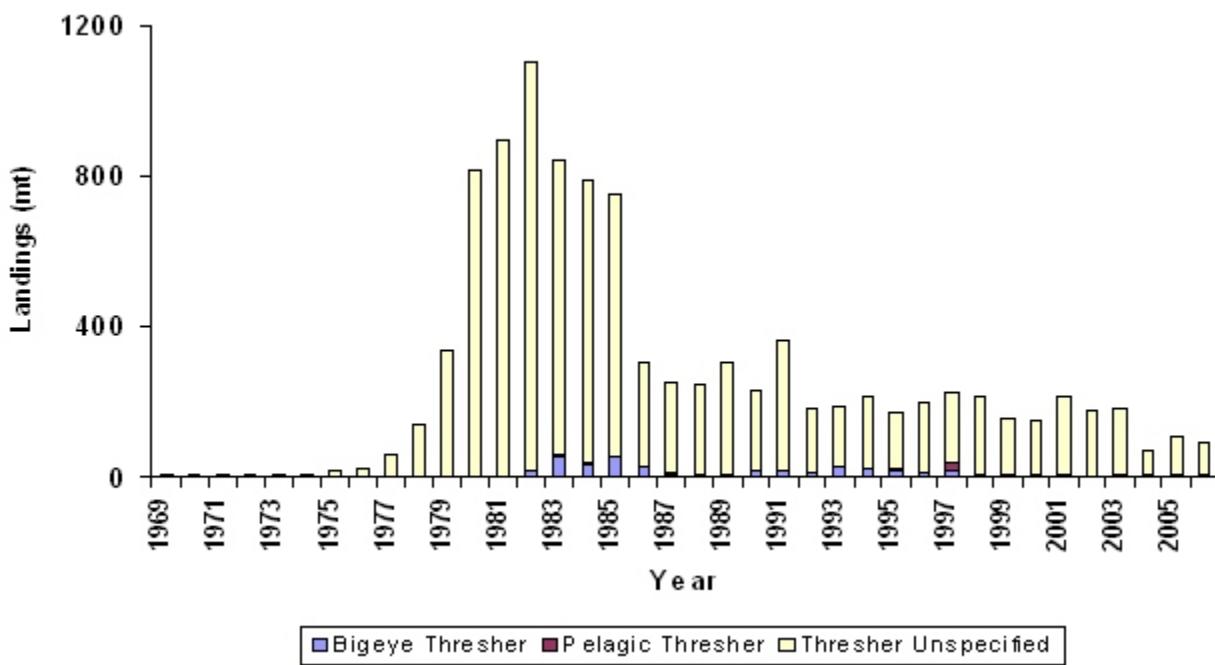
Figure 9. Estimated annual commercial landings (metric tons) of
thresher shark from California. Landings are shown by species as
estimated from landing receipts.
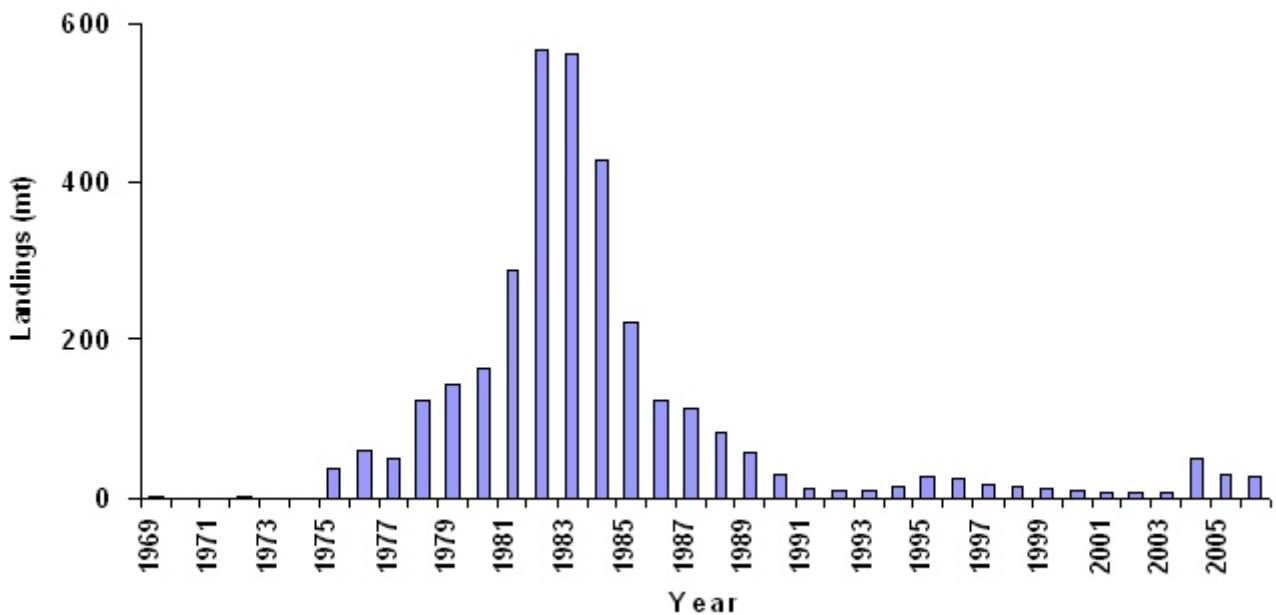
Figure 10. Estimated annual commercial landings (metric tons) of
unspecified shark from California, 1969-2006.
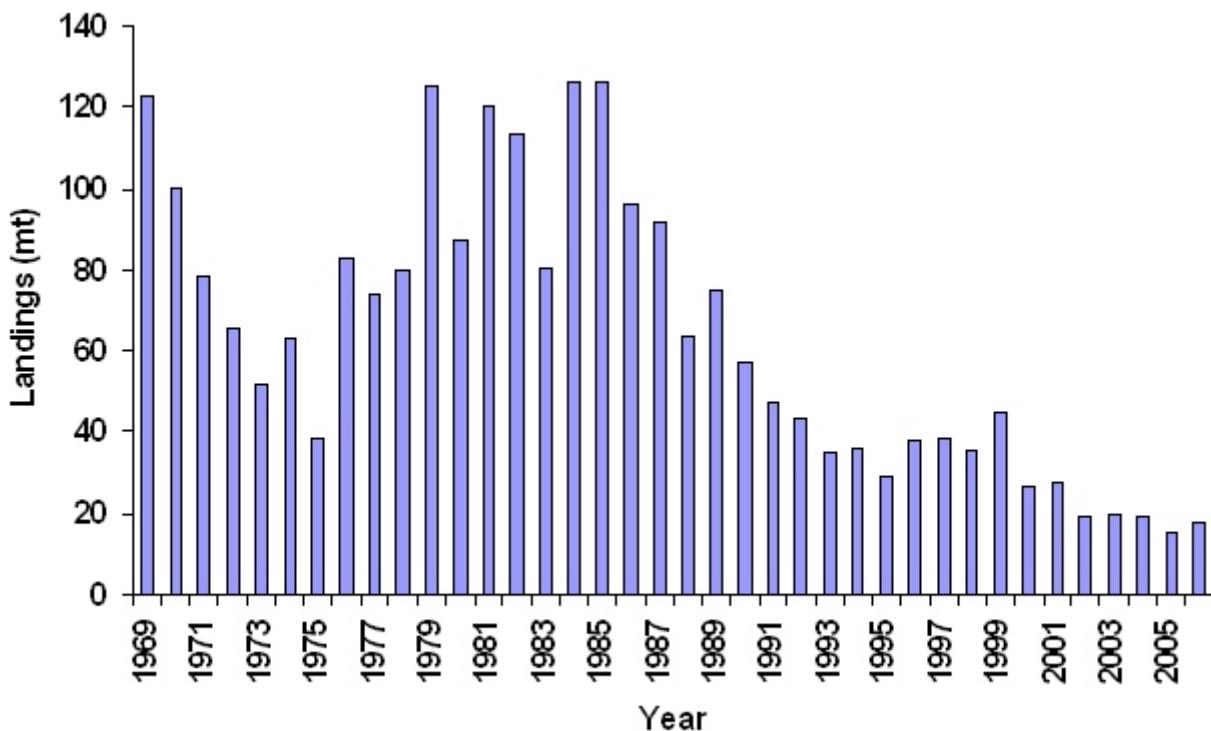
Figure 11. Estimated annual commercial landings (metric tons) of soupfin shark from California, 1969-2006.

Spiny dogfish

Scientific Name: *Squalus acanthias*
Principal Gear(s) used: trawl and gill net
Principal Area(s): all
Market Category(ies): 152 - shark, spiny dogfish

General Information:

This species is readily identifiable and is probably not landed with other species. It is possible that a small fraction of the spiny dogfish landings are reported as unspecified sharks. Between 1977 and 1981 there were large landings in southern California (Figure 12). It is possible that some spiny dogfish were reported as unspecified shark prior to 1987; however, this cannot be confirmed. Since 2000, landings have increased somewhat, possibly as a result of increased landing restrictions on other species. We feel the landing estimates for this species are generally reliable.
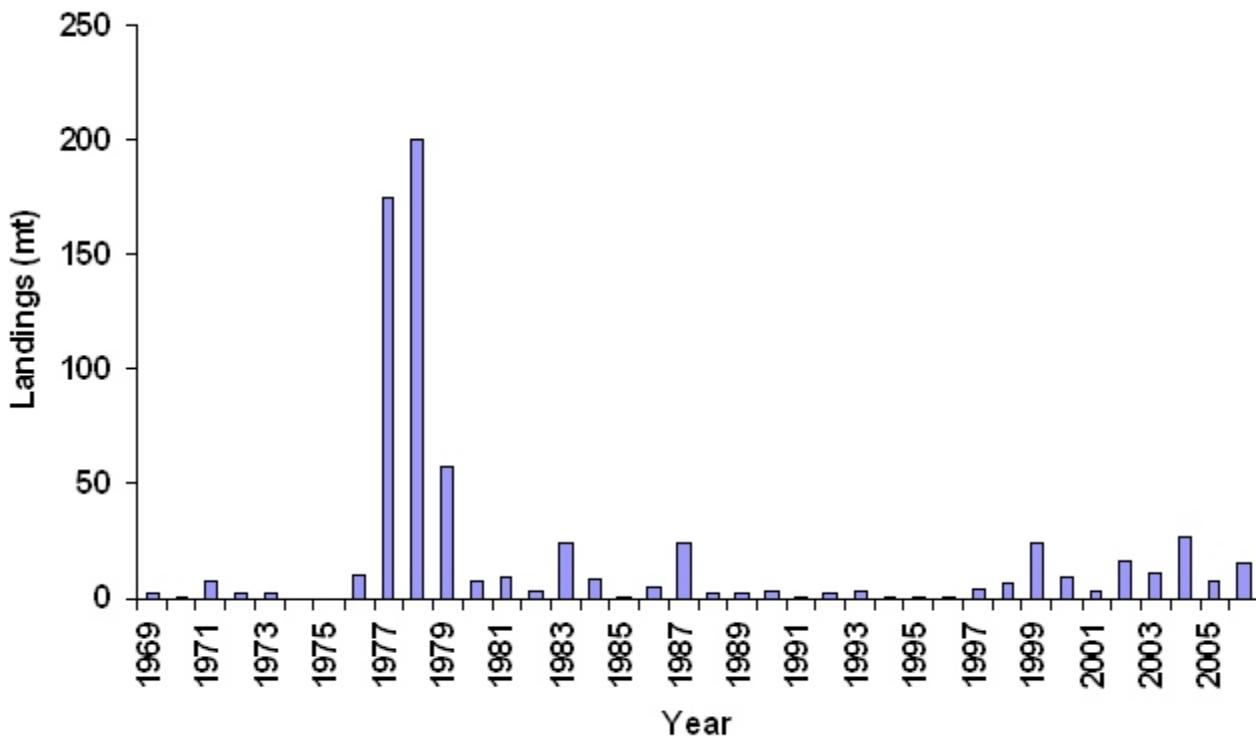
Figure 12. Estimated annual commercial landings (metric tons) of spiny dogfish from California, 1969-2006.

Angel shark
Scientific Name: *Squatina californica*
Principal Gear(s) used: drift gill net
Principal Area(s): Santa Barbara
Market Category(ies): 165 - Angel shark

General Information:
    Angel sharks were targeted heavily in the mid 1980s by the drift gill net fishery (Ebert, 2003). The species was highly prized, and as a result, was probably sorted into the angel shark market category. We feel landing estimates for this species are likely to be very reliable (Figure 13).

Leopard shark
Scientific Name: *Triakis semifasciata*
Principal Gear(s) used: gill net
Principal Area(s): all
Market Category(ies): 153 - leopard shark

General Information:
    This species is readily identifiable. Landings have been generally low and widespread (Figure 14). A general decline in landings after 1993 coincided with a reduction in the use of gill nets.

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A small directed fishery was conducted on this species in San Francisco Bay during the 1970s and 1980s (Ebert, 2003). We feel the landing estimates for this species are very reliable.
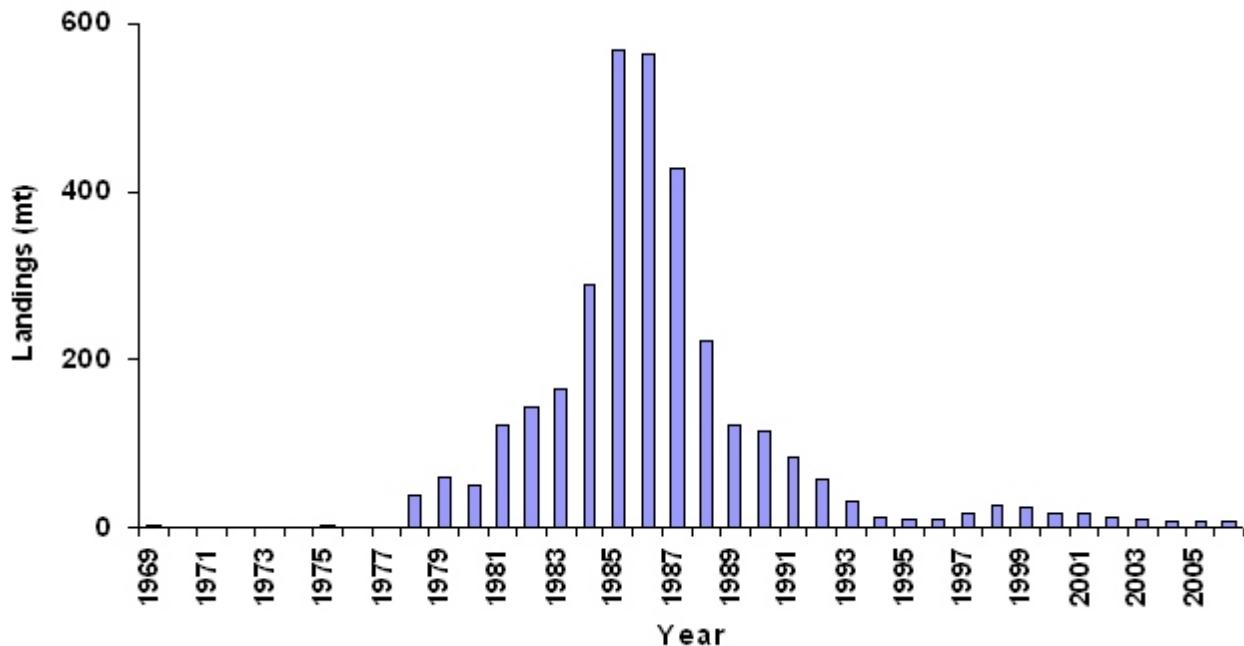
Figure 13. Estimated annual commercial landings (metric tons) of angel shark from California 1969-2006.
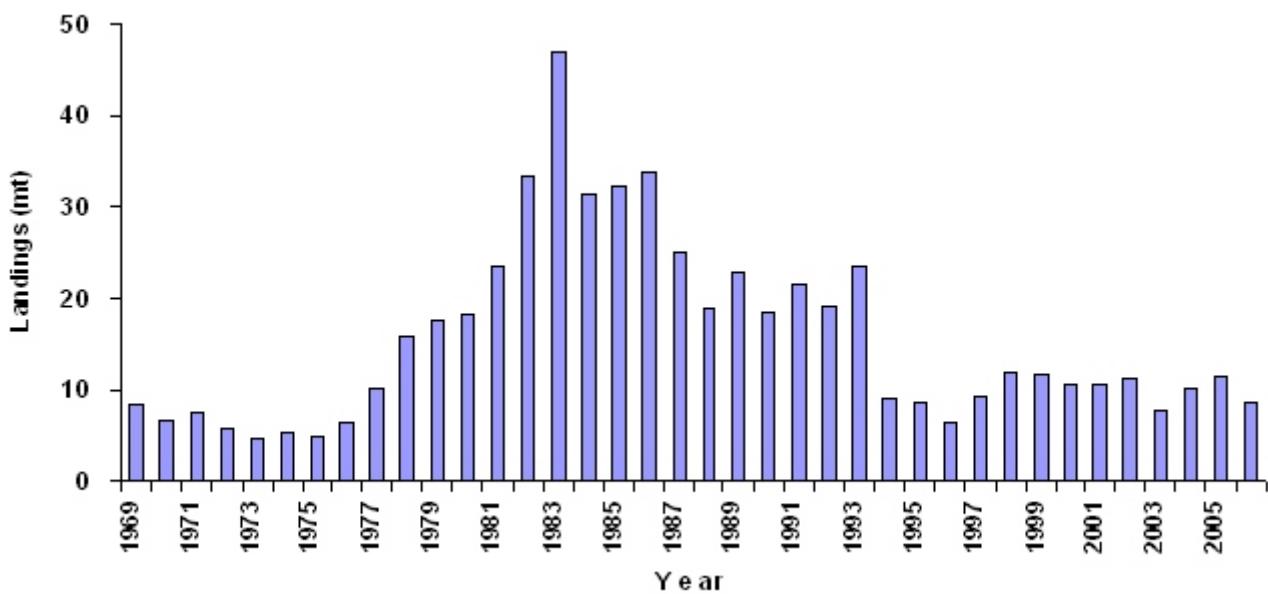

Figure 14. Estimated annual commercial landings (metric tons) of leopard shark from California, 1969-2006.

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                              Skates
Scientific Names:  various species
Principal Gear(s) used: trawl
Principal Area(s): northern California
Market Category(ies): 175 - unspecified skate, 176 - big skate (Raja
binoculata), 177 - California skate (Raja inornata)
```

General Information:

     Currently there is no defined market category for the longnose skate (*Raja rhina*) even though it is identified in the GFMP. In addition, there are several other species of skates not listed in the GFMP, which do not have separate market categories, and which could be landed in California. The vast majority of skates are landed in the unspecified skate market category. Large landings were made in the late 1990s and early 2000s with most occurring in northern California (Figure 15). Landings in market categories 176 (big skate) and 177 (California skate) never exceeded 2 mt, while landings in the unspecified market category ranged from 550 to 1350 mt. It is therefore not possible to estimate species-specific landings for skates in California using landing receipt data and no port sample data exist.
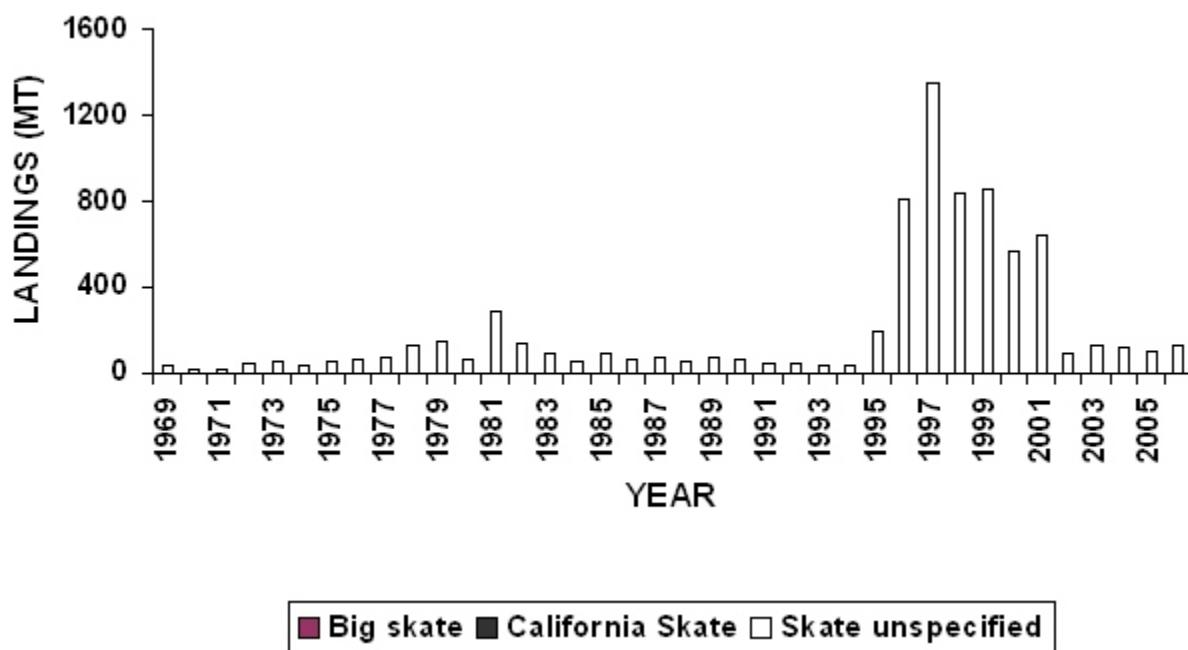

Figure 15. Estimated annual commercial landings (metric tons) of skates from California, 1969-2006. Although three market categories exist for skates, more than 99% of all skates are landed in the unspecified skate market category; therefore, all three market categories are combined in this figure.

<pre>
                        Spotted Ratfish
Scientific Names: *Hydrolagus colliei*
Principal Gear(s) used: all
Principal Area(s): all
Market Category(ies): 166 - Spotted ratfish
</pre>

General Information:

Only 5,700 pounds of spotted ratfish have been reported in California for all years combined. It is possible that some ratfish were landed in the miscellaneous fish category (999); however, this cannot be confirmed. We feel that landing estimates for this species are very unreliable. However, total landings are probably low.

                        Elasmobranch Summary

Port sampling of the elasmobranchs has not been done, although a pilot program was initiated in 2008. Virtually no information exists on skate landings. Landing estimates of most sharks are probably reliable, although species-specific estimates of thresher sharks are not available.

                             FLATFISH

Until 2003, there was no information on species composition of flatfish market categories even though port samples were collected for sex, age, and length. For the most part it was assumed that nearly all landings in a market category consisted of the defined nominal species. Starting in 2003, species-composition port samples were collected from flatfish market categories. These samples demonstrated that the market categories were relatively "pure" for the species. What is evident, however, is that even a small percentage of a different species in the Dover sole landings could equal a large fraction of the reported landings for the other species, resulting in underestimating the landings of that species.

<pre>
                  Flounders - Arrowtooth and Starry
Scientific Name: *Atheresthes stomias* (arrowtooth), *Platichthys
stellatus* (starry)
Principal Gear(s) used: trawl
Principal Area(s): northern California (arrowtooth), northern and
central California (starry)
Market Category(ies): 201 - arrowtooth flounder, 230 - unspecified
flounder (possibly), 231 - starry flounder
</pre>

General Information:

Arrowtooth and starry flounder landings are presented together because landing estimates of the two species are linked due to the presence of large landings in the unspecified flounder market category (230) (Figure 16). Although the two species are not closely related, there is good reason to believe the unspecified flounder market category contains both species.

The arrowtooth flounder is primarily a northern, deepwater species (typically greater than 100 meters), while starry flounders are common in both northern and central California in shallow water (typically less than 100 meters).
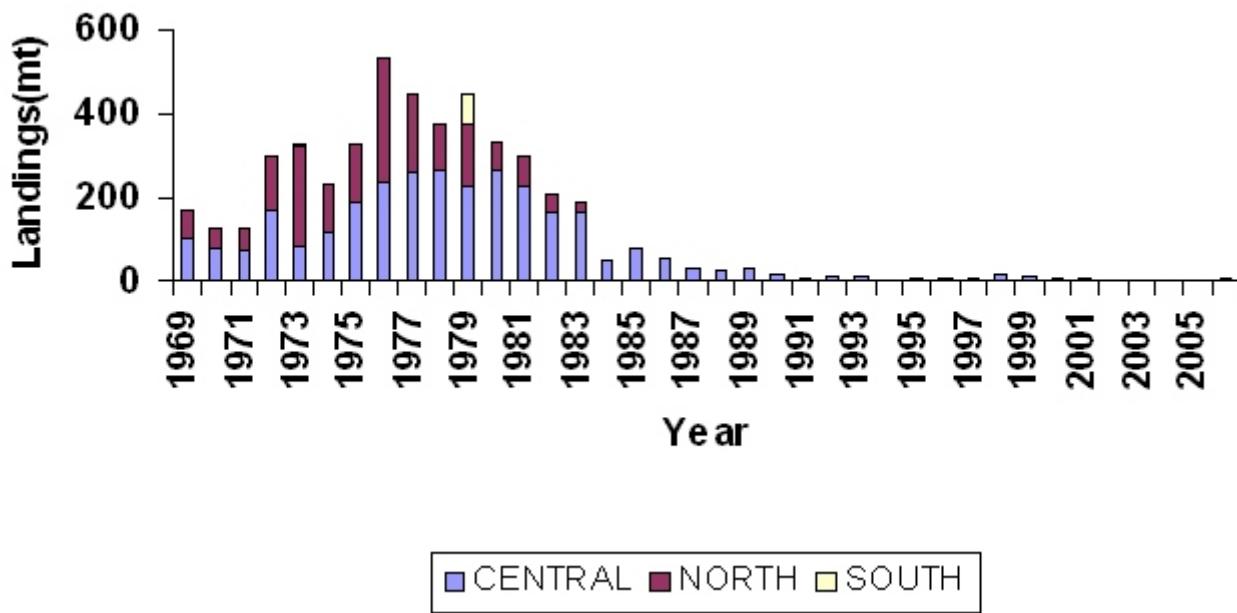

Figure 16. Estimated annual commercial landings (metric tons) of unspecified flounder from California by region, 1969-2006.
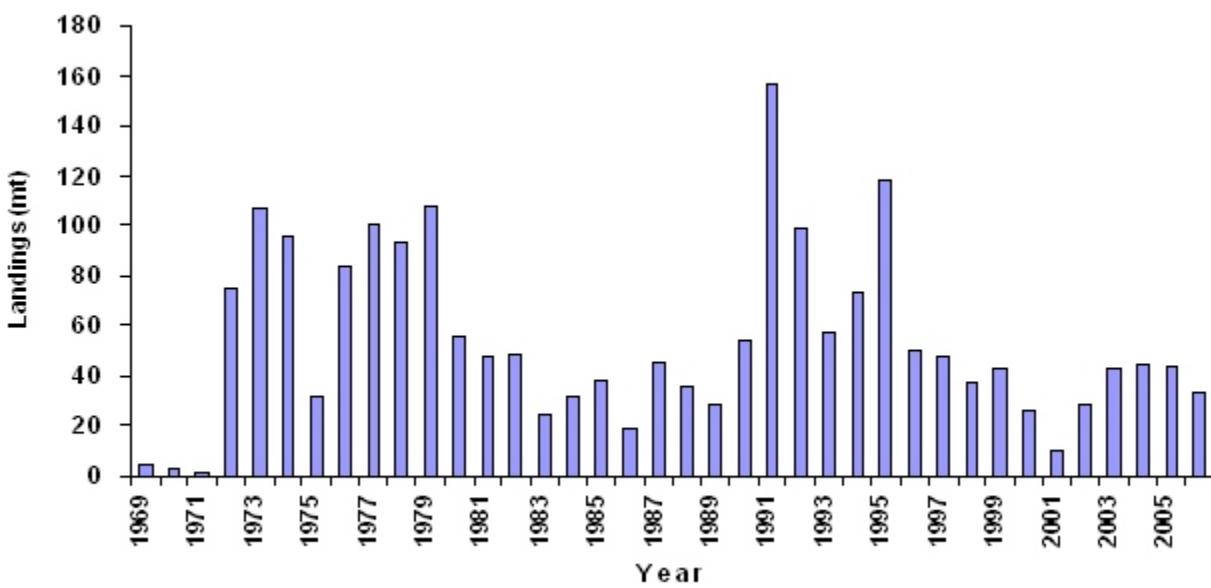
Figure 17. Estimated annual commercial landings (metric tons) of arrowtooth flounder from California, 1969-2006.

Landings in the arrowtooth market category (201) were irregular
between 1969 and 2006 (Figure 17). We feel the landing estimates of
arrowtooth flounder after 1986 are probably reliable since the amount
of unspecified flounder landings in the north is very low after 1986.

Very few landings were made in the starry flounder market
category (231) prior to 1983 (Figure 18); however, unspecified flounder
landings were quite high prior to 1984 (Figure 16). Many of the pre-
1984 landings of unspecified flounder were in central California and we
feel that many of those landings were starry flounder. Landings of
unspecified flounder in the north probably included some starry
flounder since both starry flounder and arrowtooth flounder are caught
there. Since the amount of unspecified flounder landings declined
sharply after 1983, we feel that landing estimates from 1984 through
2006 are probably reliable, but those prior to 1984 are probably not.
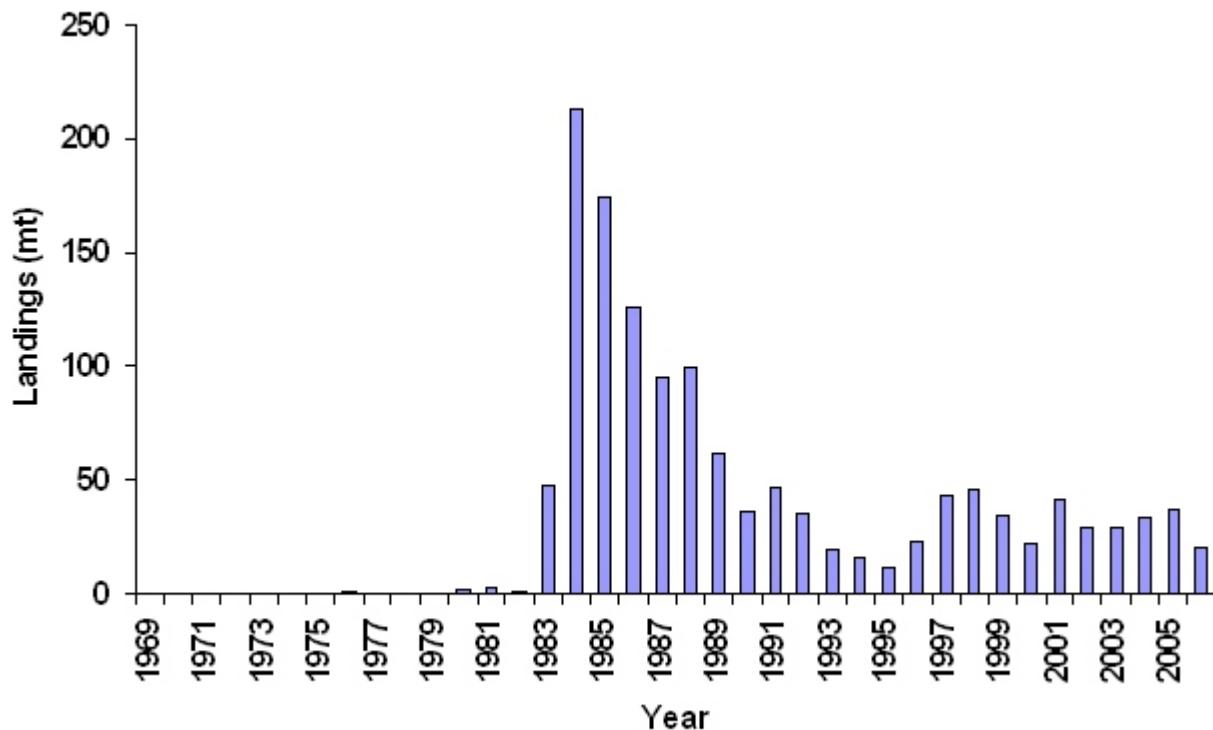
Figure 18. Estimated annual commercial landings (metric tons) of
starry flounder from California, 1969-2006.

We feel that analysis of trawl logs, paired with landing
receipts, could improve landing estimates of both arrowtooth and starry
flounder since there should be very little overlap in the depth
distributions. End users of the landing estimates of these two species
should consider conducting this analysis prior to using the landing
estimates.

Scientific Name: *Citharichthys sordidus*
Principal Gear(s) used: trawl
Principal Area(s): northern and central California
Market Category(ies): 225 - sanddab, unspecified

General Information:
     Although a market category exists for Pacific sanddab (227), it is almost never used, instead, the unspecified sanddab market category (225) is used. At least four species of sanddab are known to be taken in the commercial fishery: Pacific sanddab, longfin sanddab (*C. xanthostigma*), speckled sanddab *(C. stigmaeus*), and gulf sanddab (*C. fragilis*). Both longfin sanddab and gulf sanddab are rare in northern and central California, where well over 95% of unspecified sanddab landings are reported. Speckled sanddabs are much smaller than Pacific sanddabs (maximum total length of 15cm as opposed to 40cm for Pacific sanddab) (Miller and Lea, 1972), and are probably discarded by fishermen if they are caught.   Based on 224 port samples (5,547 fish), we found that more than 96% of the landings in the unspecified sanddab market category were Pacific sanddabs. We therefore feel the best estimate of Pacific sanddab landings is obtained from combining the landings in the Pacific and unspecified sanddab market categories (Figure 19).
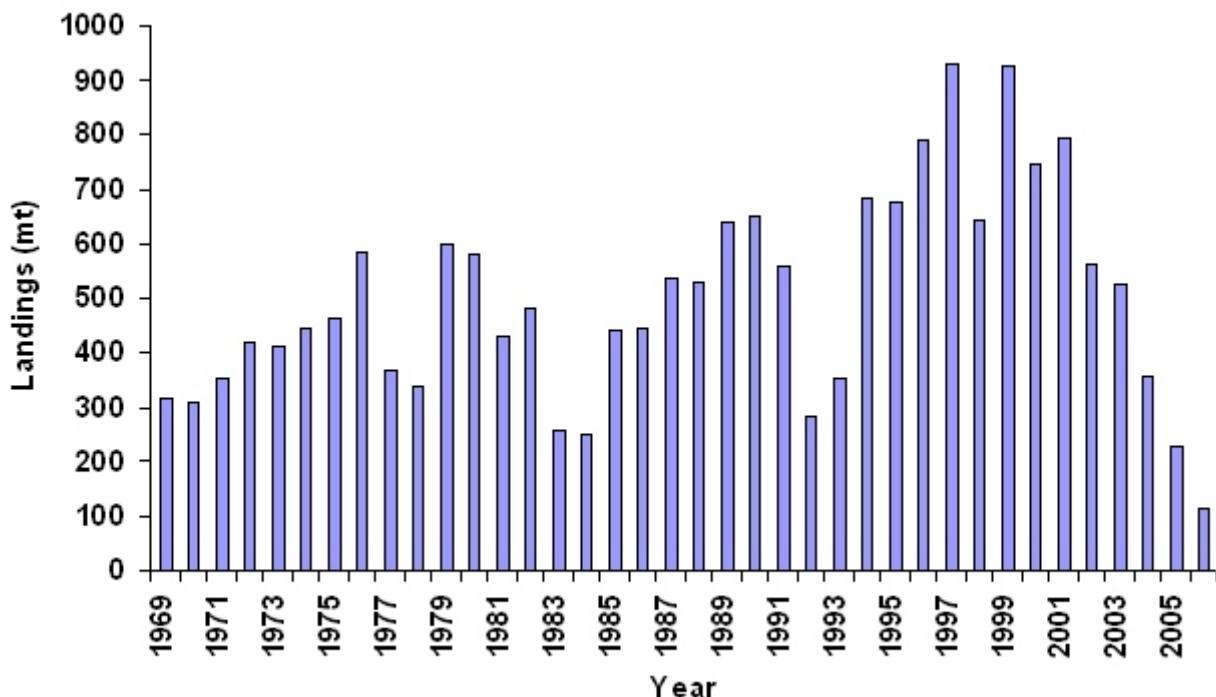

Figure 19. Estimated annual commercial landings (metric tons) of Pacific sanddab (based on landings from the unspecified sanddab and the Pacific sanddab market categories combined) from California, 1969-2006.

Sanddab landings varied substantially among years (Figure 19). It is possible that many of the fluctuations were market-driven as well as a response to regulations closing areas of the shelf to trawling where sanddabs are typically caught.

Some sanddabs are landed mixed with other species in different flatfish market categories; however, port sample data indicates that only small quantities are landed this way. Of 3,514 non-sanddab flatfish port samples with 132,035 fish, only 35 of the fish were sanddabs. Overall we feel Pacific sanddab landing estimates are generally reliable if it is assumed that nearly all the unspecified sanddab landings are Pacific sanddab.

Speckled Sanddab
Scientific Name: *C. stigmaeus*
Principal Gear(s) used: unknown
Principal Area(s): unknown
Market Category(ies): 225 - unspecified sanddab, 228 - speckled sanddab

General Information:
Although a separate market category exists for this species, fewer than 300 pounds were reported in it for all years combined. It is likely some of the landings in the unspecified sanddab market category were speckled sanddab. Given the maximum total length of this species (15cm), it is likely that total landings are extremely low since small fish are typically discarded. In general we feel that landing estimates for this species are very unreliable.

Longfin Sanddab
Scientific Name: *C. xanthostigma*
Principal Gear(s) used: hook-and-line (possibly), trawl (possibly)
Principal Area(s): southern California
Market Category(ies): 225 - unspecified sanddab, 226 - longfin sanddab

General Information:
Although a separate market category exists for this species, fewer than 500 pounds were reported in it for all years combined. It is possible that landings reported as unspecified sanddab for southern California may include some longfin sanddab; however, annual landings in the unspecified sanddab market category in southern California have never exceeded 15 metric tons. We feel that total landings of longfin sanddabs are probably very low. Overall, we feel that landing estimates for this species are very unreliable.

Petrale Sole
Scientific Name: *Eopsetta jordani*
Principal Gear(s) used: trawl
Principal Area(s): northern and central California
Market Category(ies): 209 - petrale sole

General Information:

        The petrale sole is a highly desirable species with one of the
highest prices per pound of any flatfish (PacFIN, 2006). Between 1969
and 2006, landings were highest in the early 1970s at more than 1,600
metric tons and declined to less than 800 metric tons in recent years
(Figure 20). Based on 3,411 port samples (132,110 fish), from non-
petrale sole market categories, only 148 fish were petrale sole. In
addition, about 0.5% of the petrale sole market category landings were
other species, mostly English sole. In spite of this mixing, we feel
the amounts are not large and therefore believe our estimates are very
reliable.
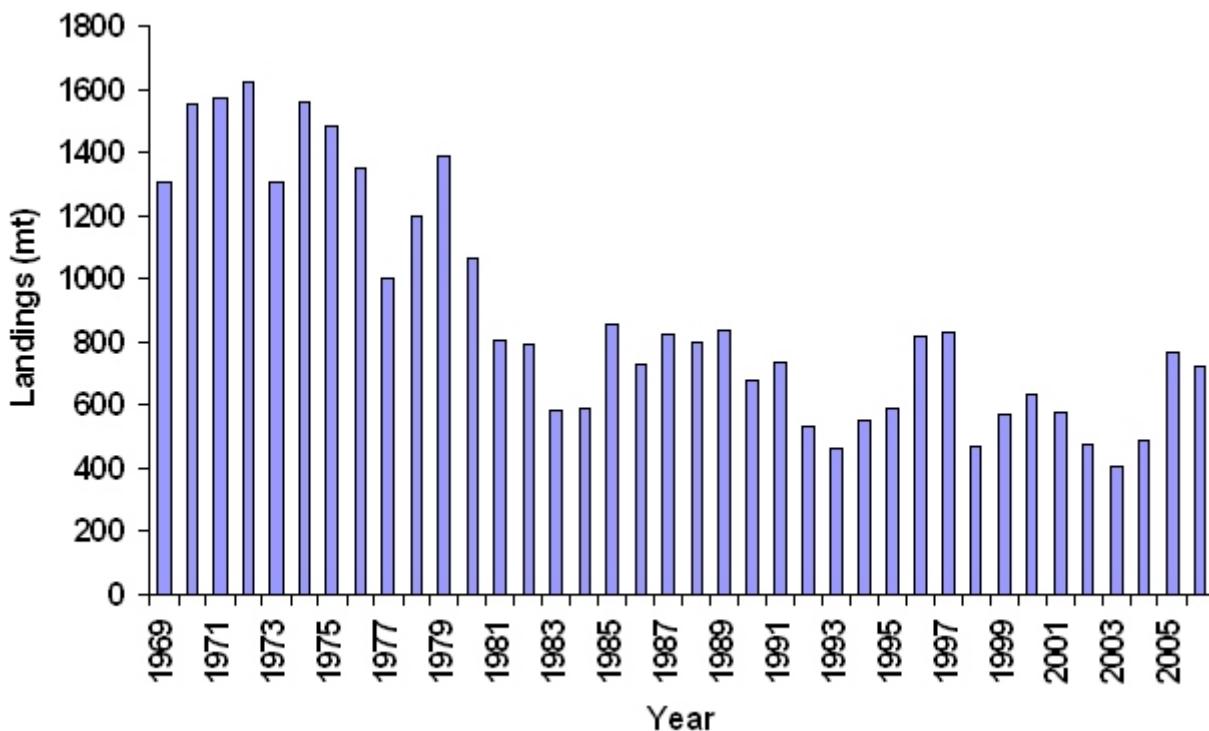
Figure 20. Estimated commercial landings (metric tons) of petrale sole
from California, 1969-2006.

                              Rex Sole
Scientific Name: *Glyptocephalus zachirus*
Principal Gear(s) used: trawl
Principal Area(s): northern and central California
Market Category(ies): 207 - rex sole

General Information:

        The rex sole is one of the top five most heavily landed flatfish
in California. Landings averaged around 800 metric tons through the
late 1980s and declined to less than 200 metric tons in 2006 (Figure

                                  29

21). Thirty-two port samples were taken from the rex sole market category and show that more than 98% of the landings were rex sole. Species composition port samples of the Dover sole market category (211) indicate that perhaps as much as 0.67% of the Dover sole landings in some years were rex sole. Since landings of Dover sole are typically very high, 0.67% can mean as much as 80 metric tons in the best years of the Dover sole fishery. This could mean as much as 10% of the rex sole landings are not being accounted for in some years. We feel our estimated landings for rex sole are low and that our current estimates of landings for this species are only somewhat reliable. Further analysis of the landings and species compositions could easily improve the reliability of the estimates.
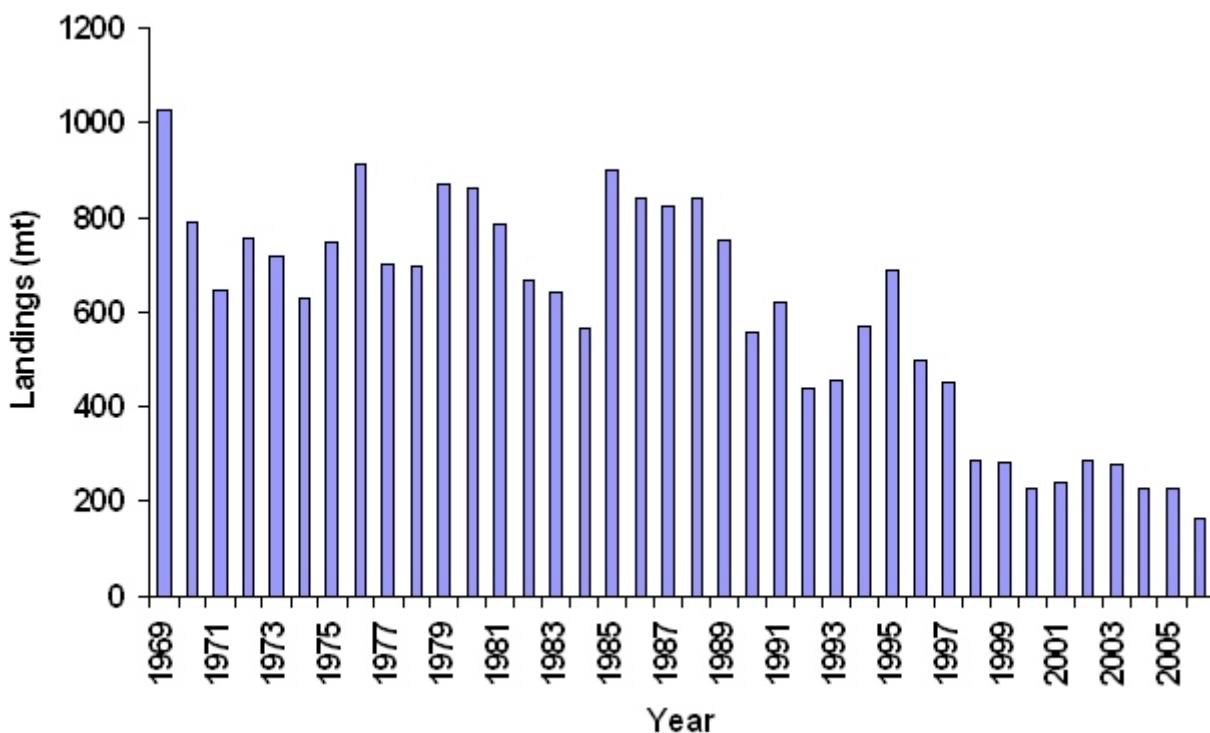
Figure 21. Estimated annual commercial landings (metric tons) of rex sole for California, 1969-2006.

                          Pacific Halibut
Scientific Name: *Hippoglossus stenolepis*
Principal Gear(s) used: hook-and-line
Principal Area(s): northern California
Market Category(ies): 221 - Pacific halibut

General Information:
     Since 1970, Pacific halibut landings have never exceeded 30 metric tons and were usually less than 5 metric tons (Figure 22).

30

Virtually all reported landings of this species occurred in northern
California and were caught with hook-and-line gear. A small quantity
is landed as bycatch in the whiting trawl fishery.

    It is unlikely that very much Pacific halibut is landed in the
unspecified halibut category since most of the reported landings in
this market category occurred in central and southern California where
Pacific halibut are rare. Even if some Pacific halibut were included
in the unspecified halibut market category (220) landings, they would
still be low since annual landings of unspecified halibut were low
(Figure 23). We therefore feel that estimated landings of Pacific
halibut are very reliable.
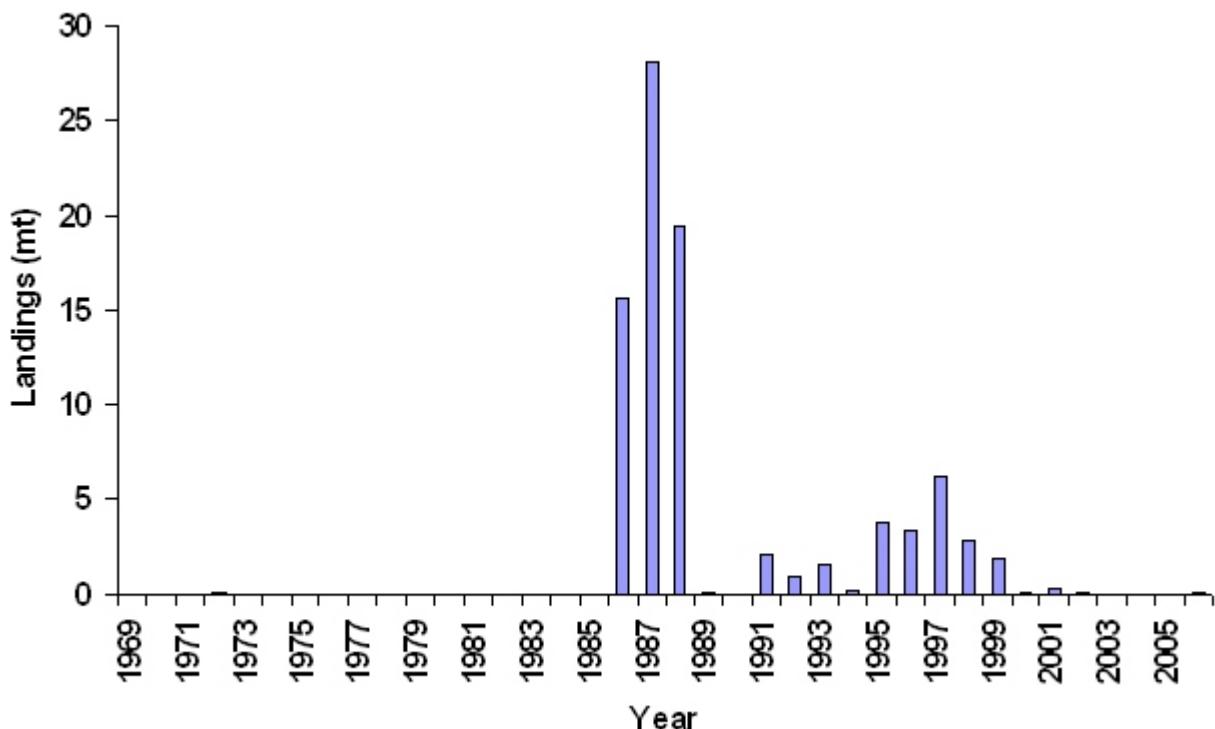
Figure 22. Estimated annual commercial landings (metric tons) of
Pacific halibut from California, 1969-2006.

                        Dover Sole
Scientific Name: *Microstomus pacificus*
Principal Gear(s) used: trawl
Principal Area(s): northern and central California
Market Category(ies): 211 - Dover sole

General Information:
    The Dover sole is by far the most heavily landed flatfish in
California with peak landings of more than 12,000 metric tons in 1985
(Figure 24). A few other species are occasionally mixed with the
landings; however, 99.6% of all fish sampled in the Dover sole market

category were Dover sole. A few Dover soles are mixed in with landings of other species as well and some are probably included in the unspecified sole market category (200); however, the vast majority are landed in the Dover sole market category. Overall, we feel the landing estimates for this species are very reliable.
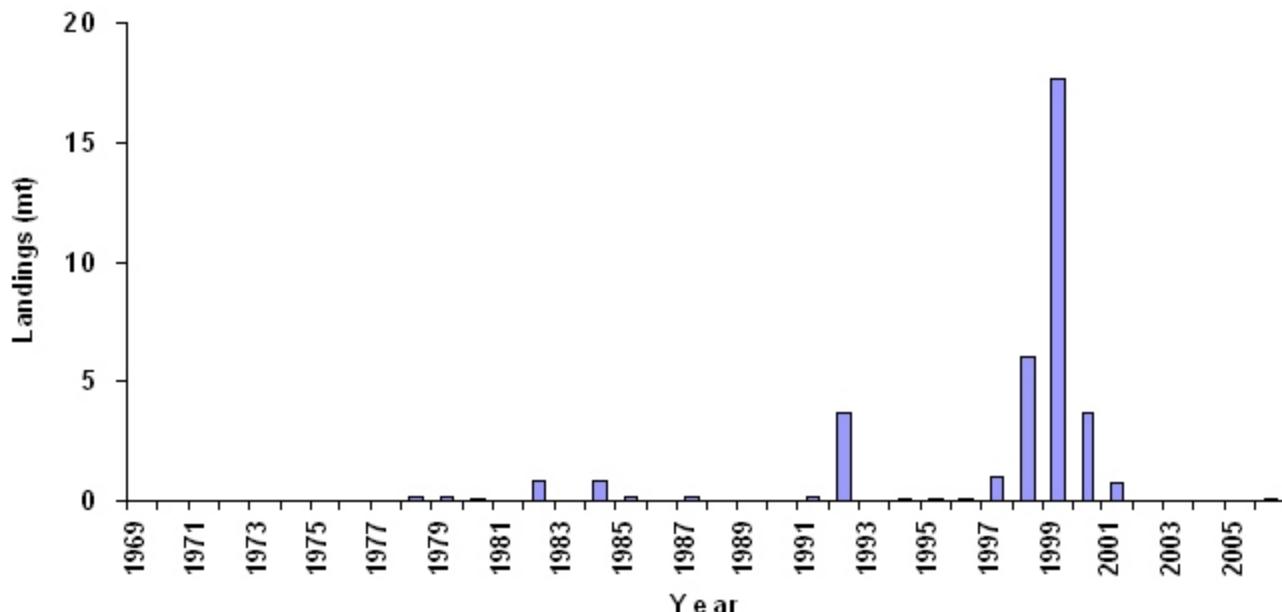
Figure 23. Estimated annual commercial landings (metric tons) of unspecified halibut from California, 1969-2006.
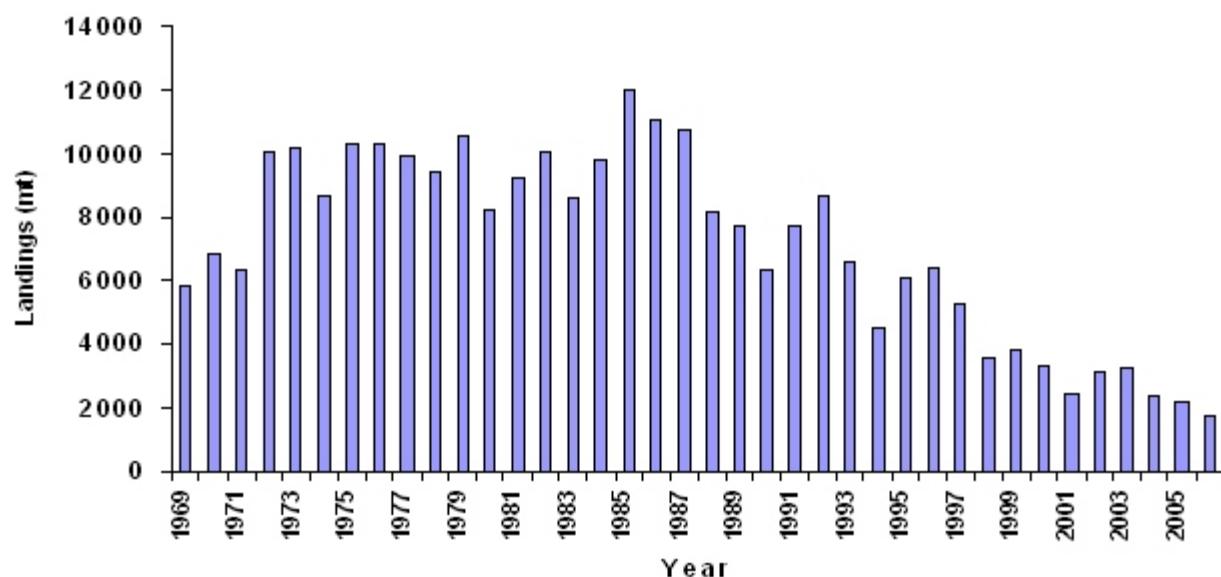

Figure 24. Estimated annual commercial landings (metric tons) of Dover sole from California, 1969-2006.

California Halibut
Scientific Name: *Paralichthys californicus*
Principal Gear(s) used: gill net and trawl
Principal Area(s): southern and central California
Market Category(ies): 222 - California halibut

General Information:
     More than 95% of all halibut are landed in the California halibut
market category. Landings were generally low through the 1970s and then
increased in the 1980s (Figure 25). Landings in central California were
about equal to those in southern California.

     The California halibut is a highly prized commercial species and
the price per pound is the highest of all California's flatfish (PacFIN,
2006). It is likely that nearly all California halibut are landed in
the California halibut market category. There are probably some landed
in the unspecified halibut market category (220). However, annual
landings in that category are quite low (Figure 23). We therefore feel
that landing estimates for this species are very reliable.
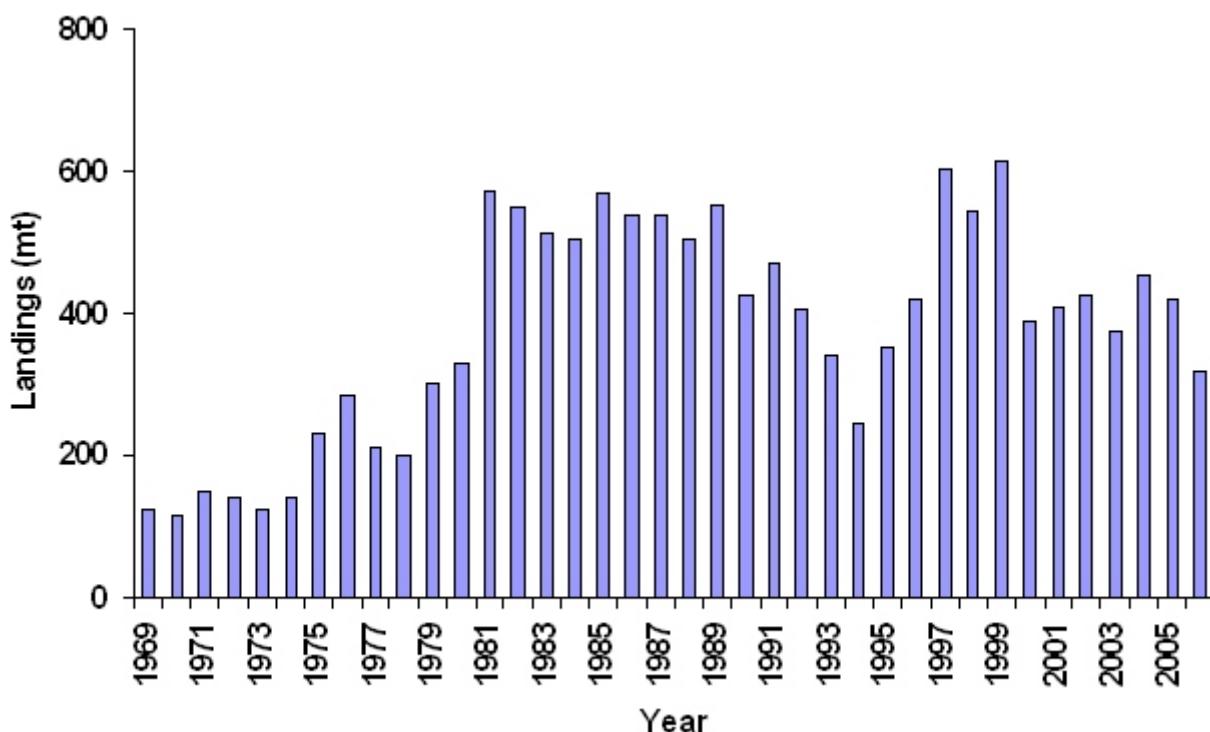
Figure 25. Estimated annual commercial landings (metric tons) of
California halibut from California, 1969-2006.

English Sole

Scientific Name: *Parophrys vetulus*
Principal Gear(s) used: trawl
Principal Area(s): northern and central California
Market Category(ies): 206 - English sole

General Information:
     Landings of English sole have declined from a high of more than
2000 metric tons in 1979 to their current levels of about 300 metric
tons (Figure 26). It is possible that the declines were market driven
although this is not clear. English sole are readily identified and
common. While a small amount (less than 1%) of landings in the English
sole market category are other species, this amount is probably offset
by the small quantity of English sole landed in other market categories
including unspecified sole (200). We therefore feel our estimates of
English sole landings are very reliable.
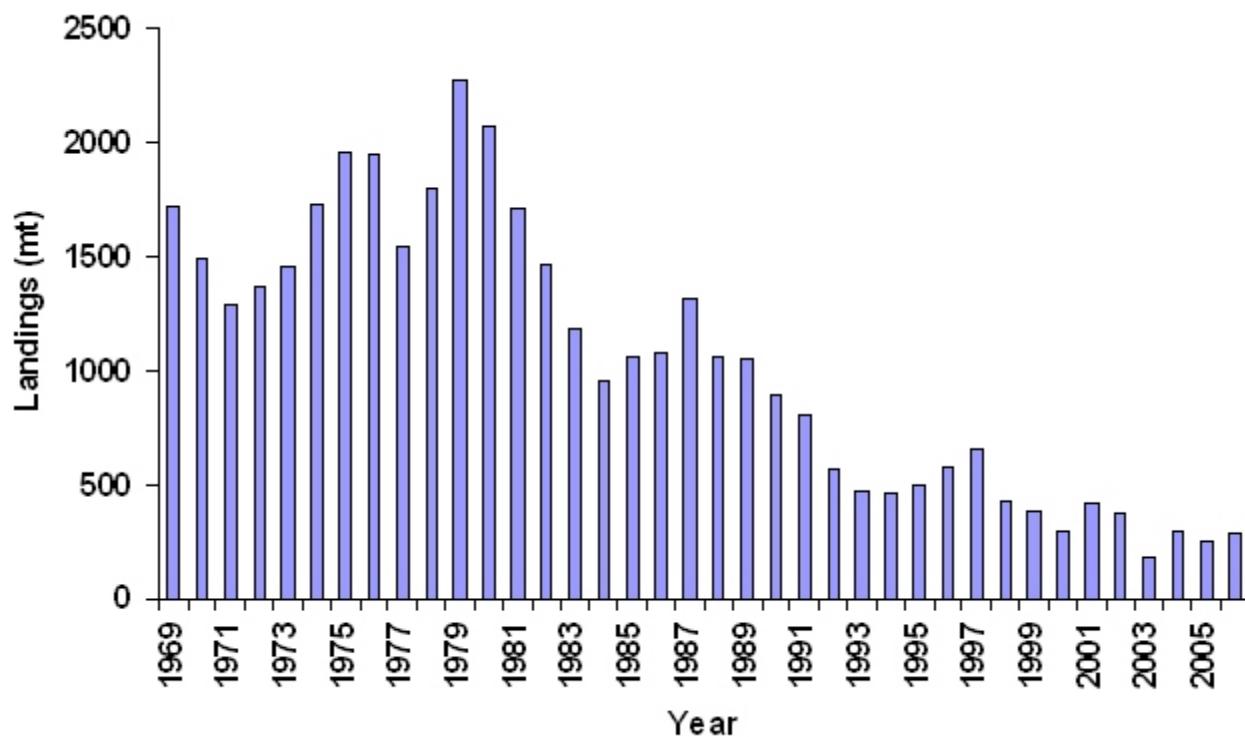

Figure 26. Estimated annual commercial landings (metric tons) of
English sole from California, 1969-2006.

Turbots

Scientific Name:
Principal Gear(s) used: trawl
Principal Area(s): northern and central California
Market Category(ies): 240 - unspecified turbots

34

General Information:
    There are six market categories for turbots; however, more than 99%
of all landings were reported using the unspecified turbot market
category. At least five species of turbots could be taken in the
commercial fishery: curlfin turbot (*Pleuronichthys decurrens*), spotted
turbot (*P. ritteri*), hornyhead turbot (*P. verticalis*), C-O turbot (*P.
coenosus*), and diamond turbot (*Hypsopsetta guttulata*).

    Reported landings using the unspecified turbot market category
peaked in the mid 1980s at about 20 metric tons and then declined to
less than one metric ton in 2006 (Figure 27). In the 1970s there were
as much as eight metric tons landed each year in southern California;
however, the landings ended after 1981. It is likely that landings in
the unspecified turbot category had other species mixed in with them.
It is also likely that turbots were mixed in other market categories
including unspecified sole (200) and unspecified sanddabs (225).
Overall, we feel that estimates of turbot landings are very unreliable
but the actual landings are probably low.
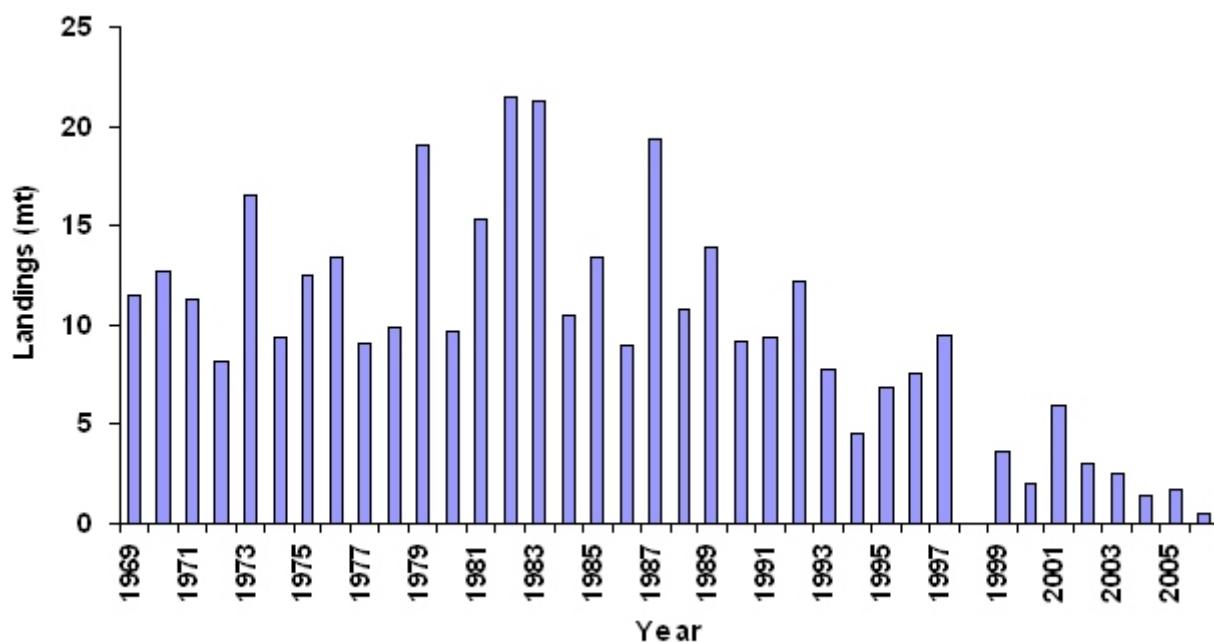
Figure 27. Estimated annual commercial landings (metric tons) for
turbots (all species) from California, 1969-2006.

                              Sand Sole
Scientific Name: *Psettichthys melanostictus*
Principal Gear(s) used: trawl
Principal Area(s): northern and central California
Market Category(ies): 205 - sand sole

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General Information:
     The sand sole is one of the highest priced flatfish, with price per
pound similar to petrale sole (PacFIN, 2006) and as such are likely to be
sorted into the sand sole market category when landed. Landings peaked
in the late 1970s at more than 300 metric tons and have since declined to
less than 10 metric tons (Figure 28). It is likely that some sand sole
were landed in other market categories including unspecified sole (200).
It is not likely that large quantities are landed in unspecified sole
since the largest quantities of unspecified sole landings occur in
southern California where sand sole are rare. We feel that, overall, our
landing estimates of sand sole are somewhat reliable.
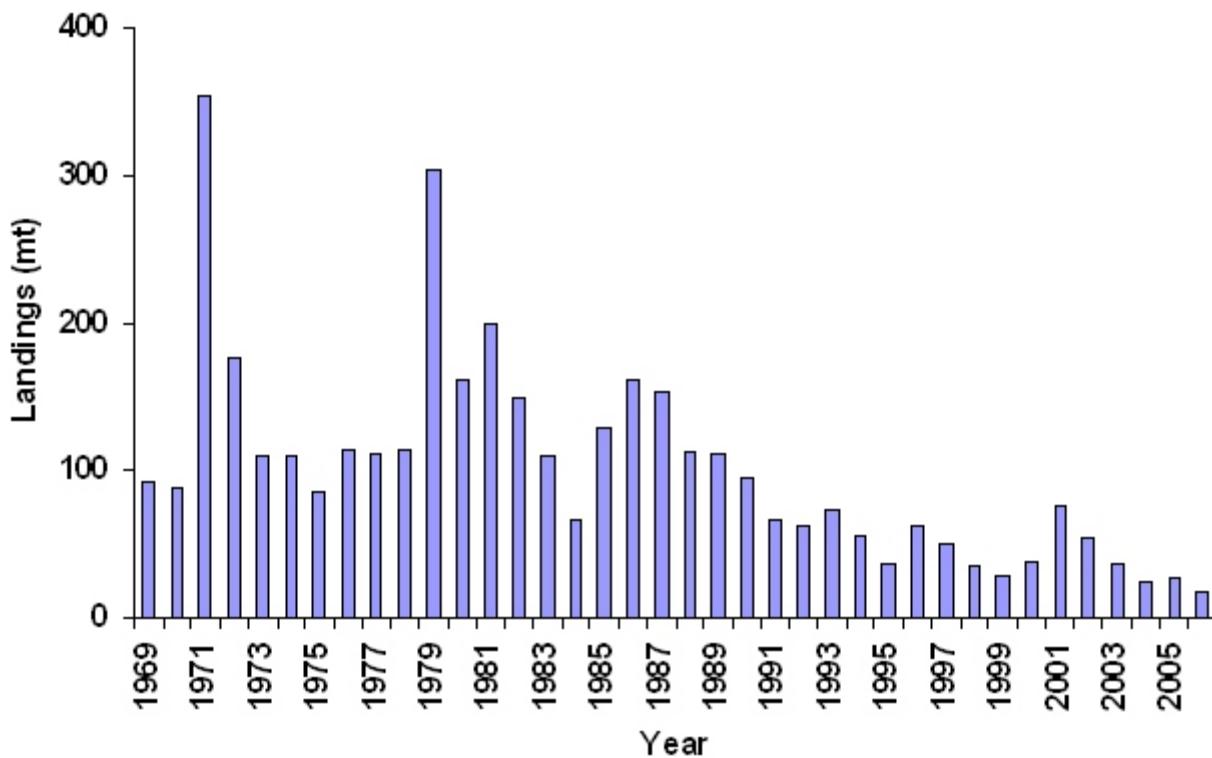

Figure 28. Estimated annual commercial landings (metric tons) of sand
sole from California, 1969-2006.

                         Other flatfish
Scientific Name:
Principal Gear(s) used:
Principal Area(s): northern and central California
Market Category(ies): 202 - bigmouth sole, 203 - rock sole, 204 -
fantail sole, 208 - butter sole, 210 - slender sole, 212 - tongue sole

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General Information:
     Landings in these market categories are low and erratic (Figure 29).
It is likely these species are landed mixed with other, more abundant
species including Dover sole, sanddabs, English sole, and petrale sole.
We therefore feel that our estimates for these species are very
unreliable.
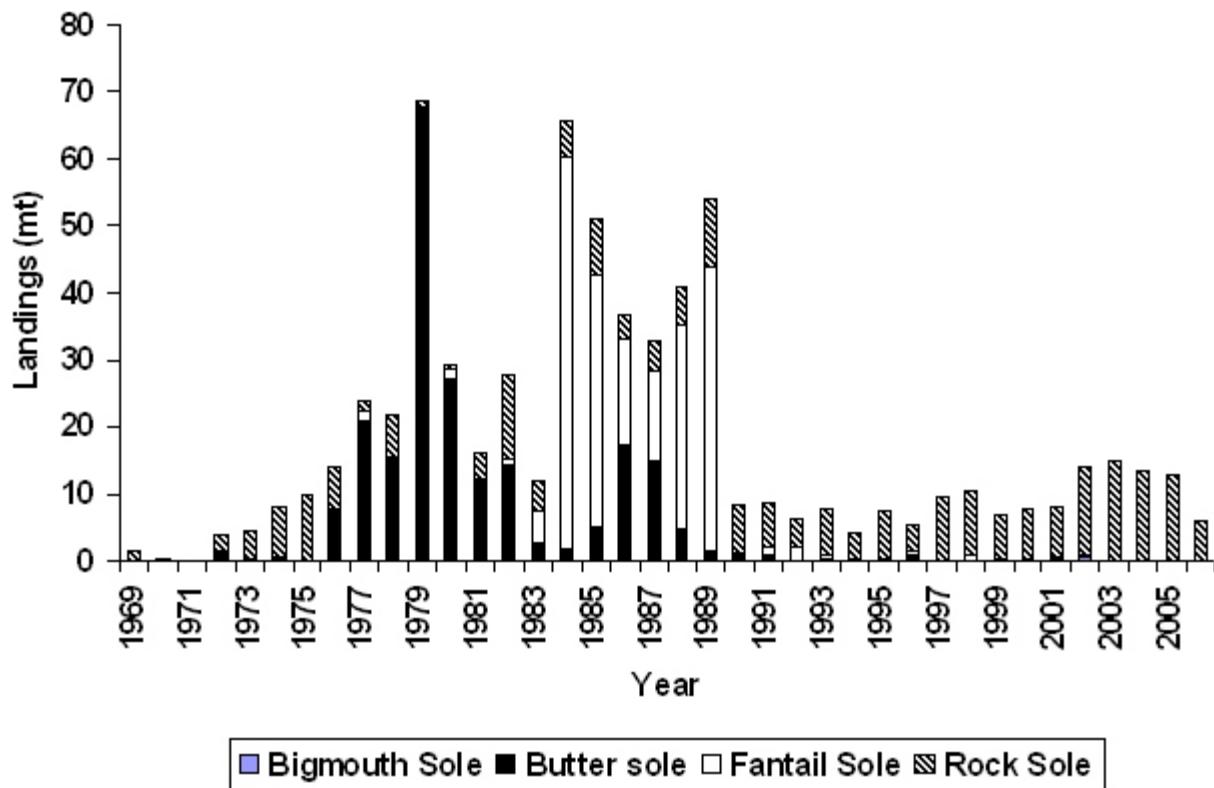
Figure 29. Estimated annual commercial landings (metric tons) of other
flatfish from California, 1969-2006.

                         Unspecified Sole
Scientific Name:
Principal Gear(s) used: trawl, gill net
Principal Area(s): southern and central California
Market Category(ies): 200 - unspecified

General Information:
     Prior to the mid 1980s, most unspecified sole were landed by gill
net in central California and averaged less than 10 metric tons per year
(Figure 30). From 1985 onwards, the majority of landings in this

category were landed by trawl in southern California and ranged from 5 to 38 metric tons. Overall, the total quantity of fish landed in this market category were small relative to other important flatfish landings. We feel that landings in this category probably do not seriously affect the reliability of estimates for the most important flatfish since landings in this market category are low relative to the total landings of those species.
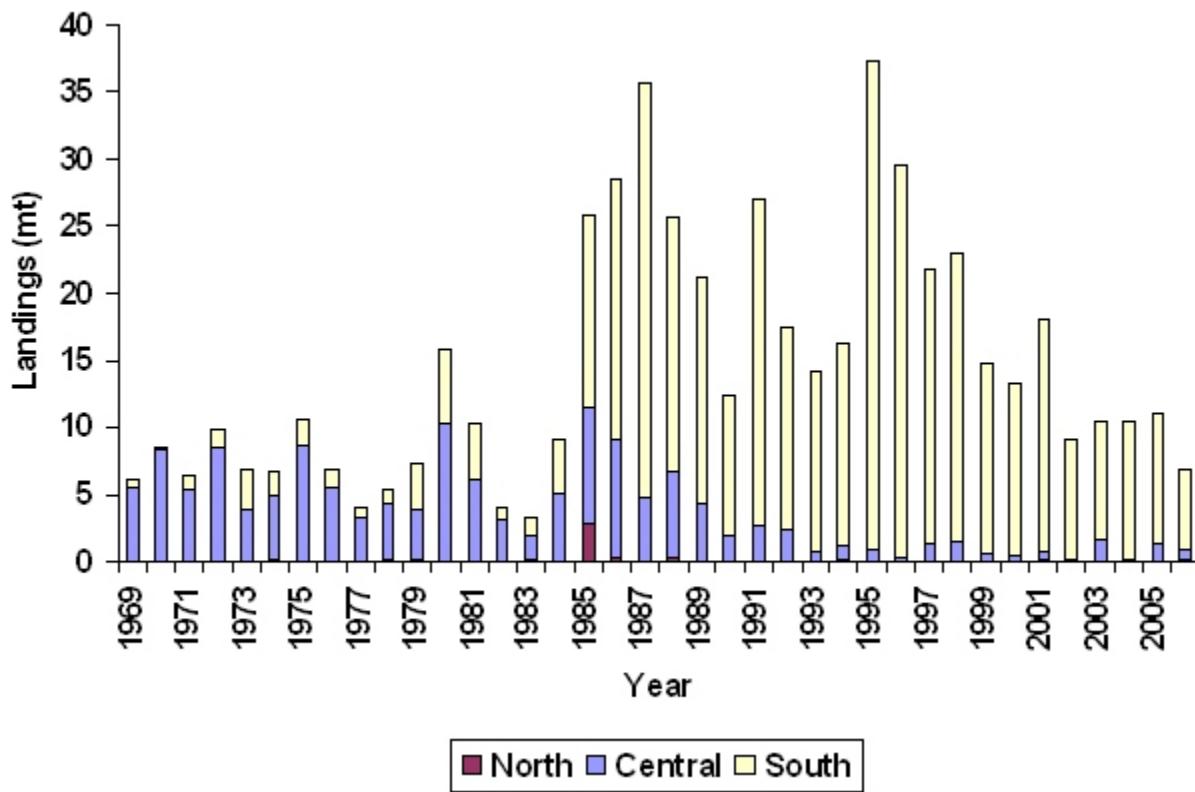
Figure 30. Estimated annual commercial landings (metric tons) of unspecified sole by geographic area from California, 1969-2006. NORTH=Crescent City, Eureka, and Fort Bragg; CENTRAL=Bodega Bay, San Francisco, Monterey, and Morro Bay; SOUTH=Santa Barbara, Los Angeles, and San Diego.

Flatfish Summary

Prior to 2003, port samples from the flatfish market categories were only collected to estimate biological data, and no species composition data were recorded. For the most part it was assumed that nearly all landings in a flatfish market category consisted of the defined species. Starting in 2003, species composition port samples were collected from flatfish market categories. These samples demonstrated that the market categories were relatively "pure" for the species. What was evident, however, was that even a small percentage of a different species in the

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Dover sole landings could equal a large fraction of the reported landings for other species, resulting in underestimating the landings of those species.

Landing estimates for most flatfish species are generally reliable; however, there are problems with sanddabs, starry flounder, and arrowtooth flounder. These problems can be corrected with additional sampling and further analysis. In addition, we have no information on what species are present in the unspecified turbot and unspecified sole market categories. Since landings in the unspecified sole and unspecified turbot market categories are low, we do not feel that landing estimates of the major flatfish are seriously affected.

Current port sampling efforts for flatfish are expected to help resolve species composition problems. It is likely that landing estimates for some species will be adjusted if ongoing analyses indicate that it is necessary.

ROCKFISH AND THORNYHEADS

These accounts are sorted by scientific name and use the following format:
Common Name: the generally accepted common name as reported in Love et al. 2002.
Scientific Name: as reported in Love et al., 2002
Similar Species: as reported in Love et al., 2002
Confusing Common Names: Alternate common names that might result in data recording errors, as reported by Love et al., 2002.
Principal Gear(s): The most important gear(s) used to catch the species. This is determined by inspection and typically includes the gear(s) responsible for more than 90% of the catch.
Principal Area(s): The principal area(s) or port(s) responsible for the majority of the catch.
Principal Market Category(ies): The principal sort group(s) (market category) into which the species are sorted Typically these groups would account for more than 75% of landings. Both the market category code(s) and a brief description are included.
Sampled Strata Index: A range of annual values for the index and a mean value for all sampled years are provided.
Landing Estimate Score: The score for each of the eight criteria are shown as well as the total score.
Discussion: A brief discussion and final evaluation are provided. In many cases the discussion is broken into a late time interval (1983-2006) and an early time interval (1969-1982) due to the absence of port samples in the early years, particularly for southern California. We discuss the late interval first, because landing estimates for the early time interval often rely on data collected during the late interval.

Rougheye rockfish

Scientific Name: *S. aleutianus*
Similar Species: Shortraker rockfish
Confusing Common Names: None
Principal Gear(s): trawl, hook-and-line
Principal Area(s): northern California
Principal Market Categories: 250 - unspecified rockfish, 975 - slope rockfish
Sampled-Strata Index: Range: 0 - 0.0237 Mean: 0.0017

	Landing Estimate Score
Sampled-Strata Index:	2
Misidentification:	3
Mandatory Sorting:	2
Percent Using Actual:	3
Market Category Anomaly:	5
Landing Anomaly:	1
Nominal Reliability:	2
Percentile Observed:	1
Total Score:	19

Discussion:
1983-2006:
    Rougheye rockfish are a minor component of the rockfish landings. Since they are uncommon in commercial landings, they are seldom sorted into their own market category, but instead are sorted into the well sampled, unspecified rockfish market category (250). Landing estimates (Figure 31) are erratic, an indication of how uncommon they are in the landings. As a result, the landing estimates are considered only somewhat reliable.
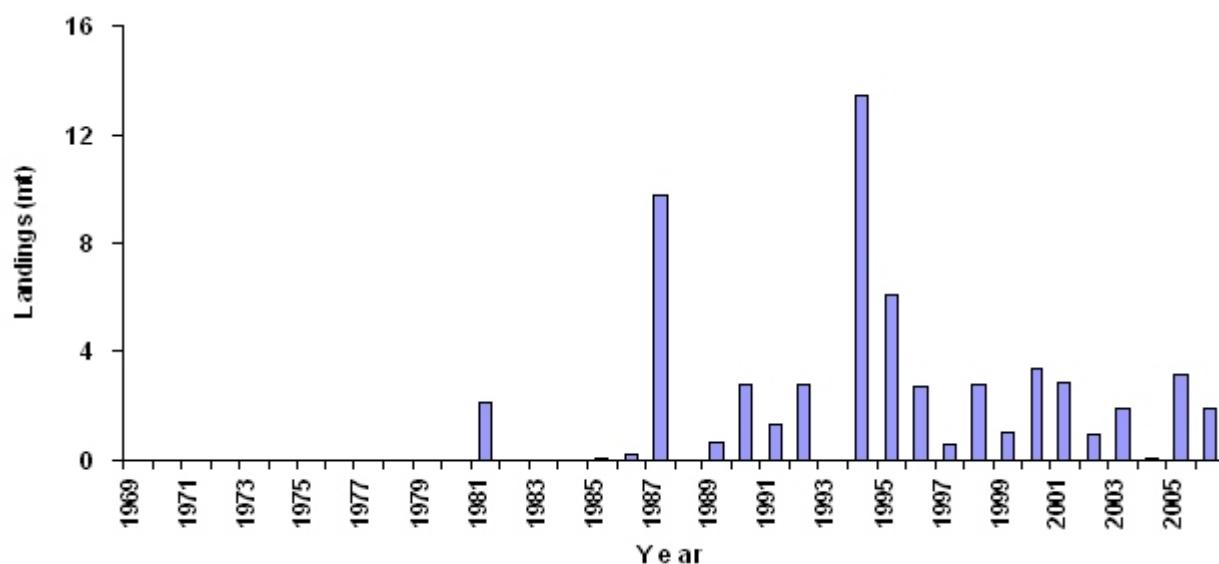
Figure 31. Estimated annual commercial landings (metric tons) of rougheye rockfish from California, 1969-2006.

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1969-1982:
     Rougheye rockfish are uncommon in commercial landings. Since the
pattern of landings after 1977 was very erratic, and since the ratio
estimation method relies on samples after 1977, the landing estimates
from 1969 through 1977 were generally unreliable.

                    Pacific Ocean Perch
Scientific Name: *S. alutus*
Similar Species: yellowmouth rockfish, sharpchin rockfish, chilipepper,
redstripe rockfish
Confusing Common Names: rosefish
Principal Gear(s): trawl
Principal Region(s): northern California
Principal Market Category(ies): 250 - unspecified rockfish, 960 -
rockfish, group small, 271 - Pacific ocean perch
Sampled-Strata Index: Range: 0-0.0074 Mean: 0.0026

                    Landing Estimate Score
Sampled-Strata Index: 3
Misidentification: 3
Mandatory Sorting: 5
Percent Using Actual: 3
Market Category Anomaly: 5
Landing Anomaly: 1
Nominal Reliability: 5
Percentile Observed: 3
Total Score: 28

Discussion:
1983-2006:
     Pacific ocean perch was the first rockfish species in California to
be classified as overfished and, as a result, landings were heavily
restricted from the 1980s through 2006. Overall landings show
substantial differences among years which, combined with the possibility
of misidentification, reduces the landing estimate reliability somewhat
(Figure 32). Overall, we consider landing estimates of this species to
be generally reliable from 1983 through 2006.

1969-1982:
     After 1984, most Pacific ocean perch were landed in market category
960 (rockfish, group small). The Pacific ocean perch market category
(271) was widely used prior to 1984 and that is probably where most of
the landings were being sorted into. This is supported by port samples
taken from this market category prior to 1984 which showed a high
concentration of the species. Since this species occurs principally in
the north, where sample coverage was good between 1978 and 1983, we feel
our landing estimates of this species are somewhat reliable. Overall we
feel that our landing estimates for 1969-1982 are generally reliable.
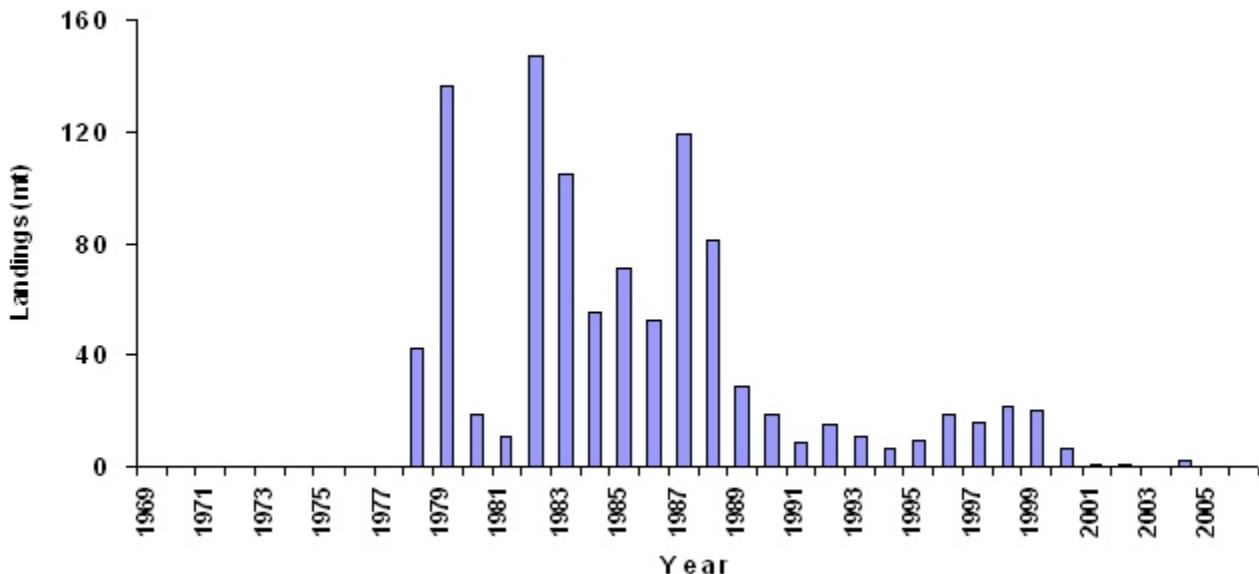
Figure 32. Estimated annual commercial landings (metric tons) of
Pacific Ocean perch from California, 1969-2006.

                         Kelp rockfish
Scientific Name: *S. atrovirens*
Similar Species: copper rockfish, black-and-yellow rockfish, gopher
rockfish
Confusing Common Names: gopher
Principal Gear(s): hook-and-line
Principal Region(s): Monterey and Morro Bay
Principal Market Categories: 962 - group gopher, 659 - Kelp rockfish,
250 - unspecified rockfish, 960 - rockfish, group small
Sampled-Strata Index: Range: 0-0.0742 Mean: 0.0091

                      Landing Estimate Score
Sampled-Strata Index: 4
Misidentification: 3
Mandatory Sorting: 2
Percent Using Actual: 1
Market Category Anomaly: 4
Landing Anomaly: 3
Nominal Reliability: 5
Percentile Observed: 2
Total Score: 24

Discussion:
1983-2006:
     This species is not common in most areas. It is sorted into
several market categories, and landing estimates are generally not based
on actual sampling (Figure 33). The few port samples taken of the kelp

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rockfish market category (659) indicated that it was usually 100% kelp rockfish. Landings in early years were quite low and probably not well estimated; however, with the advent of the nearshore, live fish fishery in the early 1990s, landings have increased. Overall, we feel the landing estimates are generally reliable.

1969-1982:
        Kelp rockfish are a very minor component of the fishery with estimated annual landings never greater than 12 metric tons. Since kelp rockfish are caught principally in the nearshore hook-and-line fishery, which began in the early 1990s, we are confident that landings prior to 1983 were fairly low. We cannot discount the possibility of the existence of isolated local fisheries for the species having existed prior to 1983; however, we have no evidence of this. We therefore conclude that landings of this species have always been low; however, we feel that our actual estimates prior to 1983 are generally unreliable.
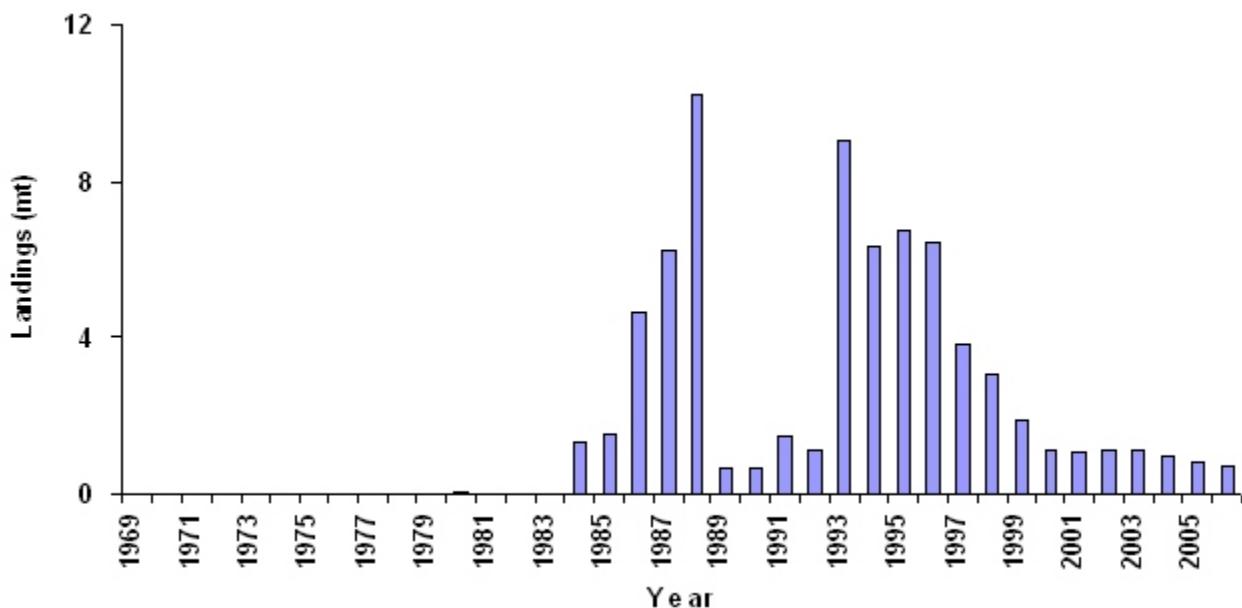

Figure 33. Estimated annual commercial landings (metric tons) of kelp rockfish from California, 1969-2006.

                            Brown rockfish
Scientific Name: *S. auriculatus*
Similar Species: copper rockfish, grass rockfish
Confusing Common Names: Brown bomber (also a common name for widow rockfish)
Principal Gear(s): trawl, hook-and-line
Principal Region(s): San Francisco

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Principal Market Categories: 957 - group bolinas, 267 - brown rockfish,
250 - unspecified rockfish
Sampled-Strata Index: Range: 0-0.0180 Mean: .0045

```
                              Landing Estimate Score
Sampled-Strata Index:             3
Misidentification:                4
Mandatory Sorting:                2
Percent Using Actual:             2
Market Category Anomaly:          1
Landing Anomaly:                  3
Nominal Reliability:              1
Percentile Observed:              4
Total Score:                     20
```

Discussion:
1983-2006:

     Brown rockfish are fairly abundant and not difficult to identify.
The overall landing estimates show a somewhat incoherent pattern (Figure
34). Much of the fluctuation in the landings is probably due to the way
in which this species was sorted. A common name for widow rockfish is
"brownies" and as a result, dealers in the early 1980s routinely used
the brown rockfish market category for widow rockfish. This was
determined by actual port sampling. In addition, brown rockfish were
landed in market categories which are poorly sampled including market
category 957 (bolinas). Since both the brown rockfish market category
and the group bolinas market category contain a large fraction of other
species, we consider the landing estimates for this species to be only
somewhat reliable.
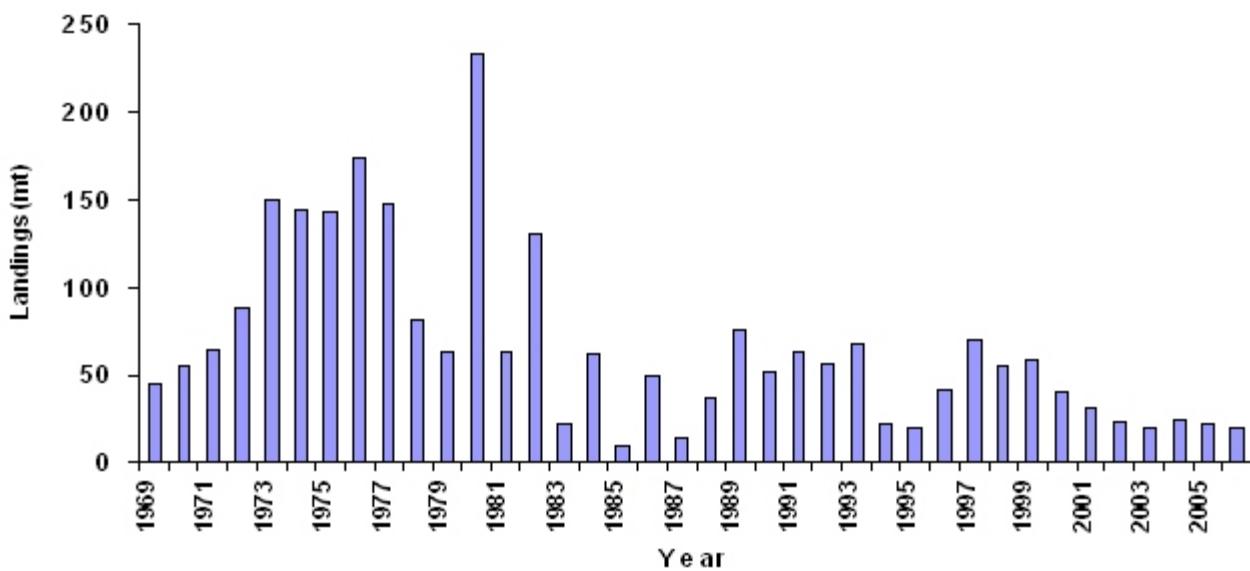
Figure 34. Estimated annual commercial landings (metric tons) of brown
rockfish from California, 1969-2006.

1969-1982:
    Landing estimates for this species prior to 1983 are probably not reliable. The use of the ratio method between 1969 and 1977 relied largely on NOMINAL and BORROW type estimation from 1978 to 1980. The NOMINAL type of estimation is generally unreliable for this species. People who wish to use these data should exercise caution and consider examining the raw data in detail.

Aurora rockfish

Scientific Name: *S. aurora*
Similar Species: splitnose rockfish, chameleon rockfish
Confusing Common Names: none
Principal Gear(s): trawl
Principal Region(s): northern and central California
Principal Market Categories: 961 - group rosefish
Sampled-Strata Index: Range: 0-0.0627 Mean: 0.0111

Landing Estimate Score

Sampled-Strata Index:	4
Misidentification:	1
Mandatory Sorting:	1
Percent Using Actual:	2
Market Category Anomaly:	5
Landing Anomaly:	1
Nominal Reliability:	5
Percentile Observed:	4
Total Score:	23

Discussion:
1983 to 2006:
    Aurora rockfish are similar in appearance to both splitnose and chameleon rockfish. In addition, they are landed in the same market categories as those two species. Aurora rockfish are seldom landed in their own market category, but when they are, the landing is nearly pure for the species. Landing estimates have been erratic suggesting they may not be well sampled (Figure 35). Based on this, we feel that the landing estimates are only somewhat reliable.

1969-1982:
    Aurora rockfish are principally caught in northern and central California where sampling was fairly good during this time interval. This improves the reliability of the landing estimates; however, given the highly variable nature of their annual landings, we feel the landing estimates are only somewhat reliable.

    The principal market category into which aurora rockfish were sorted (961) did not exist prior to 1982, which meant that aurora were sorted into other market categories. Since this sorting resulted in a dilution of their abundance in any given sample, we feel the ratio estimation method used to estimate landings prior to 1978 may not provide reliable estimates. Overall we feel that our landing estimates for 1969 through 1982 are generally unreliable.

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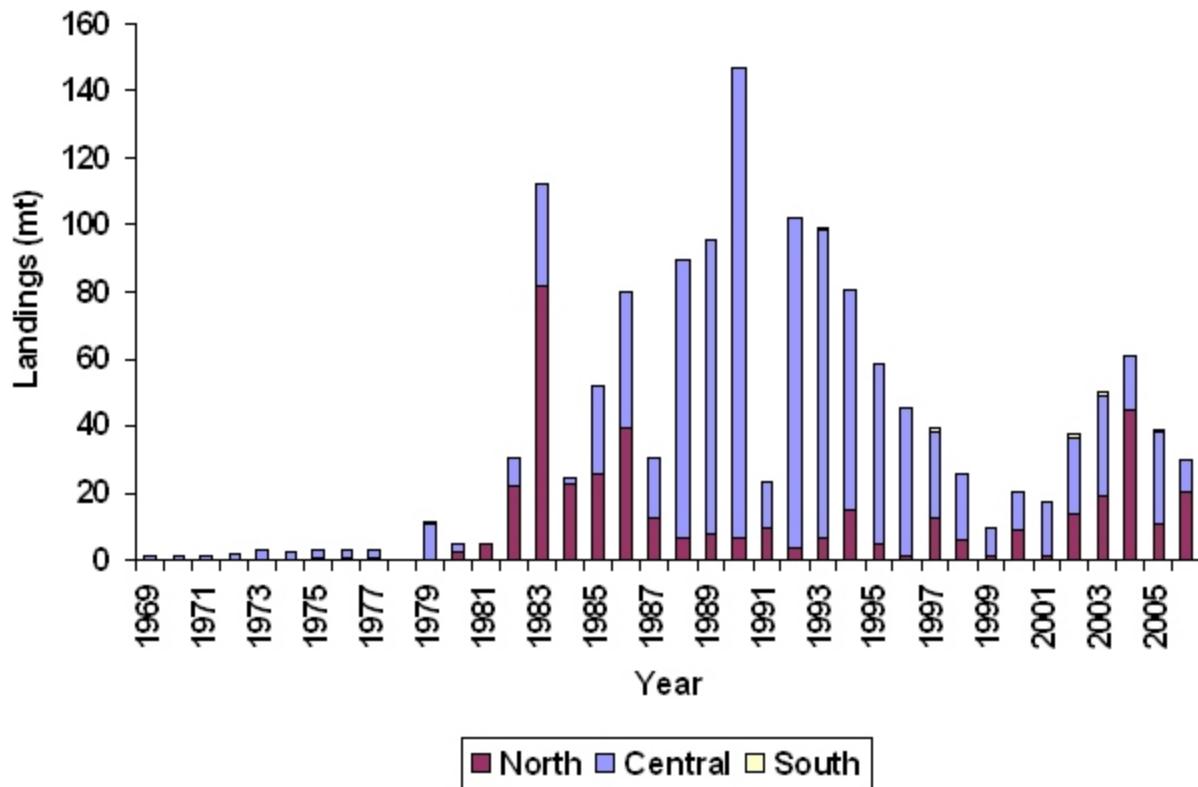
Figure 35. Estimated annual commercial landings (metric tons) of aurora rockfish by geographic area from California, 1969-2006. NORTH=Crescent City, Eureka, and Fort Bragg; CENTRAL=Bodega Bay, San Francisco, Monterey, and Morro Bay; SOUTH=Santa Barbara, Los Angeles, and San Diego

                            Redbanded rockfish
Scientific Name: *S. babcocki*
Similar Species: flag rockfish
Confusing Common Names: canary rockfish, flag rockfish
Principal Gear(s): trawl
Principal Region(s): northern California
Principal Market Categories: 250 - unspecified rockfish, 959 - group red, 960 - group small rockfish, 253 - bocaccio
Sampled-Strata Index: Range: 0-0.0044 Mean: 0.0011

                         Landing Estimate Score
Sampled-Strata Index: 2
Misidentification: 3
Mandatory Sorting: 1
Percent Using Actual: 4
Market Category Anomaly: 5
Landing Anomaly: 2
Nominal Reliability: 3
Percentile Observed: 2
Total Score: 22

Discussion:
1983-2006
        Redbanded rockfish are seldom sorted into their own market
category; however, the categories they are sorted into are generally
well sampled. The estimated landings are fairly coherent with the
exception of a large anomaly between 1981 and 1985, which cannot be
readily explained (Figure 36). This anomaly coincided with the
expansion of the widow rockfish fishery on the north coast where most
redbanded rockfish were landed. Examination of the species compositions
for the principal market categories suggests that widow rockfish are
mixed with redbanded rockfish in the port samples. Most of the
estimated landings are based on actual sampled strata which argues for
the estimates to be somewhat reliable; however, the landing anomalies
between 1981 and 1985 suggest potential problems. We feel that overall,
landing estimates for this species are generally reliable with the
possible exception of 1981-1985.
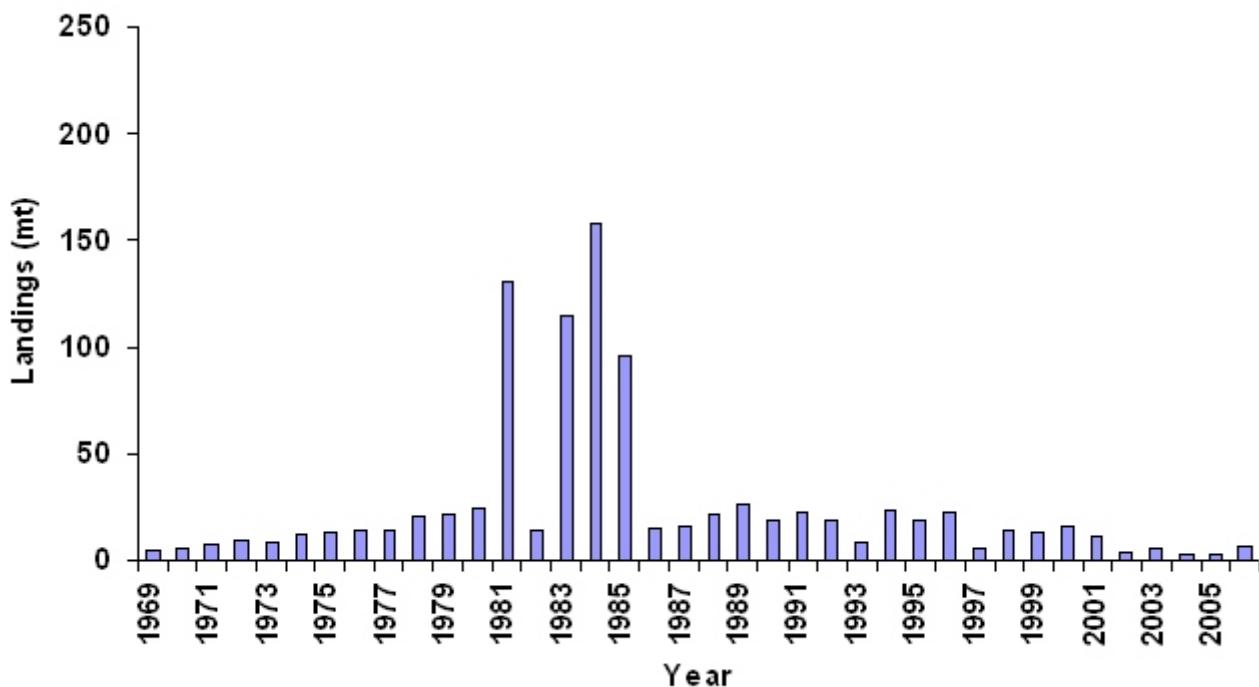
Figure 36. Estimated annual commercial landings (metric tons) of
redbanded rockfish from California, 1969-2006.

1969-1982:
        The ratio estimation method for landings between 1969 and 1977 are
based on a large number of samples. We therefore feel that the landing
estimates between 1969 and 1982 are somewhat reliable.

Shortraker rockfish
Scientific Name: *S. borealis*
Discussion:
     Only 11 individuals were observed by port samplers in all years.
We therefore feel that while landings are probably low, our estimates
are very unreliable.
                         Silvergray rockfish
Scientific Name: *S. brevispinus*
Discussion:
     Only 58 individuals were observed by port samplers in all years.
We therefore feel that while landings are probably quite low, our
estimates are very unreliable.

                          Gopher rockfish
Scientific Name: *S. carnatus*
Similar Species: black-and-yellow rockfish, china rockfish
Confusing Common Names: none
Principal Gear(s): hook-and-line
Principal Region(s): Monterey and Morro Bay
Principal Market Categories: 962 - group gopher, 263 - gopher rockfish,
250 - unspecified rockfish
Sampled-Strata Index: Range: 0-0.0232 Mean: 0.0047

                      Landing Estimate Score
Sampled-Strata Index: 3
Misidentification: 1
Mandatory Sorting: 2
Percent Using Actual: 2
Market Category Anomaly: 1
Landing Anomaly: 2
Nominal Reliability: 4
Percentile Observed: 4
Total Score: 19

Discussion:
     This species is often confused with black-and-yellow rockfish, and
there is a continuing controversy about whether or not they are a
distinct species (Love et al., 2002). The fact that the majority of
estimated landings are not based on actual sampling, combined with the
likelihood for misidentification, suggests that our landing estimates
are generally unreliable (Figure 37). This is particularly true for the
time interval between 1983 and 1988. Between 1983 and 1988, market
category 962 (group gopher) landings increased sharply while market
category 263 (gopher rockfish) landings declined (not visible in Figure
37 since the stratum was unsampled and the landings were converted to
unspecified rockfish). Port samples indicated a shift from gopher
rockfish to black-and-yellow rockfish during the same time interval,
suggesting problems with identification. We suggest that if black-and-
yellow landings are combined with gopher landings, the estimates would
be generally reliable for the group.

                                48
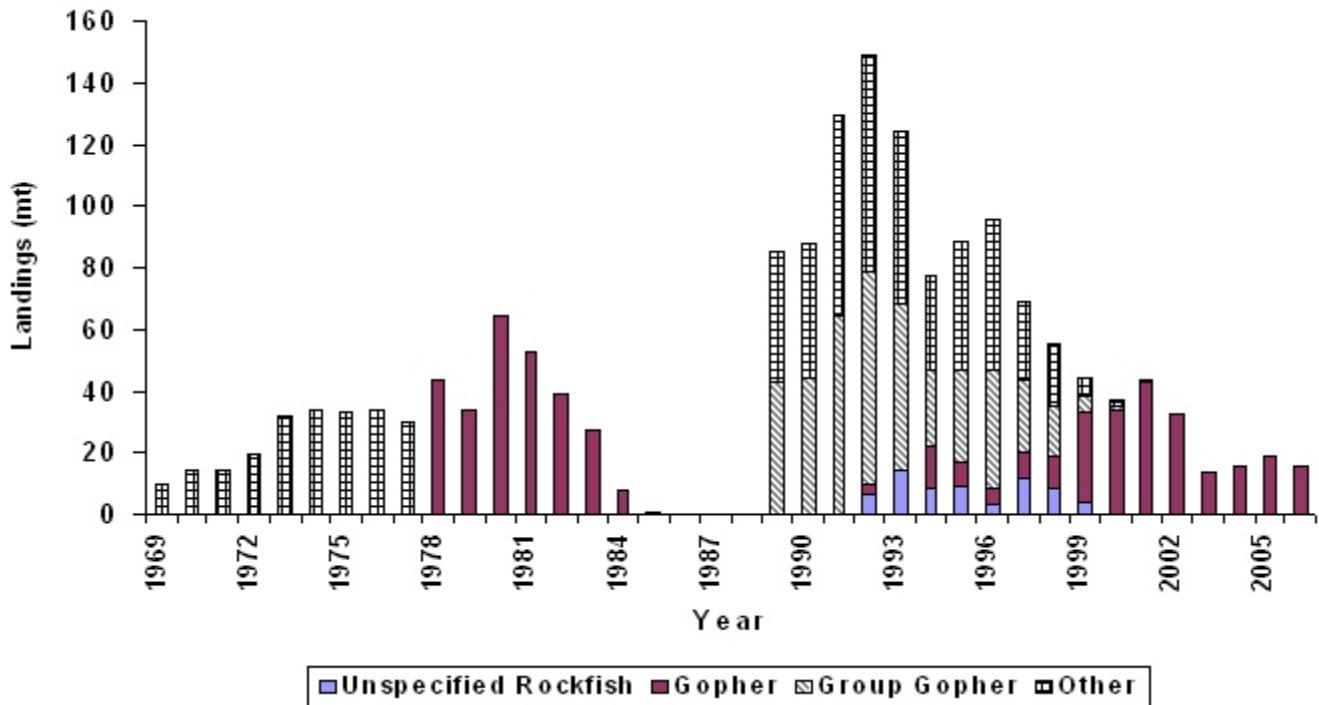
Figure 37. Estimated annual commercial landings (metric tons) of gopher rockfish by principle market categories from California, 1969-2006.

                    Black-and-yellow rockfish
Scientific Name: *S. chrysomelas*
Similar Species: gopher rockfish
Confusing Common Names: none
Principal Gear(s): hook-and-line
Principal Region(s): Monterey and Morro Bay
Principal Market Categories: 962 - group gopher, 251 - Black-and-yellow rockfish, 263 - gopher rockfish
Sampled-Strata Index: Range: 0-0.0513 Mean: 0.0088

                    Landing Estimate Score
Sampled-Strata Index: 4
Misidentification: 1
Mandatory Sorting: 2
Percent Using Actual: 1
Market Category Anomaly: 1
Landing Anomaly: 3
Nominal Reliability: 3
Percentile Observed: 4
Total Score: 19

Discussion:
    As discussed in the gopher rockfish section, these two species may not be separate species, creating problems with identification. Our landing estimates of black-and-yellow rockfish are therefore considered generally unreliable (Figure 38). We feel that both species should be

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combined to obtain a reliable estimate for these two species as a group(Figure 39).
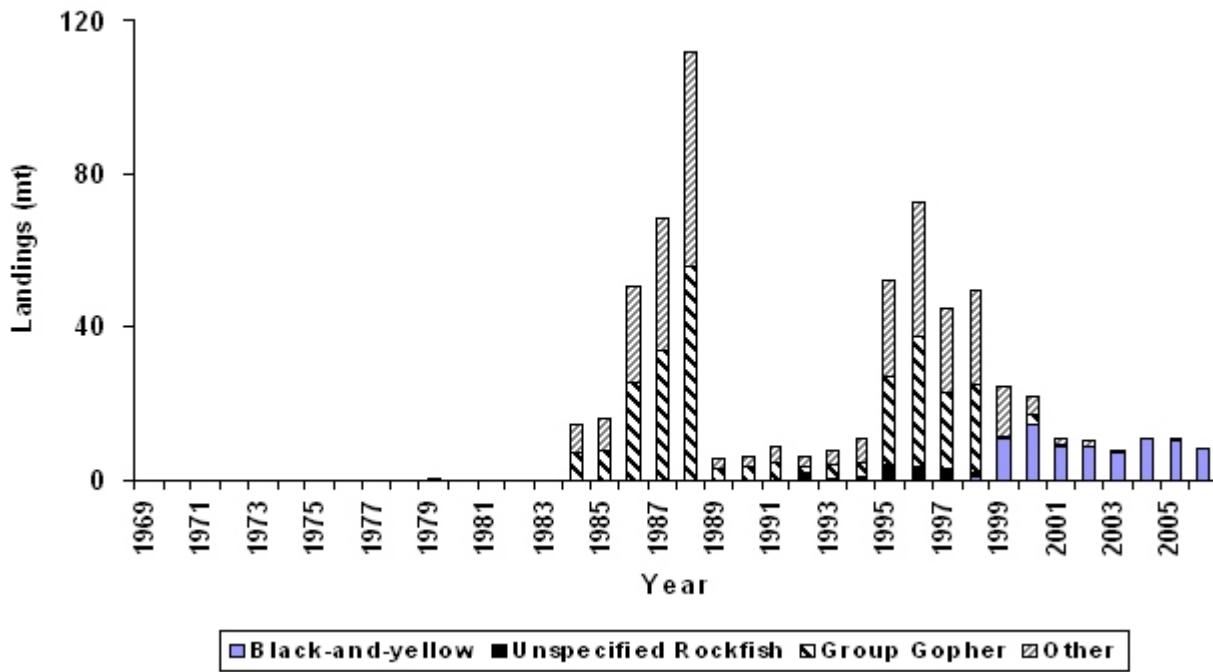
Figure 38. Estimated annual commercial landings (metric tons) of black-and-yellow rockfish by principle market category from California, 1969-2006.
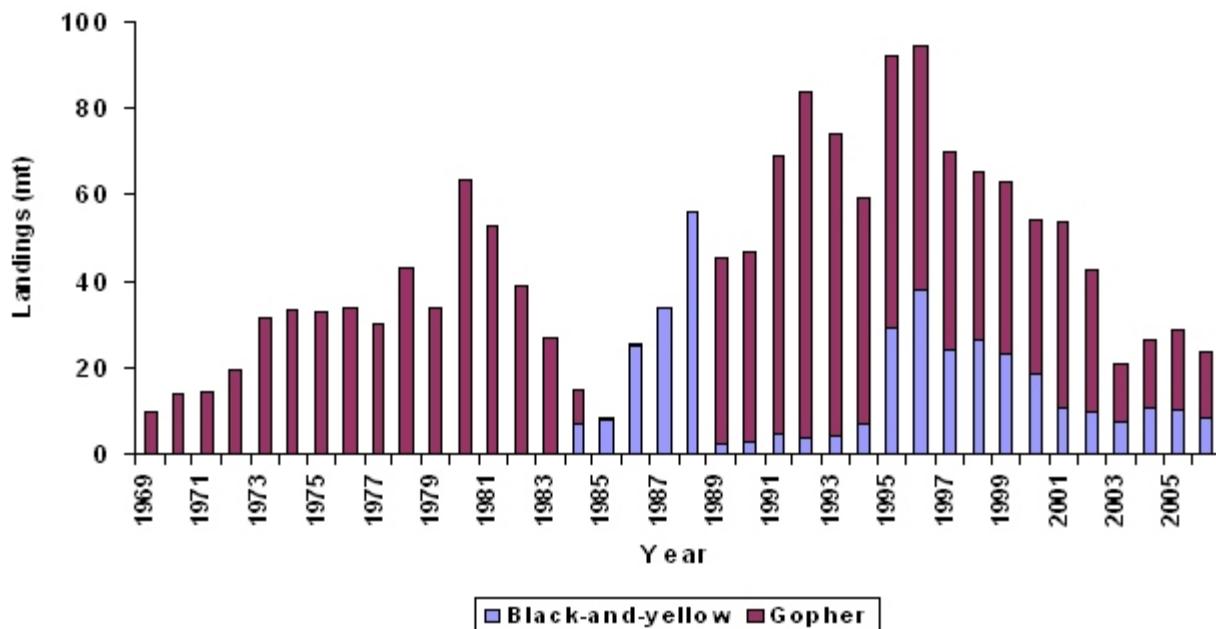
Figure 39. Estimated annual commercial landings (metric tons) of gopher and black-and-yellow rockfish from California, 1969-2006.

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                         Copper rockfish
Scientific Name: S. caurinus
Similar Species: brown rockfish
Confusing Common Names: none
Principal Gear(s): hook-and-line
Principal Region(s): coastwide
Principal Market Categories: 655 - copper rockfish, 959 - group reds,
957 - group bolinas, 250 - unspecified rockfish
Sampled-Strata Index: Range: 0-0.0217  Mean: 0.0048

                      Landing Estimate Score
Sampled-Strata Index:           4
Misidentification:              3
Mandatory Sorting:              2
Percent Using Actual:           2
Market Category Anomaly:        3
Landing Anomaly:                1
Nominal Reliability:            4
Percentile Observed:            3
Total Score:                   22
```

Discussion:
1983-2006:

   The copper rockfish is a highly prized species. At one time it was thought there were two species, copper rockfish and whitebelly rockfish (Love et al., 2002). In fact, whitebelly rockfish were given the scientific name of *S. vexillaris* until it was determined they were actually copper rockfish. Whitebelly were given their own market category (246) and as a result, copper rockfish have two market categories, although the whitebelly market category is seldom used. Estimated landings have been highly erratic (Figure 40). The bulk of copper rockfish are caught by hook-and-line gears; however, between 1983 and 1985, there were quite a few caught by trawl in central California. In the 1990s, landings increased substantially due to the nearshore live fish fishery. Since copper rockfish are typically caught in fairly shallow water (less than 50 fathoms) and since they are very hearty, they are an ideal species for the live fish fishery. Since line gear was poorly sampled prior to 1991, the estimates prior to 1991 are only considered to be somewhat reliable.

1969-1982:

   Since copper rockfish were caught primarily by hook-and-line, and the fishery was relatively small, it is likely that overall landings of copper rockfish were fairly small during this time interval. This is supported by our landing estimates. We therefore feel our estimates from 1969-1982 are somewhat reliable.
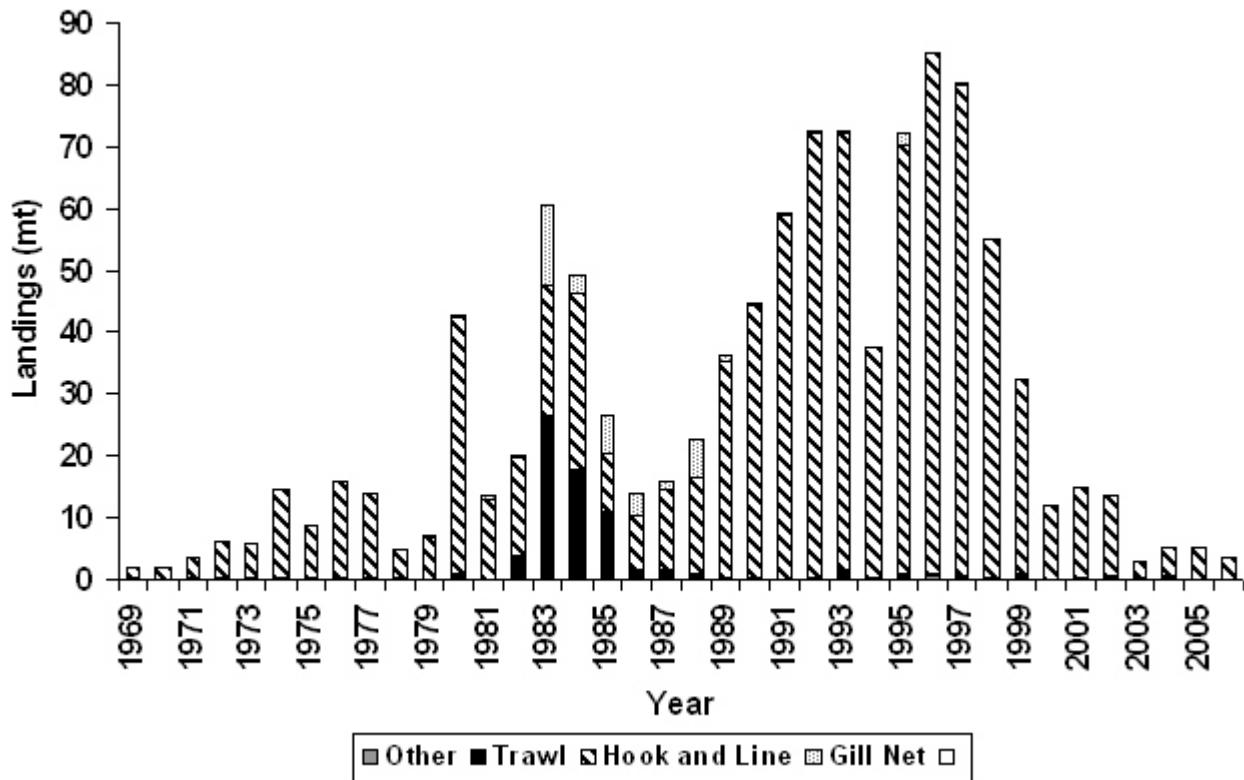
Figure 40. Estimated annual commercial landings (metric tons) of copper rockfish by gear group from California, 1969-2006.

                          Greenspotted rockfish
Scientific Name: *S. chlorostictus*
Similar Species: greenblotched rockfish, pink rockfish
Confusing Common Names: chinafish
Principal Gear(s): trawl, hook-and-line
Principal Region(s): coastwide
Principal Market Categories: 250 - unspecified rockfish, 959 - group reds, 255 - greenspotted rockfish, 960 - rockfish, group small
Sampled-Strata Index: Range: 0-0.0062 Mean: 0.0026

                          Landing Estimate Score
Sampled-Strata Index: 3
Misidentification: 3
Mandatory Sorting: 2
Percent Using Actual: 3
Market Category Anomaly: 2
Landing Anomaly: 2
Nominal Reliability: 5
Percentile Observed: 4
Total Score: 24

Discussion:
1983-2006:
     Greenspotted rockfish are common in commercial landings, and
although there is a possibility of misidentification with rare species
such as greenblotched rockfish (*S. rosenblatti*), we do not believe this
has a large effect on landing estimates. Landing estimates present a
fairly coherent picture with the exception of 1991, which is
substantially higher than any other year (Figure 41). We suspect this
estimate is unrealistically high and is possibly caused by borrowing of
the species composition from Fort Bragg and applying it to both Eureka
and Crescent City.
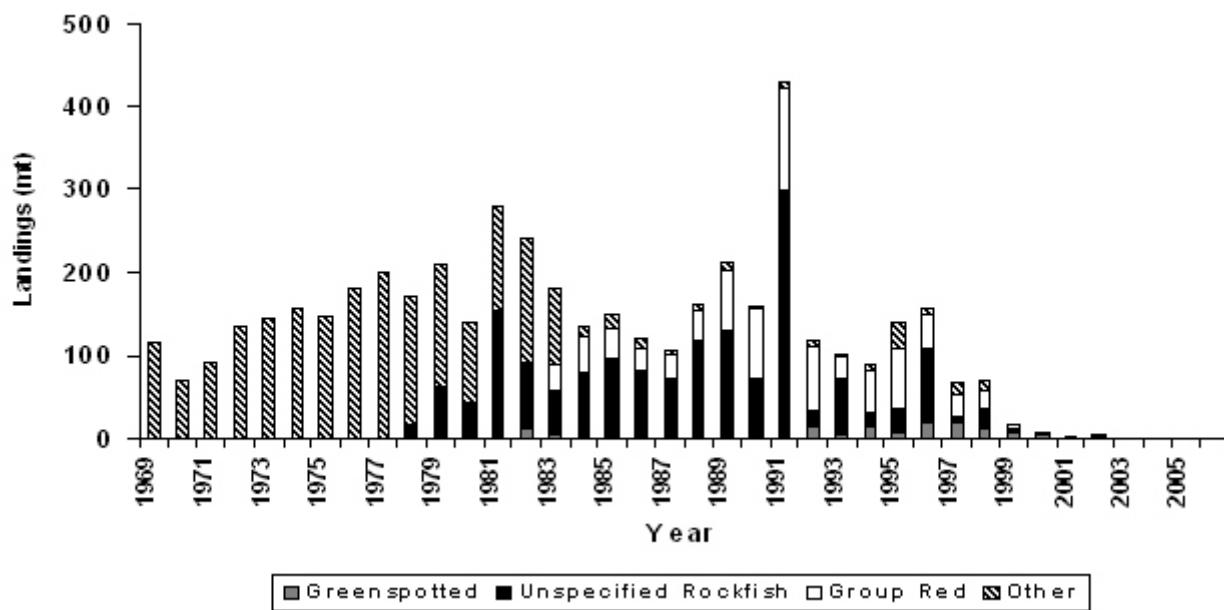
Figure 41. Estimated annual commercial landings (metric tons) of green-
spotted rockfish by principal market category from California, 1969-
2006.

     The biggest problem with landing estimates for this species is the
common name of chinafish. Large China rockfish (*S. nebulosus*) landings
by trawl are unlikely since they inhabit nearshore rocky reefs with high
relief: areas which are unsuitable for trawling and are closed to
trawling by regulation. Port samples of the China rockfish market
category in the Monterey area taken in the early 1980s indicate that
they were, in fact, greenspotted rockfish. Since the port samples
caught this problem in many cases, and since most of the greenspotted
landings occur in other market categories, we feel landing estimates
from 1983-2006 are generally reliable.

1969-1982:
     Landing estimates prior to 1983 are reasonably coherent with no
dramatic fluctuations. Since greenspotted rockfish are fairly common
and relatively easy to identify, the ratio estimation is likely to be
reasonably accurate. We therefore feel that landing estimates from
1969-1982 are generally reliable.

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                            Starry rockfish
Scientific Name: S. constellatus
Similar Species: none
Confusing Common Names: chinafish
Principal Gear(s): hook-and-line
Principal Region(s): central and southern California
Principal Market Categories: 959 - group reds, 250 - unspecified
rockfish, 256 - starry rockfish
Sampled-Strata Index: Range: 0-0.0148  Mean: 0.0032


                          Landing Estimate Score
Sampled-Strata Index:            3
Misidentification:               4
Mandatory Sorting:               1
Percent Using Actual:            2
Market Category Anomaly:         2
Landing Anomaly:                 1
Nominal Reliability:             3
Percentile Observed:             3
Total Score:                    19
```

Discussion:1983-2006:

  This is a fairly minor species in commercial landings. The pattern of estimated landings is somewhat erratic, which could reduce the reliability of our estimates (Figure 42). The increase in landings in the 1990s coincides with the advent of the live-fish fishery; however, few starry rockfish are landed live. We have very few port samples from the starry rockfish market category (256), making the assumption that the market category is relatively "pure" to be questionable. We feel our landing estimates for this species are only somewhat reliable; however, we are reasonably certain the landings are low.
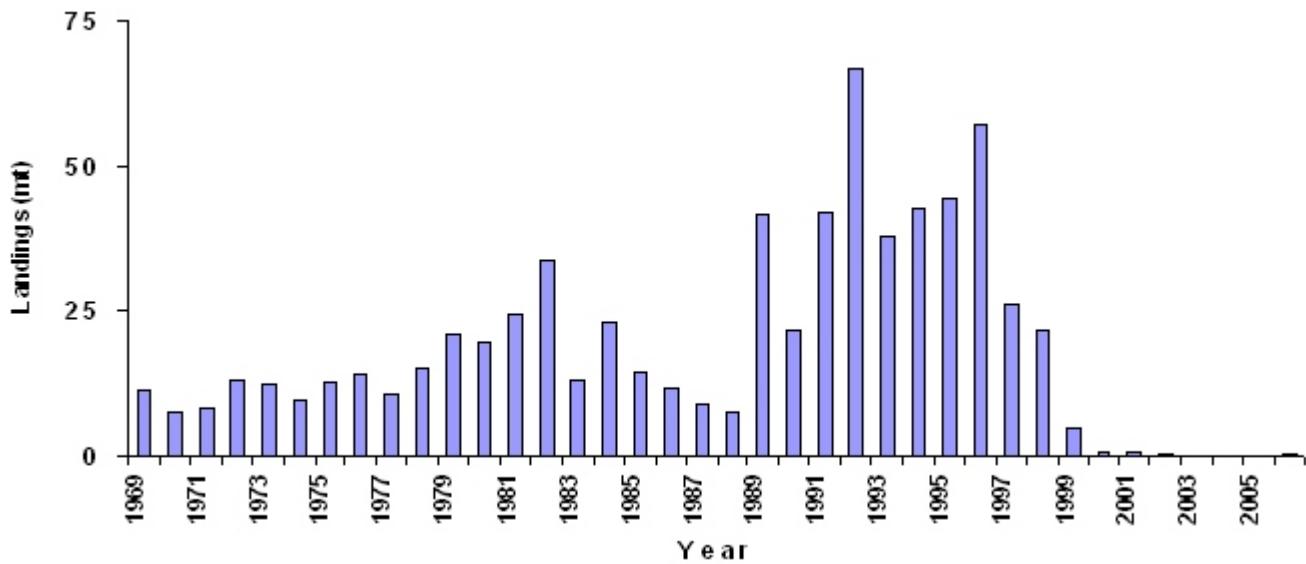

Figure 42. Estimated annual commercial landings (metric tons) of starry rockfish from California, 1969-2006.

54

1969-1982:
     The ratio estimation approach to estimating the landings prior to
1983 suggests relatively stable landings. While the overall pattern of
landings from 1983-1988 is not stable, it suggests that landings were
probably low and that our estimates are at least somewhat reliable.

                         Darkblotched rockfish
Scientific Name: *S. crameri*
Similar Species: blackgill rockfish
Confusing Common Names: none
Principal Gear(s): trawl
Principal Region(s): northern California
Principal Market Categories: 250 - unspecified rockfish, 960 - rockfish,
group small, 959 - group reds, 975 - slope rockfish
Sampled-Strata Index: Range: 0.0054-0.1008 Mean: 0.0270

                         Landing Estimate Score
Sampled-Strata Index: 5
Misidentification: 3
Mandatory Sorting: 3
Percent Using Actual: 4
Market Category Anomaly: 2
Landing Anomaly: 2
Nominal Reliability: 4
Percentile Observed: 5
Total Score: 28

Discussion:
1983-2006:
     Although darkblotched rockfish can potentially be misidentified
with blackgill rockfish, they are very abundant in northern California
where blackgill are not common, which reduces the possibility that
misidentification would have a strong impact on the landing estimates.
It is important to note that the vast majority of darkblotched rockfish
are not landed in the darkblotched rockfish market category. Relying
solely on landings in this market category for total landing estimates
would result in a gross underestimation of the landings. The overall
pattern of landings is fairly irregular. However, most of the landing
estimates are based on actual port samples (Figure 43). After 1998,
regulations were placed on landings of this species which resulted in a
decline in landings. Overall, we feel our estimates of landings between
1983 and 2006 are generally reliable.

1969-1982:
     Landing estimates for darkblotched rockfish prior to 1981 were
relatively low and then jumped dramatically in 1981. The landings then
dropped sharply in 1982 and rebounded in 1983. It is possible this was
a result of the widow rockfish fishery. In 1980, the number of trawlers
on the north coast increased sharply in response to the developing widow
rockfish fishery. In 1982, widow rockfish landings jumped sharply and
then declined in 1983. This suggests that the trawl fleet shifted their
efforts in 1982 from deeper water where darkblotched rockfish were more

abundant to shallower water where widow rockfish were more abundant. In 1983, they appear to have resumed fishing in somewhat deeper water.
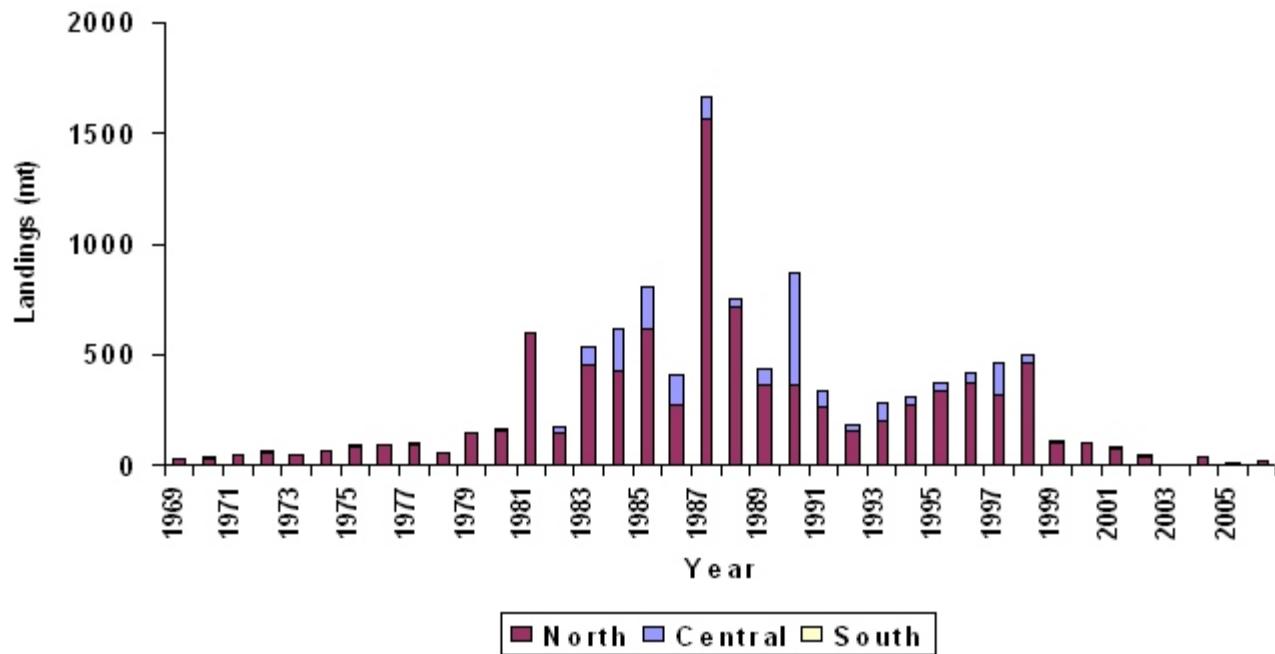
Figure 43. Estimated annual commercial landings (metric tons) of darkblotched rockfish by geographic region from California, 1969-2006. NORTH=Crescent City, Eureka, and Fort Bragg; CENTRAL=Bodega Bay, San Francisco, Monterey, and Morro Bay; SOUTH=Santa Barbara, Los Angeles, and San Diego.

        Overall we feel our landing estimates are very reliable for this species from 1978 through 1982. We base this on good sampling coverage for the principal market categories and the fact that the area where they are most abundant has low concentrations of blackgill with which they might be misidentified. The ratio estimation method for landings prior to 1978 was probably at least somewhat reliable.

                        Calico rockfish
Scientific Name: *S. dalli*

Discussion:
        Only six individuals were observed by port samplers in all years. We therefore feel that while landings are probably low, our estimates are very unreliable.

                        Splitnose rockfish
Scientific Name: *S. diploproa*
Similar Species: aurora rockfish, chameleon rockfish
Confusing Common Names: rosefish
Principal Gear(s): trawl
Principal Region(s): northern and central California

Principal Market Categories: 961 - rockfish, group rosefish, 960 - rockfish, group small, 250 - unspecified rockfish, 270 - splitnose rockfish, 956 - chilipepper/bocaccio
Sampled-Strata Index: Range: 0.0014 - 0.1611 Mean: 0.0301

```
                         Landing Estimate Score
Sampled-Strata Index:          5
Misidentification:             3
Mandatory Sorting:             2
Percent Using Actual:          4
Market Category Anomaly:       3
Landing Anomaly:               3
Nominal Reliability:           4
Percentile Observed:           5
Total Score:                  29
```

Discussion:
1983-2006:
     This is an abundant species in northern and central California. One characteristic of the fishery is that occasionally they became locally very abundant in some areas, leading to spikes in the landings, as seen in 1998 (Figure 44). Anecdotal reports from commercial fishermen indicated that in 1998, splitnose rockfish were unusually abundant from California to Washington. This suggests that large spikes in the landings were real. Another important characteristic is that less than 5% of splitnose rockfish are landed in the splitnose market category (270): the majority are landed in the rosefish market category (961). Therefore, using the splitnose market category landings as an estimate of actual catch will grossly underestimate actual landings.

     Although splitnose rockfish can be misidentified, the species with which they can be confused are much less abundant; therefore, misidentification is not likely to have a large impact on landing estimates. Since the principal market categories into which they are sorted are well sampled, we feel the estimated landings in this time period are generally reliable.

1969-1982:
     Since splitnose rockfish can occasionally become extremely abundant, our estimates that rely on ratio estimation may not be reliable for any given year. Since splitnose rockfish are fairly small (46cm maximum total length) they are not a highly desirable for commercial fishermen and it is likely that targeting on this species in the early years was limited. We therefore believe that our estimates of landings between 1969 and 1982 are only somewhat reliable but that the landings were probably not high.
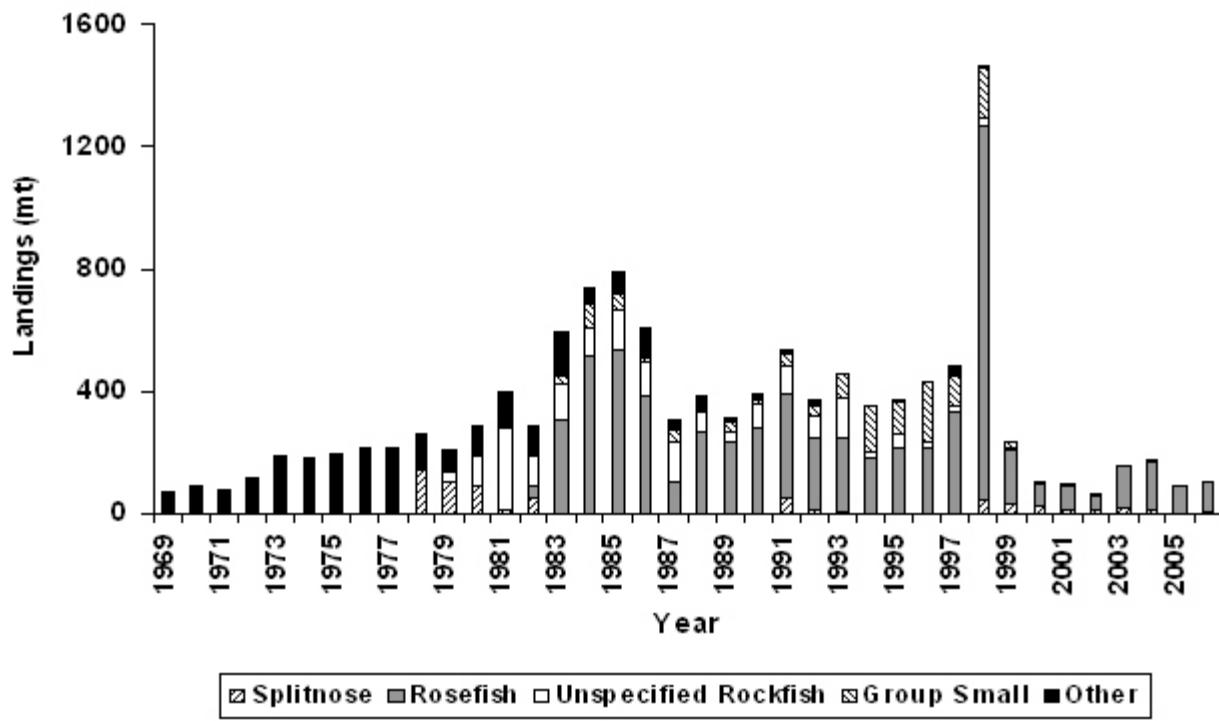
Figure 44. Estimated annual commercial landings (metric tons) of splitnose rockfish by principle market category from California, 1969-2006.

Greenstriped rockfish
Scientific Name: *S. elongatus*
Similar Species: none

Confusing Common Names: none
Principal Gear(s): trawl
Principal Region(s): northern California
Principal Market Categories: 250 - unspecified rockfish, 960 - rockfish, group small, 959 - rockfish, group red, 956 - chilipepper/bocaccio, 254 - chilipepper rockfish, 654 - greenstriped rockfish
Sampled-Strata Index: Range: 0-0.0040 Mean: 0.0009

	Landing Estimate Score
Sampled-Strata Index:	1
Misidentification:	5
Mandatory Sorting:	1
Percent Using Actual:	4
Market Category Anomaly:	2
Landing Anomaly:	1
Nominal Reliability:	3
Percentile Observed:	3
Total Score:	20

Discussion:
1983-2006:
    The greenstriped rockfish is one of the most easily identifiable
rockfish species. It is sorted into a large number of market categories
in part because it is a small fish (43cm maximum total length) and
typically make up a small fraction of any given landing. Due to their
small size, they are often discarded. Estimated landings are very
irregular, suggesting that even though the principal market categories
they are sorted into are well sampled, its relatively low abundance in
any given sample may not allow for a reliable estimate (Figure 45).

1969-1982:
    The ratio estimation for this species provided unreasonably high
estimates. Examination of the data by port complex shows the estimated
landings for Fort Bragg between 1978 and 1980 were unrealistically high
based on a few port samples. When the ratio estimation method used the
overall species composition, the effect of the poor sample expansions
was carried over to 1969-1977, resulting in unreliable estimates. We
therefore feel that our landing estimates for this species are generally
unreliable; however, we feel the actual total landings are probably low.
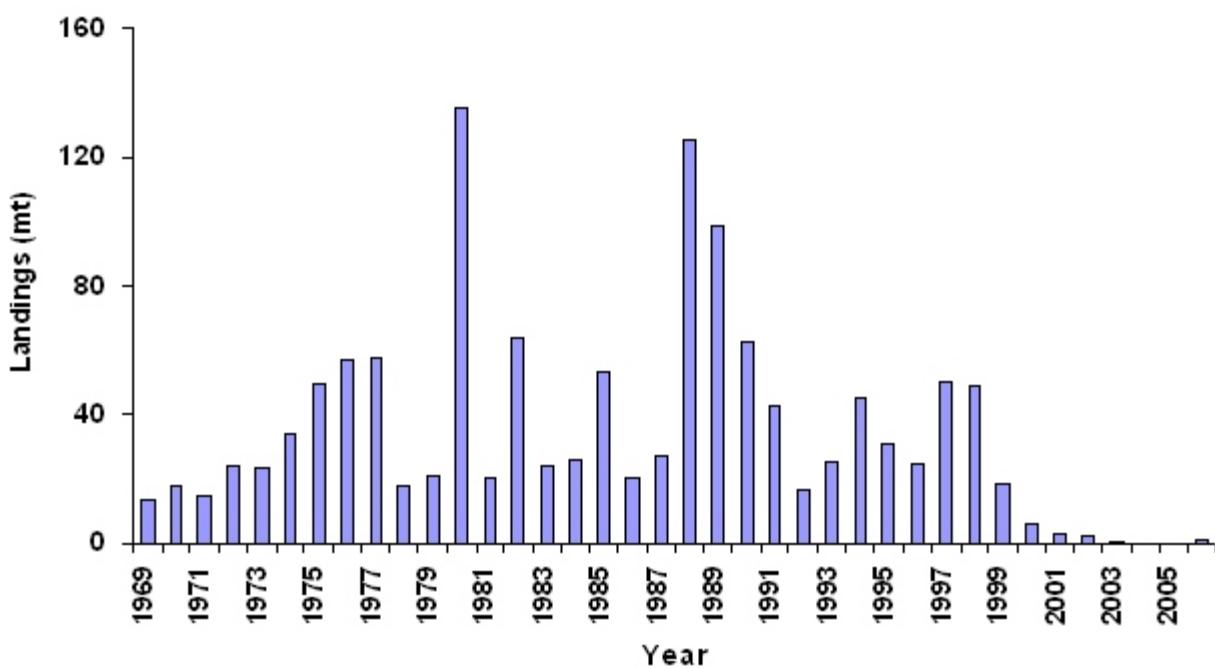

Figure 45. Estimated annual commercial landings (metric tons) of
greenstriped rockfish from California, 1969-2006.

Swordspine rockfish
Scientific Name: *S. ensifer*

Discussion:
     Only eight individuals were observed by port samplers in all years.
We therefore feel that while landings are probably low, our estimates
are very unreliable.

                          Widow rockfish
Scientific Name: *S. entomelas*
Similar Species: squarespot rockfish
Confusing Common Names: brownie, brown bomber
Principal Gear(s): trawl
Principal Region(s): northern and central California
Principal Market Categories: 269 - widow rockfish, 250 - unspecified
rockfish
Sampled-Strata Index: Range: 0-0.7151 Mean: 0.1948

                        Landing Estimate Score
Sampled-Strata Index: 5
Misidentification: 3
Mandatory Sorting: 5
Percent Using Actual: 4
Market Category Anomaly: 5
Landing Anomaly: 5
Nominal Reliability: 5
Percentile Observed: 5
Total Score: 37

Discussion:
1983-2006:
     Widow rockfish have been the most abundant rockfish in commercial
landings since the early 1980s. They are easily identified by most
people since they are so common. Since 1983, regulations required them
to be sorted into the widow rockfish market category, which has been
relatively pure. For the most part, total landings are driven by
fishing regulations. The estimated landings show a coherent and readily
explainable pattern (Figure 46). This species has the highest landing
estimate score (37) of any rockfish species. We feel that our estimates
are very reliable for this species from 1983 through 2006.

1969-1982:
     Between 1979 and 1982, large landings were made using the brown
rockfish market category (267). This occurred because one of the common
names for this species is "brownies". Port sampling of market category
267 (brown rockfish) made it possible to correctly estimate the
landings.
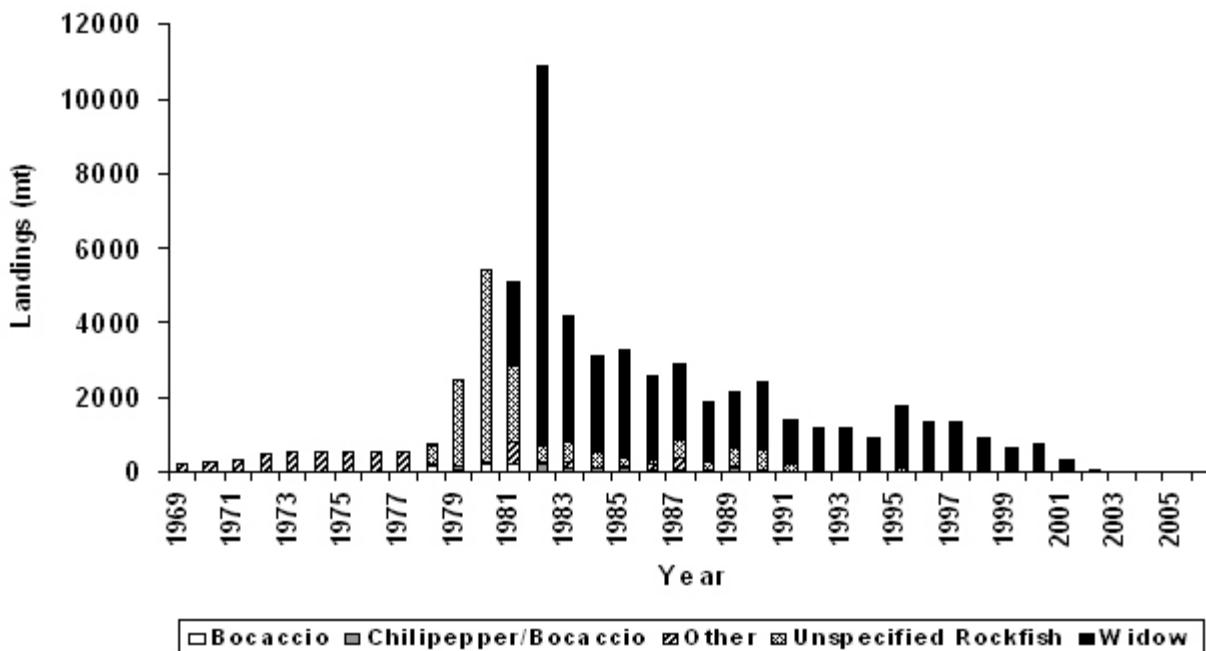
Figure 46. Estimated annual commercial landings (metric tons) of widow rockfish by principle market category from California, 1969-2006.

Widow rockfish are most abundant north of San Francisco, and sample coverage of the north coast between 1978 and 1980 was good for the trawl fishery. The fishery began to expand dramatically in the late 1970s in the northern area. As a result, the species compositions for 1978-1980 for Eureka, which were used in the ratio estimation method, contained a disproportionately high amount of widow rockfish. We corrected for this problem using a modification of the ratio estimation method. We therefore feel that landing estimates for the northern area are generally reliable between 1969 and 1977.

Pink rockfish
Scientific Name: *S. eos*
Similar Species: greenblotched rockfish, greenspotted rockfish
Confusing Common Names: none
Principal Gear(s): hook-and-line, gill net
Principal Region(s): southern California
Principal Market Categories: 959 - rockfish, group red, 250 - unspecified rockfish, 254 - chilipepper rockfish, 245 - cowcod rockfish
Sampled-Strata Index: Range: 0-0.0057 Mean: 0.0004

```
                          Landing Estimate Score
Sampled-Strata Index:            1
Misidentification:               2
Mandatory Sorting:               1
Percent Using Actual:            4
Market Category Anomaly:         4
Landing Anomaly:                 1
Nominal Reliability:             3
Percentile Observed:             1
Total Score:                    17
```

Discussion:

The pink rockfish is one of the least abundant species in the commercial landings. It is landed in several market categories, some of which are poorly sampled. Pink rockfish can be misidentified with at least two other species. Annual landing estimates are erratic, suggesting the sampling effort is not good for this species (Figure 47). As a result, we feel our estimates of annual landings for this species are generally unreliable.
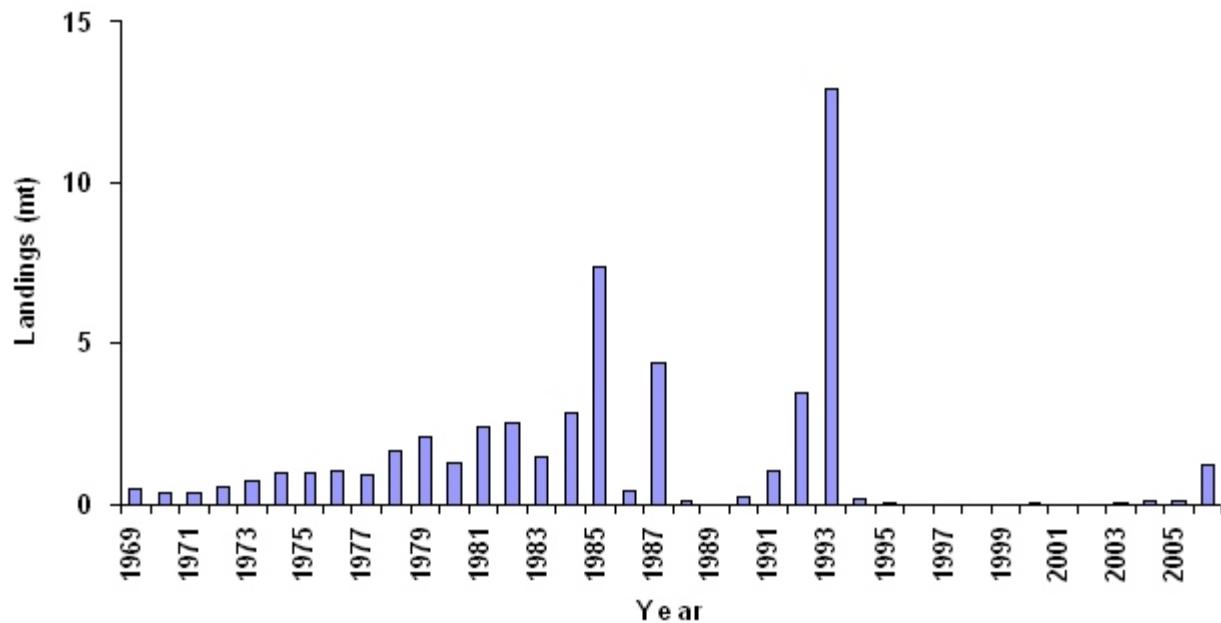

Figure 47. Estimated annual commercial landings (metric tons) of pink rockfish from California, 1969-2006.

```
                         Yellowtail rockfish
Scientific Name: S. flavidus
Similar Species: olive rockfish
Confusing Common Names: brown bomber
Principal Gear(s): all
Principal Region(s): northern and central California
Principal Market Categories: 250 - unspecified rockfish, 259 -
yellowtail rockfish, 956 - chilipepper/bocaccio, 959 - rockfish, group
red
Sampled-Strata Index: Range: 0.0001-0.1081  Mean: 0.0169

                        Landing Estimate Score
Sampled-Strata Index:         5
Misidentification:            3
Mandatory Sorting:            2
Percent Using Actual:         3
Market Category Anomaly:      3
Landing Anomaly:              3
Nominal Reliability:          5
Percentile Observed:          5
Total Score:                 29
```

Discussion:
1983-2006:

The yellowtail rockfish is a common species in the commercial landings for northern and central California. Although similar in appearance to olive rockfish, experienced fishermen and port samplers can readily distinguish the two species. All gear types catch significant quantities of yellowtail rockfish, and there have been substantial shifts between years among the types of gears responsible for the bulk of the landings. In addition, there are large variations in annual estimated landings which cannot be readily explained (Figure 48). The large peak in the 1984 landings was in large part due to gill net activity in central California and in part due to higher landings overall at most port complexes. Low landings in 1988 were a widespread phenomena and not attributable to any single port or gear. We believe our landing estimates are generally reliable.

1969-1982:

Since the majority of yellowtail rockfish are caught in northern and central California, and since these areas were reasonably well sampled from 1978 through 1980, the ratio estimation method probably worked reasonably well for this species. Somewhat higher landing estimates in the mid 1970s correspond to a short-term yellowtail gill net fishery that developed in Monterey during that time. Overall, we feel our yellowtail rockfish landing estimates for this species between 1969 and 1982 to be generally reliable.
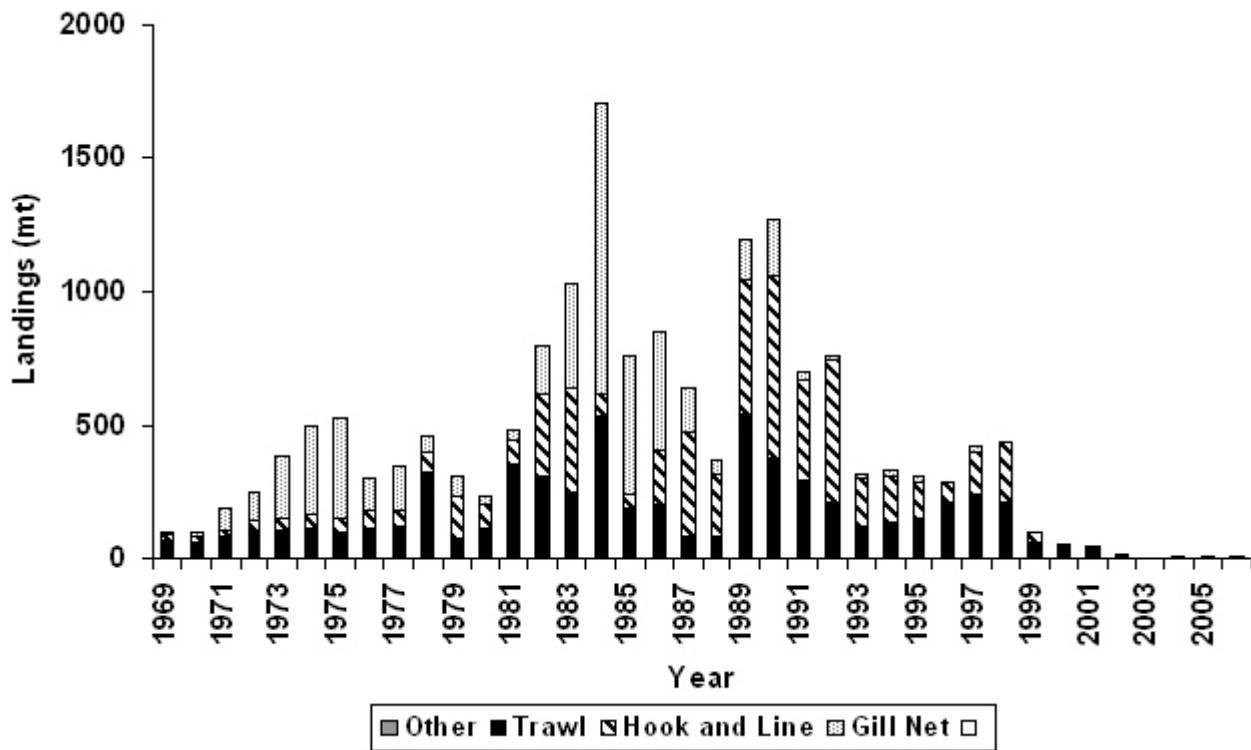
Figure 48. Estimated annual commercial landings (metric tons) of yellowtail rockfish by gear group from California, 1969-2006.

Bronzespotted rockfish

Scientific name: *S. gilli*
Similar Species: none
Confusing Common Names: none
Principal Gear(s): hook-and-line
Principal Region(s): southern California
Principal Market Categories: 959 - rockfish, group red, 250 - unspecified rockfish, 245 - cowcod rockfish, 259 - yellowtail rockfish
Sampled-Strata Index: Range: 0-0.0055 Mean: 0.0011

	Landing Estimate Score
Sampled-Strata Index:	2
Misidentification:	4
Mandatory Sorting:	1
Percent Using Actual:	5
Market Category Anomaly:	4
Landing Anomaly:	4
Nominal Reliability:	3
Percentile Observed:	2
Total Score:	25

Discussion:
1983-2006:
    Bronzespotted rockfish are found primarily in southern California
and are not particularly abundant. They are easily identifiable and it
is unlikely they would be mistaken for a different species. The pattern
of estimated landings for this species shows a sharp decline to nearly
zero by the early 1990s (Figure 49). The overall landing estimate score
for this species is high (25), suggesting that our estimates are
generally reliable.
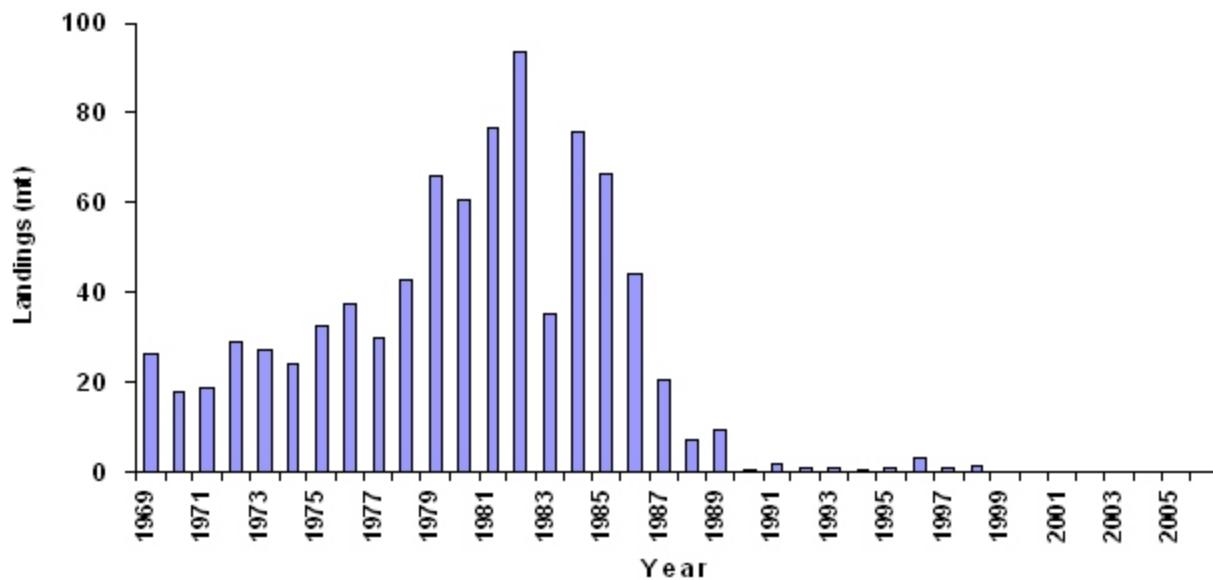
Figure 49. Estimated annual commercial landings (metric tons) of
bronzespotted rockfish from California, 1969-2006.

1969-1982:
    Sampling in southern California ports from 1983 to 1986 was
reasonably good suggesting the ratio estimation method could have
resulted in generally reliable estimates. If that is so, then landings
were relatively stable through 1978 when landings abruptly increased
until their rapid decline in 1987.

                        Chilipepper rockfish
Scientific Name: *S. goodei*
Similar Species: shortbelly rockfish, bocaccio
Confusing Common Names: none
Principal Gear(s): trawl
Principal Region(s): northern and central California
Principal Market Categories: 250 - unspecified rockfish, 254 -
chilipepper rockfish, 956 - chilipepper/bocaccio, 960 - rockfish, group
small, 959 - rockfish, group red
Sampled-Strata Index: Range: 0.0318-0.1691 Mean: 0.0617

65

```
                  Landing Estimate Score
Sampled-Strata Index:            5
Misidentification:               3
Mandatory Sorting:               2
Percent Using Actual:            4
Market Category Anomaly:         5
Landing Anomaly:                 5
Nominal Reliability:             5
Percentile Observed:             5
Total Score:                    34
```

Discussion:
1983-2006:

    The chilipepper is one of the most abundant rockfish in California's commercial landings. It is fairly easy to identify and is landed in well sampled market categories. In addition, the pattern of estimated landings is smooth and variations are readily explainable (Figure 50). Finally, the chilipepper market category (254), when sampled, consisted primarily of chilipepper rockfish. The overall landing estimate score is very high (34) and we feel our landing estimates for this time interval are very reliable.

    1969-1982:

    Since the sample coverage for this species has always been good, the ratio estimation method probably produced reliable estimates. The gradual increase in landings throughout the time interval coincides with the overall increase in rockfish landings which further suggests our landing estimates are generally reliable.
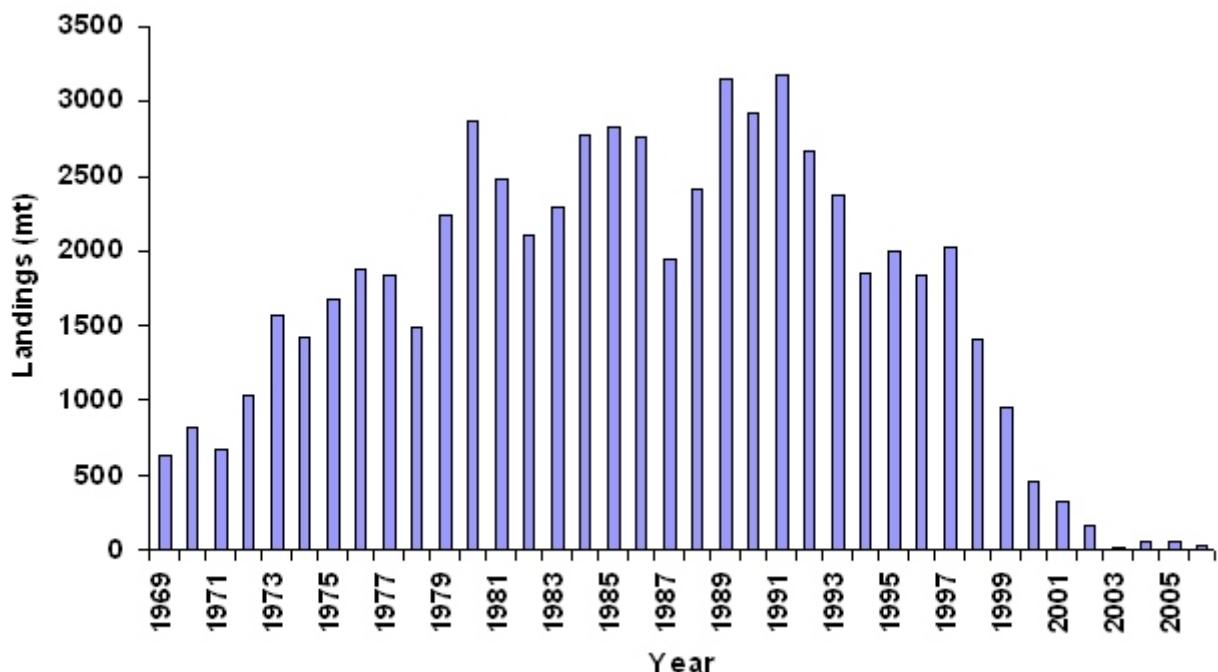
Figure 50. Estimated annual commercial landings (metric tons) of chilipepper rockfish from California, 1969-2006.

                        Rosethorn rockfish
Scientific Name: *S. helvomaculatus*
Similar Species: rosy rockfish, swordspine rockfish
Confusing Common Names: rosy
Principal Gear(s): trawl, hook-and-line
Principal Region(s): northern California
Principal Market Categories: 960 - rockfish, group small, 250 -
unspecified rockfish, 664 - rosethorn rockfish, 961 - rockfish, group
rosefish, 959 - rockfish, group red
Sampled-Strata Index: Range: 0-0.0023 Mean: 0.0006

                        Landing Estimate Score
Sampled-Strata Index: 1
Misidentification: 1
Mandatory Sorting: 1
Percent Using Actual: 2
Market Category Anomaly: 2
Landing Anomaly: 1
Nominal Reliability: 1
Percentile Observed: 2
Total Score: 11

Discussion:

     The rosethorn rockfish can be easily misidentified. It is a low
value species due to its small size (41cm maximum total length). It is
sorted into many market categories and are never abundant in any given
landing. The pattern of landings is extremely erratic suggesting that
sampling of this species is poor (Figure 51). The overall landing
estimate score (11) was one of the lowest for any species. We feel our
estimates of landings for this species are very unreliable.
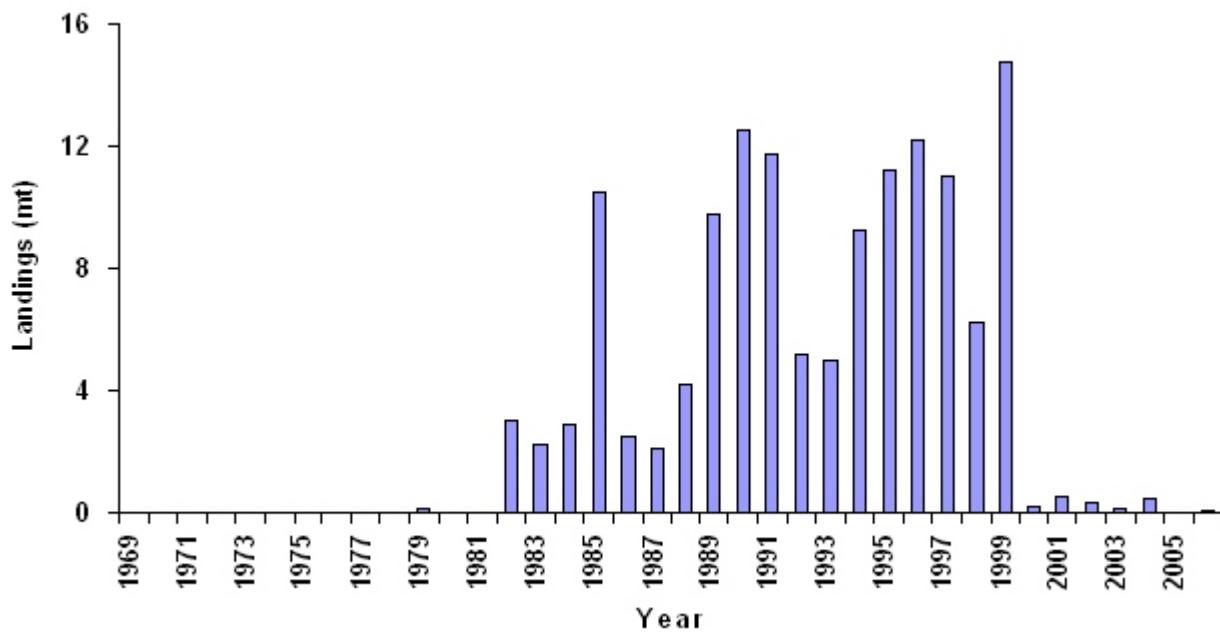
Figure 51. Estimated annual commercial landings (metric tons) of
rosethorn rockfish from California, 1969-2006.

                         Squarespot rockfish
Scientific Name: *S. hopkinsi*
Discussion:
     Only 39 individuals were observed by port samplers in all years.
We therefore feel that while actual landings are probably low, our
estimates are very unreliable.

                         Shortbelly rockfish
Scientific Name: *S. jordani*
Similar Species: chilipepper rockfish
Confusing Common Names: none
Principal Gear(s): trawl
Principal Region(s): northern and central California
Principal Market Categories: 672 - shortbelly rockfish, 960 - rockfish,
group small, 250 - unspecified rockfish
Sampled-Strata Index: Range: 0-0.0738 Mean: 0.0040

68

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                         Landing Estimate Score
Sampled-Strata Index:             3
Misidentification:                3
Mandatory Sorting:                2
Percent Using Actual:             2
Market Category Anomaly:          1
Landing Anomaly:                  1
Nominal Reliability:              1
Percentile Observed:              1
Total Score:                     14
```

Discussion:

  The shortbelly rockfish is rare in commercial landings, although it is one of the most abundant species in California waters based on fisheries-independent surveys (Pearson et al., 1991). Fishermen typically discard shortbelly rockfish due to their small size (35cm maximum total length). The overall pattern of landings is erratic (Figure 52). They are landed in several market categories, and few fish are typically present in any given landing. The relatively large landings in 1997 were the result of two unusual port samples in Fort Bragg from the group small rockfish market category (960). The overall landing estimate score (14) is one of the lowest and consequently we feel our landing estimates for this species are generally unreliable; however, we feel certain that landings are generally quite low.
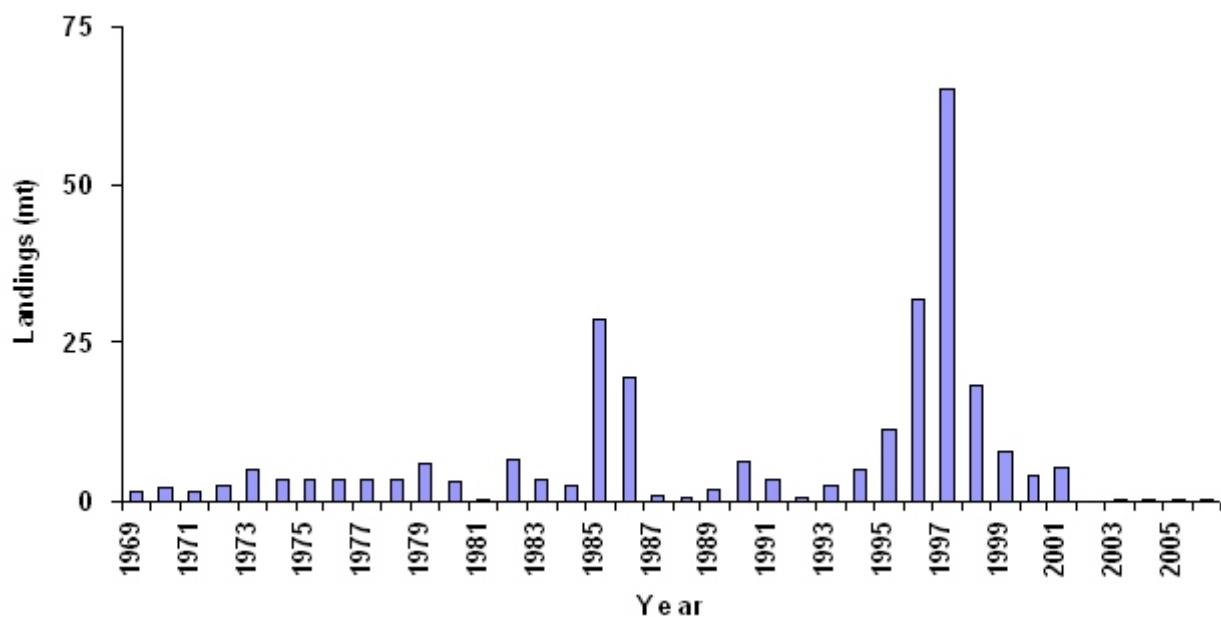

Figure 52. Estimated annual annual commercial landings (metric tons) of shortbelly rockfish from California, 1969-2006.

Cowcod

Scientific Name: *S. levis*
Similar Species: none
Confusing Common Names: none
Principal Gear(s): all
Principal Region(s): southern California
Principal Market Category(ies): 959 - rockfish, group red, 245 - cowcod
rockfish, 250 - unspecified rockfish, 956 - chilipepper/bocaccio
Sampled-Strata Index: Range: 0-0.0063 Mean: 0.0015

                        Landing Estimate Score
Sampled-Strata Index: 2
Misidentification: 4
Mandatory Sorting: 3
Percent Actual: 3
Market Category Anomaly: 3
Landing Anomaly: 4
Nominal Reliability: 4
Percent Landings: 3
Total Score   26

Discussion:
1983-2006:
     The cowcod is one of the largest species of rockfish and are highly
prized by commercial fishermen and recreational anglers. The species is
easily identifiable and it is unlikely that misidentification could
significantly affect landing estimates. The overall pattern of landings
is fairly coherent (Figure 53). Currently it is believed the stock has
been overfished, and strict management measures are in effect (Dick et
al., 2007). Since southern California ports were poorly sampled in the
past, the sampled-strata index is relatively low in many years. The
assumption of the cowcod market category (245) as being pure is not
supported since bronzespotted, chilipepper, and vermilion rockfish also
commonly occur in that market category. In addition, most cowcod do not
occur in the cowcod market category (Figure 54). In spite of this,
overall landing estimates are felt to be generally reliable because of
the ease of identification, lack of landing anomalies, and overall
abundance.

1969-1982:
     Since sampling for southern California was reasonably good from
1983 to 1985, the ratio estimation method probably produced reliable
landing estimates. The overall pattern of landings suggests a gradual
increase in landings from 1969 through 1982, which is consistent with
the overall pattern of all rockfish landings. We feel that estimates of
landings from 1969 through 1982 are generally reliable.
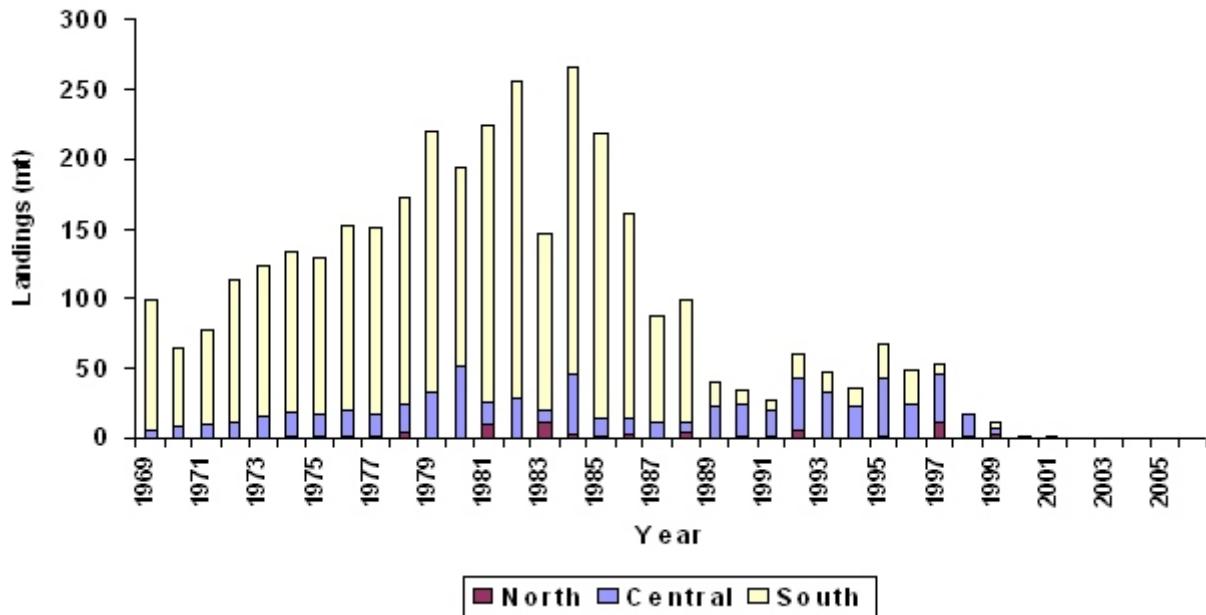
Figure 53. Estimated annual commercial landings (metric tons) of cowcod by geographic area from California, 1969-2006. NORTH=Crescent City, Eureka, and Fort Bragg; CENTRAL=Bodega Bay, San Francisco, Monterey, and Morro Bay; SOUTH=Santa Barbara, Los Angeles, and San Diego.
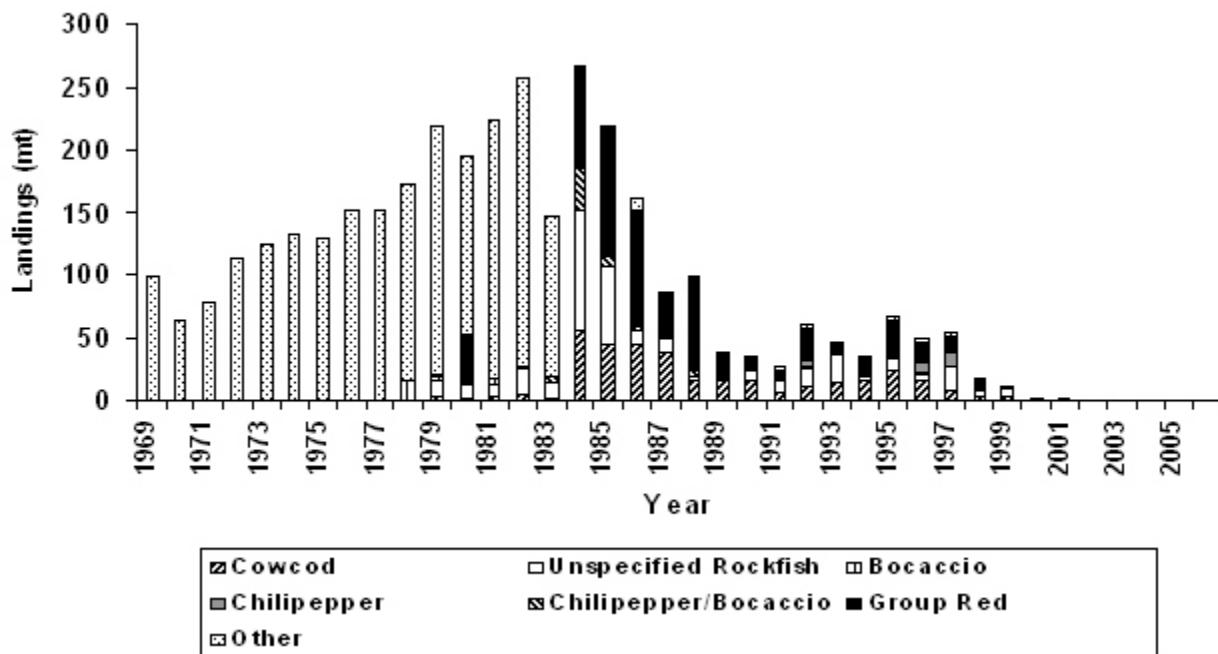
Figure 54. Estimated annual commercial landing (metric tons) by principle market category for cowcod rockfish from California, 1969-2006.

Mexican rockfish
Scientific Name: *S. macdonaldi*
Similar Species: bocaccio
Confusing Common Names: none
Principal Gear(s): trawl
Principal Region(s): southern California
Principal Market Category(ies): 250 - unspecified rockfish, 959 -
rockfish, group red, 956 - chilipepper/bocaccio
Sampled-Strata Index: Range: 0-0.0030 Mean: 0.0003

                         Landing Estimate Score
Sampled-Strata Index: 1
Misidentification: 3
Mandatory Sorting: 1
Percent Using Actual: 4
Market Category Anomaly: 5
Landing Anomaly: 1
Nominal Reliability: 3
Percentile Observed: 1
Total Score: 19

Discussion:
     Mexican rockfish are uncommon in commercial landings and are taken
almost exclusively in southern California. The strata in which they
were landed were poorly sampled. The overall pattern of annual landings
is extremely erratic, suggesting the port sampling effort for this
species is not adequate to provide reliable estimates; however, we feel
that actual landings for the species were low (Figure 55). Overall we
feel that our landing estimates for this species are generally
unreliable.
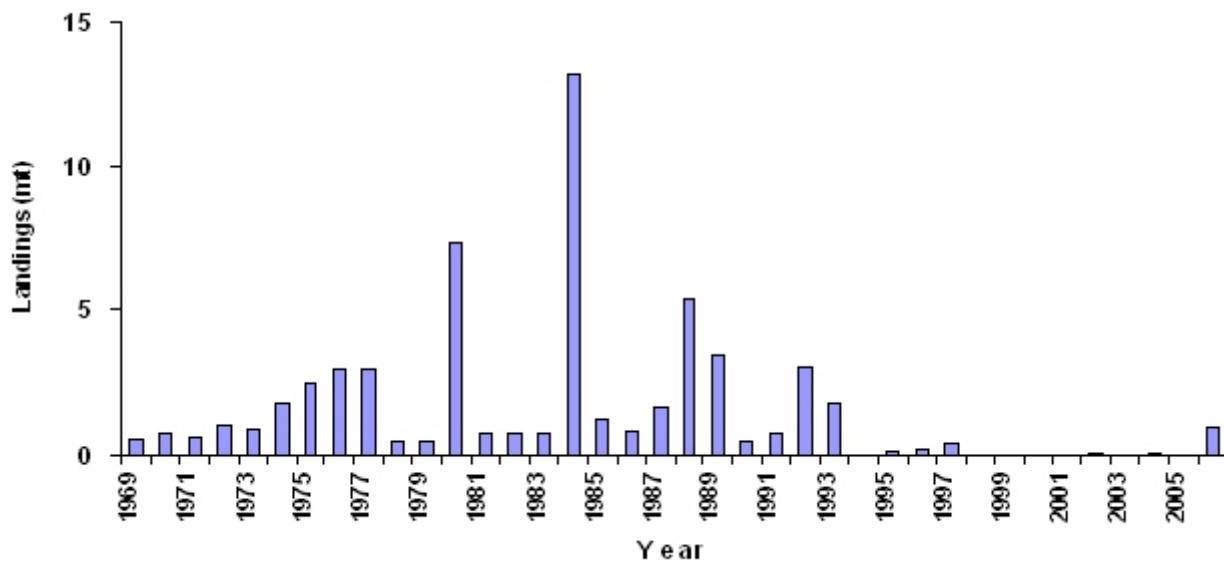
Figure 55. Estimated annual commercial landings (metric tons) for
mexican rockfish from California, 1969-2006.

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Quillback rockfish

Scientific Name: *S. maliger*
Similar Species: none
Confusing Common Names: gopher, brown, speckled
Principal Gear(s): hook-and-line
Principal Region(s): northern California
Principal Market Category(ies): 970 - quillback rockfish, 250 -
unspecified rockfish, 258 - China rockfish
Sampled-Strata Index: Range: 0-0.0261 Mean: 0.0033

	Landing Estimate Score
Sampled-Strata Index:	3
Misidentification:	4
Mandatory Sorting:	2
Percent Using Actual:	2
Market Category Anomaly:	4
Landing Anomaly:	1
Nominal Reliability:	2
Percentile Observed:	2
Total Score:	20

Discussion:

     Quillback rockfish occur in nearshore, rocky reef habitats. They
are unlikely to be misidentified. However, since they are relatively
low in abundance, they are often sorted into market categories with
other nearshore species. The overall pattern of estimated annual
landings is erratic (Figure 56). We feel that landing estimates are
generally reliable for this species from 1992 through 2006, although
estimates prior to 1991 are generally unreliable. We feel actual
landings of this species have probably always been low.
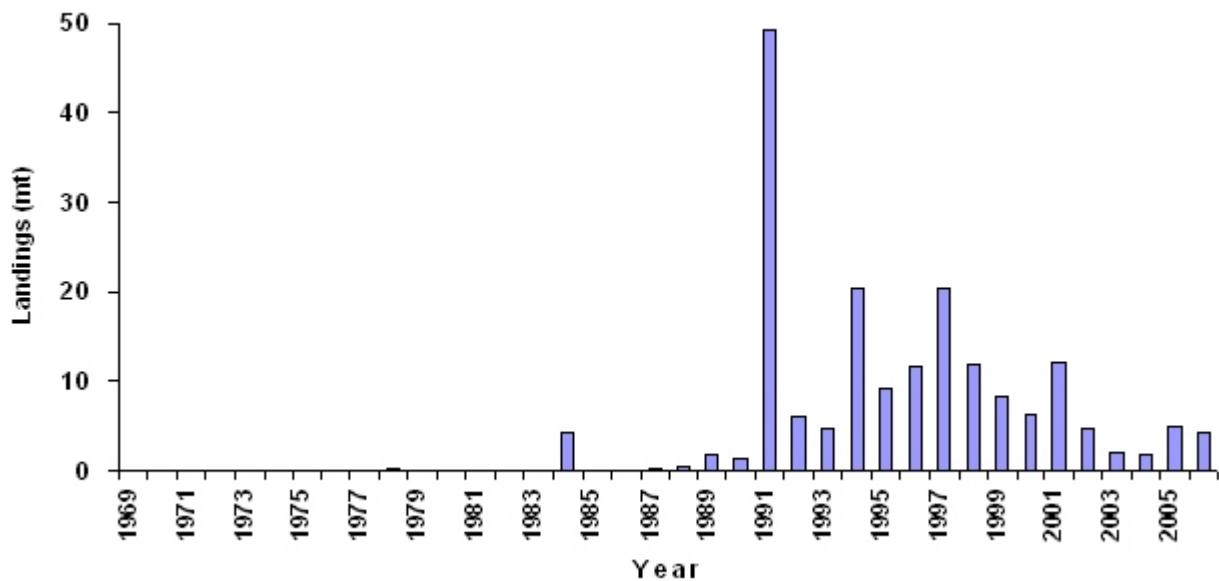
Figure 56. Estimated annual commercial landings (metric tons) for
quillback rockfish from California, 1969-2006.

Black rockfish

Scientific name: *S. melanops*
Similar Species: blue rockfish
Confusing Common Names: none
Principal Gear(s): hook-and-line, trawl
Principal Region(s): northern California
Principal Market Category(ies): 252 - black rockfish, 250 - unspecified rockfish
Sampled-Strata Index: Range: 0-0.0597 Mean: 0.0180

	Landing Estimate Score
Sampled-Strata Index:	5
Misidentification:	1
Mandatory Sorting:	2
Percent Using Actual:	2
Market Category Anomaly:	1
Landing Anomaly:	1
Nominal Reliability:	3
Percentile Observed:	4
Total Score:	19

Discussion:
1983-2006:
     Black rockfish can be readily misidentified as blue rockfish. In addition, the hook-and-line fishery was not well sampled until the 1990s. The overall pattern of annual landings is extremely erratic and the spikes are not readily explainable (Figure 57). Many of these estimated landings are not based on actual port samples, and instead are based on borrowing and treating the black rockfish market category as "pure". Port samples of the black rockfish market category (252) contain blue rockfish. Late in the time series, strong landing restrictions and a sort requirement were placed on this species. Therefore, landing estimates after 2002 are probably generally reliable. The overall landing estimate score is relatively low (19). We feel the landing estimates, especially prior to 1990, are generally unreliable.

1969-1982:
     Since landing estimates between 1978 and 1980 are erratic, it is unlikely that the ratio estimation method produced reliable estimates from 1969 through 1977. Given the problems with misidentification, we feel estimates of landings prior to 1983 are generally unreliable.
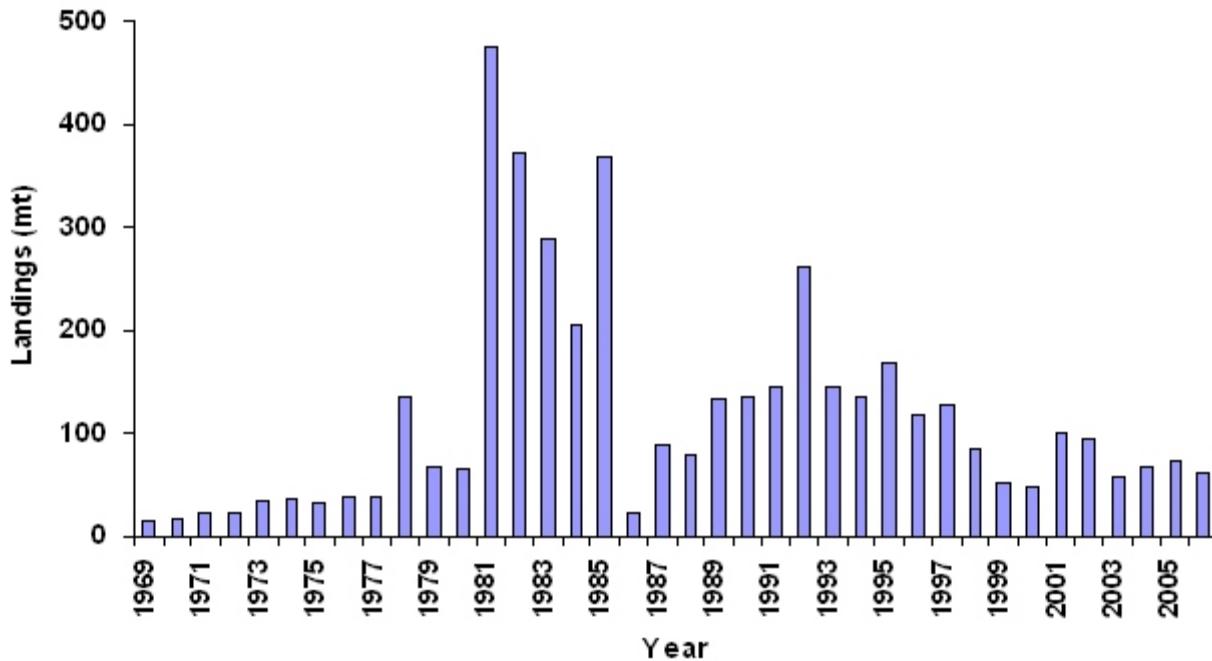
Figure 57. Estimated annual commercial landings (metric tons) of black rockfish from California, 1969-2006.

Blackgill rockfish

Scientific Name: *S. melanostomus*
Similar Species: darkblotched rockfish
Confusing Common Names: none
Principal Gear(s): all
Principal Region(s): central and southern California
Principal Market Category(ies): 250 - unspecified rockfish, 667 - blackgill rockfish, 956 - chilipepper/bocaccio, 961 - rockfish, group rosefish, 959 - rockfish, group red
Sampled-Strata Index: Range: 0.0043-0.0379 Mean: 0.0162

	Landing Estimate Score
Sampled-Strata Index:	4
Misidentification:	3
Mandatory Sorting:	2
Percent Using Actual:	3
Market Category Anomaly:	3
Landing Anomaly:	4
Nominal Reliability:	4
Percentile Observed:	5
Total Score:	28

75

Discussion:
1983-2006:

    The blackgill rockfish is an important species in California's
commercial landings. It is most abundant in waters deeper than 200
meters. In central California, it can be mistaken for darkblotched
rockfish, which is primarily a more northern species. Port samples from
the blackgill market category (667) indicate that when they are sorted
into this category, there are few other species present. The overall
pattern of landings is somewhat erratic (Figure 58). Low landings in
1984 were a result of a sharp drop in hook-and-line activity in Los
Angeles. The overall higher landings from 1982 through 1992 were due in
large part to gill net fishing which dropped sharply after 1992. Many
blackgill landings were sorted into market categories other than the
blackgill market category. Its overall landing estimate score of 28
suggests our landing estimates are generally reliable.

1969-1982:

    Annual landing estimates show a gradual increase coinciding with a
gradual increase in all rockfish landings in southern California. The
ratio estimation method is probably at least somewhat reliable for this
species. We feel that our estimates for 1969 through 1982 are generally
reliable.
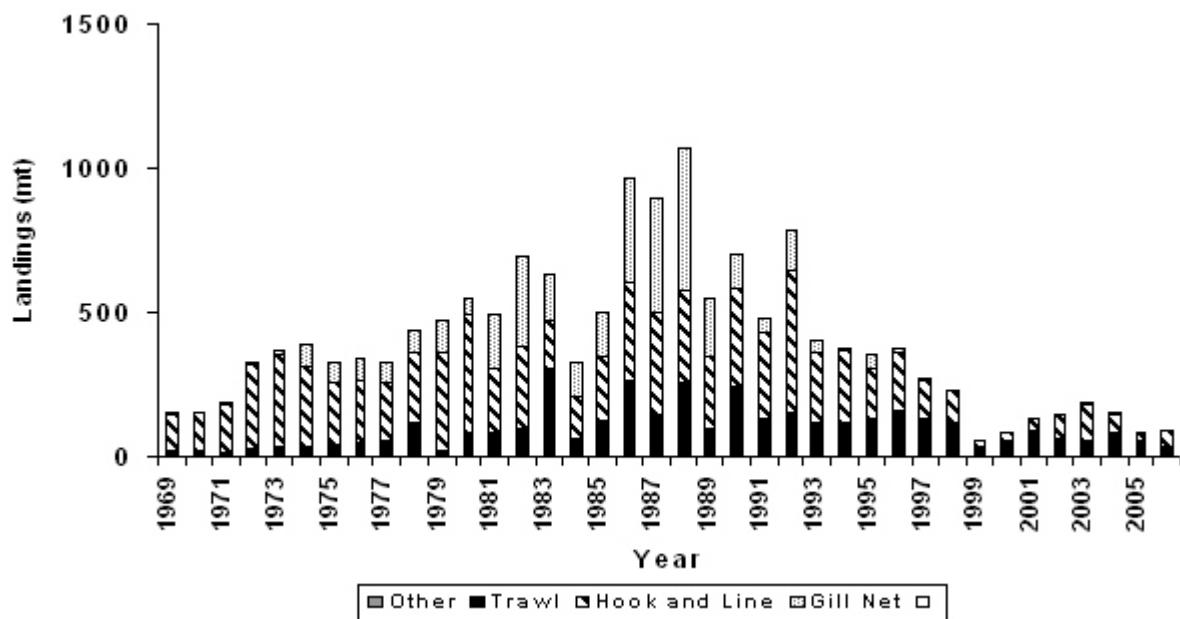
Figure 58. Estimated annual commercial landings (metric tons) of
blackgill rockfish from California, 1969-2006.

Vermilion rockfish

Scientific name: *S. miniatus*
Similar Species: canary rockfish
Confusing Common Names: none
Principal Gear(s): hook-and-line
Principal Region(s): central and southern California
Principal Market Category(ies): 959 - rockfish, group red, 250 -
unspecified rockfish, 249 - vermilion rockfish
Sampled-Strata Index: Range: 0.0002-0.0456 Mean: 0.0089

                        Landing Estimate Score
Sampled-Strata Index: 4
Misidentification: 3
Mandatory Sorting: 2
Percent Using Actual: 2
Market Category Anomaly: 1
Landing Anomaly: 4
Nominal Reliability: 3
Percentile Observed: 4
Total Score: 23

Discussion:
1983-2006:
     Vermilion rockfish have two color morphs, one of which is very
similar in appearance to the canary rockfish, which can lead to some
problems with misidentification. While most landings occur in southern
California where sampling levels have been low, the sampled strata index
suggests generally good sample coverage overall given their high
relative abundance and sorting into relatively few market categories.
There was a clear shift in the way vermilion rockfish were sorted, with
most sorted into group market categories early in the time series with
an increasing use of the vermilion rockfish market category (249) in
recent years. As a result of this shift, the market category anomaly
value is low. The overall pattern of landings is reasonably coherent
(Figure 59). The final landing estimate score of 23 is about average,
suggesting that our estimates of the landings are generally reliable.

1969-1982:
     Landings of vermilion rockfish gradually increased over time from
1969 through 1982 and then dropped sharply. This coincided with total
landings made by hook-and-line gear in Morro Bay, which was responsible
for a large fraction of the landings during that time. Since sampling
coverage was generally good for this species in most years, the ratio
estimation approach probably produced generally reliable estimates for
1969-1982.
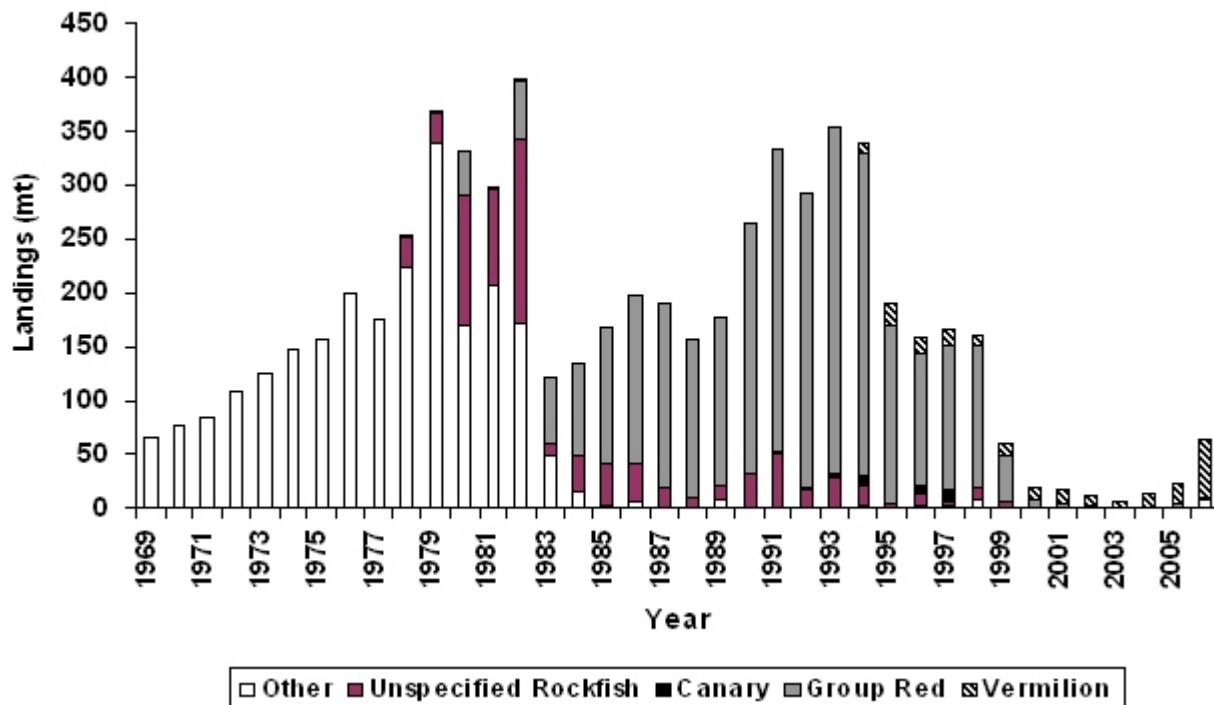
Figure 59. Estimated annual commercial landings (metric tons) of
vermilion rockfish by priciple market category from California, 1969-
2006.

                        Blue rockfish
Scientific name: *S. mystinus*
Similar Species: black rockfish, dusky rockfish
Confusing Common Names: black rockfish
Principal Gear(s): hook-and-line, gill net
Principal Region(s): northern and central California
Principal Market Category(ies): 250 - unspecified rockfish, 665 - blue
rockfish, 252 - black rockfish, and 960 - rockfish, group small
Sampled-Strata Index: Range: 0-0.0185 Mean: 0.0041

                    Landing Estimate Score
Sampled-Strata Index: 3
Misidentification: 2
Mandatory Sorting: 2
Percent Using Actual: 2
Market Category Anomaly: 2
Landing Anomaly: 1
Nominal Reliability: 2
Percentile Observed: 4
Total Score: 18

Discussion:
1983-2006:

     Blue rockfish closely resemble black rockfish. Port sample data
suggest they are often sorted into the black rockfish market category
and black rockfish are sometimes sorted into the blue rockfish market
category. Blue rockfish are seldom caught by trawl gear, while black
rockfish are vulnerable to trawling. In the market category and landing
estimates, occasional large quantities of blue rockfish are reported as
having been caught by trawl gear. Landings of blue rockfish caught by
trawl gear are therefore highly suspect and could be black rockfish.
The overall pattern of landings is extremely erratic (Figure 60). Much
of the blue rockfish is not landed in the blue rockfish market category.
From 1984 through 1991 the landings were very erratic, then in 1992 they
jumped sharply which is due in part to the development of the live fish
fishery. From 1992 through 2006, the landings declined. We feel that
overall, our landing estimates of blue rockfish are generally unreliable
and care must be taken when using these estimates.
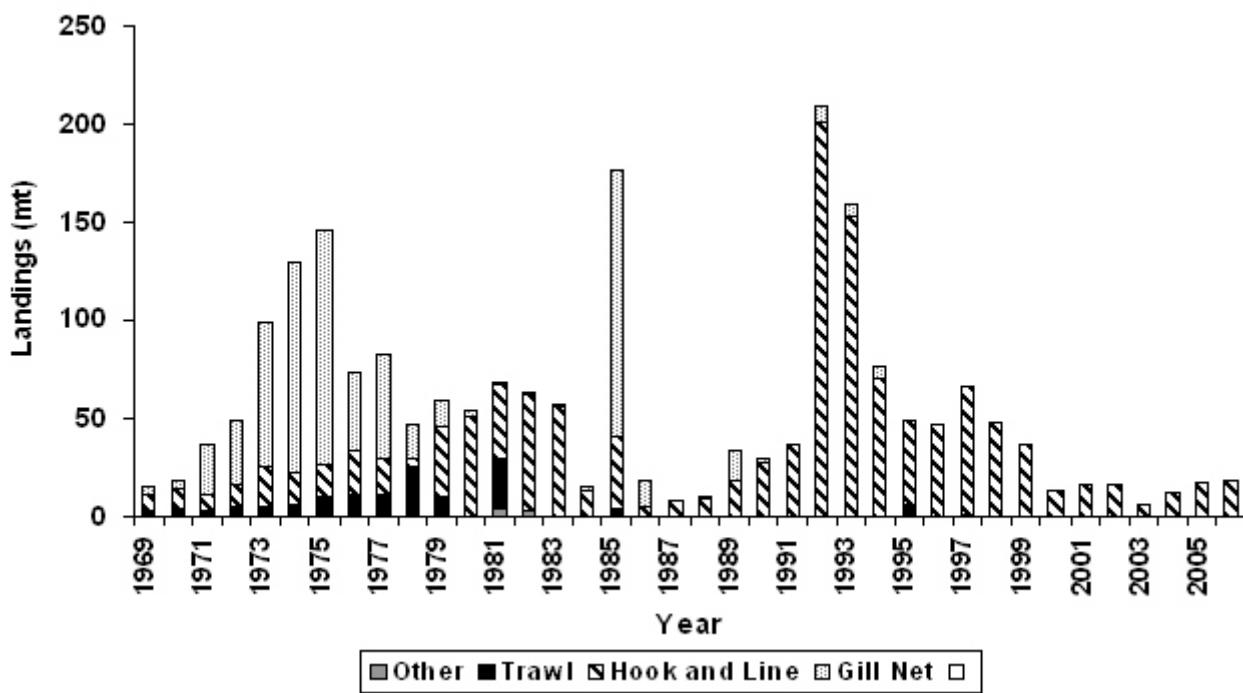
Figure 60. Estimated annual commercial landings (metric tons) of blue
rockfish by gear group from California, 1969-2006.

1969-1982:

     The estimates of blue rockfish landings prior to 1983 are generally
unreliable. Most of the landing estimates are not based on actual
sampling. The ratio estimation method probably did a poor job of
estimating landings before 1978. This is particularly true given the
problems of misidentification.

     The reliability of the estimates is further complicated by a
question about the possible presence of two species of blue rockfish.
Recently genetic studies have indicated that there may be two species of

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blue rockfish although this hasn't been fully confirmed. This issue is
discussed in the summary section.

                        China rockfish
Scientific Name: *S. nebulosus*
Similar Species: none
Confusing Common Names: gopher, black-and-yellow
Principal Gear(s): hook-and-line
Principal Region(s): central California
Principal Market Category(ies): 258 - China rockfish, 250 - unspecified
rockfish, 962 - rockfish, group gopher, 957 - rockfish, group bolinas
Sampled-Strata Index: Range: 0-0.0403 Mean: 0.0073

                       Landing Estimate Score
Sampled-Strata Index: 4
Misidentification: 3
Mandatory Sorting: 2
Percent Using Actual: 1
Market Category Anomaly: 2
Landing Anomaly: 2
Nominal Reliability: 2
Percentile Observed: 3
Total Score: 19

Discussion:
1983-2006:
     China rockfish are readily distinguishable from other species.
However, a common name for greenspotted rockfish is chinafish. This
creates a problem for landing estimates relying on treating the China
rockfish market category as pure. China rockfish inhabit nearshore,
rocky reefs with high relief: areas not considered suitable to trawling
operations. Prior to 1991 most of the estimated landings did not rely
on actual sampling (Figure 61). Landings for China rockfish increased
after 1991 with the advent of the live-fish fishery. Sampling coverage
improved substantially after 1991, making the estimates more reliable.
Therefore, we feel that estimated landings prior to 1992 are not
reliable; however, the 1992 through 2006 estimates are generally
reliable. We suspect that actual landings between 1983 and 1991 were
relatively low.

1969-1982:
     Large landings reported in the China rockfish market category (258)
in the early 1980s in the Monterey area were made using trawl gear.
Greenspotted rockfish are common in trawl gear in the Monterey area.
Because of the reported trawl catches in the China rockfish market
category and the erratic landing anomalies, we feel that landings
reported as trawl for this species were actually greenspotted rockfish.
In general we have low confidence in our estimated landings. We feel
the landing estimates would be more reliable if the reported trawl
caught landings are excluded. The ratio estimation method probably did
not produce reliable estimates for this species from 1969 through 1977
since the estimates for 1978 through 1980 are generally unreliable.
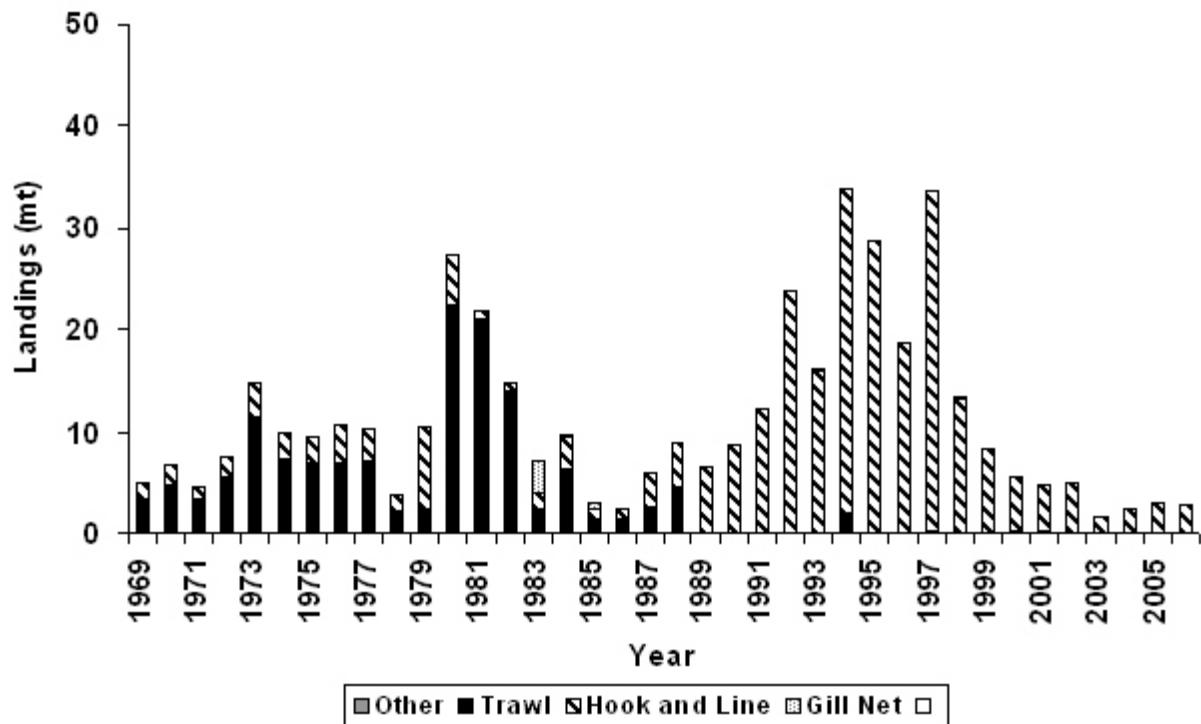
Figure 61. Estimated annual commercial landings (metric tons) of China rockfish by gear group from California, 1969-2006.

Tiger rockfish

Scientific Name: *S. nigrocinctus*

Discussion:

Only 91 individuals were observed by port samplers in all years. We therefore feel that while actual landings are low, our estimates are very unreliable.

Speckled rockfish

Scientific Name: *S. ovalis*
Similar Species: bank rockfish
Confusing Common Names: widow rockfish
Principal Gear(s): hook-and-line, gill net
Principal Region(s): central and southern California
Principal Market Category(ies): 250 - unspecified rockfish, 956 - chilipepper/bocaccio, 269 - widow rockfish, 253 - bocaccio
Sampled-Strata Index: Range: 0-0.0070 Mean: 0.0013

```
                        Landing Estimate Score
Sampled-Strata Index:           2
Misidentification:              3
Mandatory Sorting:              1
Percent Using Actual:           3
Market Category Anomaly:        5
Landing Anomaly:                1
Nominal Reliability:            2
Percentile Observed:            3
Total Score:                   20
```

Discussion:
1983-2006:

     The speckled rockfish is a reasonably common bycatch species. It can be misidentified as bank rockfish but not readily so. Most speckled rockfish are not landed in the speckled rockfish market category (669). The low value of the sampled strata index indicates that sampling coverage for this species is low. The pattern of annual landings is very erratic (Figure 62). During the mid 1980s to early 1990s, a substantial fraction of the landings were made by gill net. When that fishery was placed under heavy regulation, landings declined somewhat, although they continued until they abruptly ended in 2000. We feel our estimates of actual landings for this species are only somewhat reliable due to poor sampling coverage.
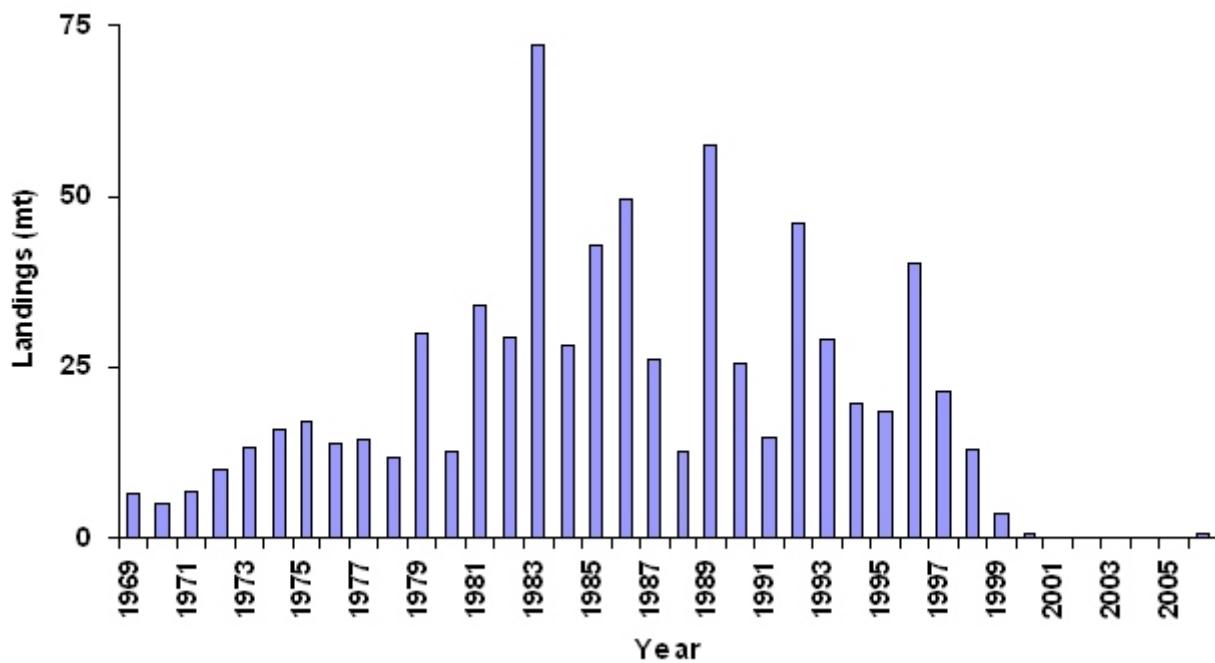

Figure 62. Estimated annual commercial landings (metric tons) of speckled rockfish from California, 1969-2006.

1969-1982:

Although sampling coverage for this species in southern California
was not good, we feel that the ratio estimation method did a fair a job
estimating the landings. Although not completely reliable, it seems
likely a small number were landed as bycatch which is what the ratio
estimation method shows.

Bocaccio

Scientific Name: *S. paucispinus*
Similar Species: mexican rockfish, silvergray rockfish
Confusing Common Names: tomcod, brown bomber
Principal Gear(s): trawl
Principal Region(s): central California
Principal Market Category(ies): 250 - unspecified rockfish, 956 -
chilipepper/bocaccio, 253 - bocaccio, 959 - rockfish, group reds
Sampled-Strata Index: Range: 0-0.1719 Mean: 0.0648

Landing Estimate Score
Sampled-Strata Index: 5
Misidentification: 4
Mandatory Sorting: 5
Percent Using Actual: 4
Market Category Anomaly: 5
Landing Anomaly: 5
Nominal Reliability: 3
Percentile Observed: 5
Total Score: 36

Discussion:
1983-2006:

The bocaccio is one of the most abundant rockfish in California and
has been one of the main components of both the commercial and
recreational fisheries in California in most years. Since 1991,
regulations required it to be sorted into a separate market category for
management purposes, and sampling coverage has been very good. Although
there are two species which are somewhat similar in appearance
(silvergray and Mexican rockfish), both species are uncommon so problems
associated with misidentification are considered to be minimal. Both
market category and annual landing plots show few anomalies, all of
which can be readily explained (Figure 63). Since 1991, landings have
been constrained by regulation. Prior to 1991, landings were sometimes
constrained by market considerations since this species was not
considered highly desirable by the commercial fishing industry. This
species has the second highest landing estimate score (36), so we feel
our annual landing estimates are very reliable.

1969-1982:

Bocaccio have always been well sampled. It is caught primarily by
trawl and easily targeted by fishermen. It is likely that it has always
been a large component of the groundfish fishery. We feel the ratio
estimation method probably did a good job at estimation of the landings
prior to 1978, and therefore feel the landing estimates prior to 1983
are generally reliable.
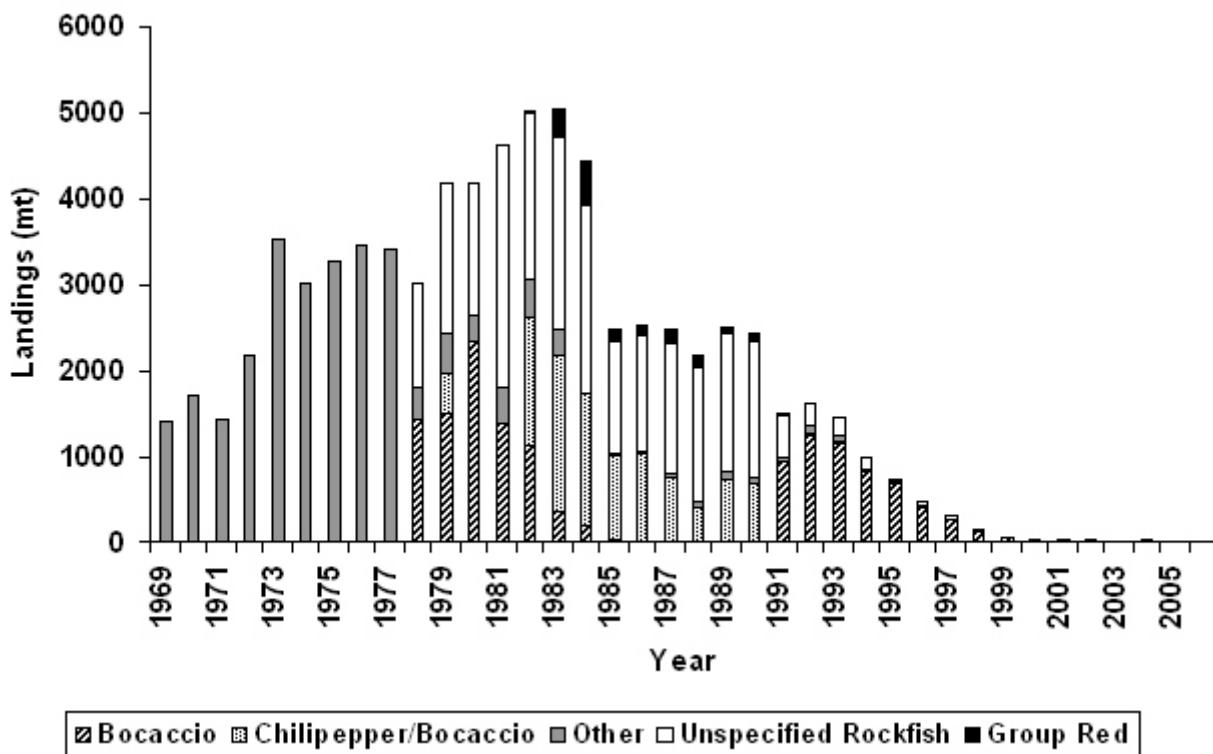
Figure 63. Estimated annual commercial landings (metric tons) of bocaccio by princple market category from California, 1969-2006.

                         Chameleon rockfish
Scientific Name: *S. phillipsi*
Similar Species: aurora rockfish, splitnose rockfish
Confusing Common Names: none
Principal Gear(s): gill net
Principal Region(s): southern California
Principal Market Category(ies): 250 - unspecified rockfish, 959 -
rockfish, group red
Sampled-Strata Index: Range: 0-0.0052 Mean: 0.0006

                     Landing Estimate Score
Sampled-Strata Index: 1
Misidentification: 1
Mandatory Sorting: 1
Percent Using Actual: 4
Market Category Anomaly: 5
Landing Anomaly: 2
Nominal Reliability: 2
Percentile Observed: 1
Total Score: 17

Discussion:

　　　Chameleon rockfish are uncommon in commercial landings, particularly in northern and central California. They can be confused with both splitnose and aurora rockfish. The strata in which they occur are not well sampled. Although the principal market categories they are landed in do not show many anomalies, their estimated landings are very erratic (Figure 64). The landing estimate score for this species (17) is low, suggesting our landing estimates for this species are only somewhat reliable; however, we feel the actual landings are low.
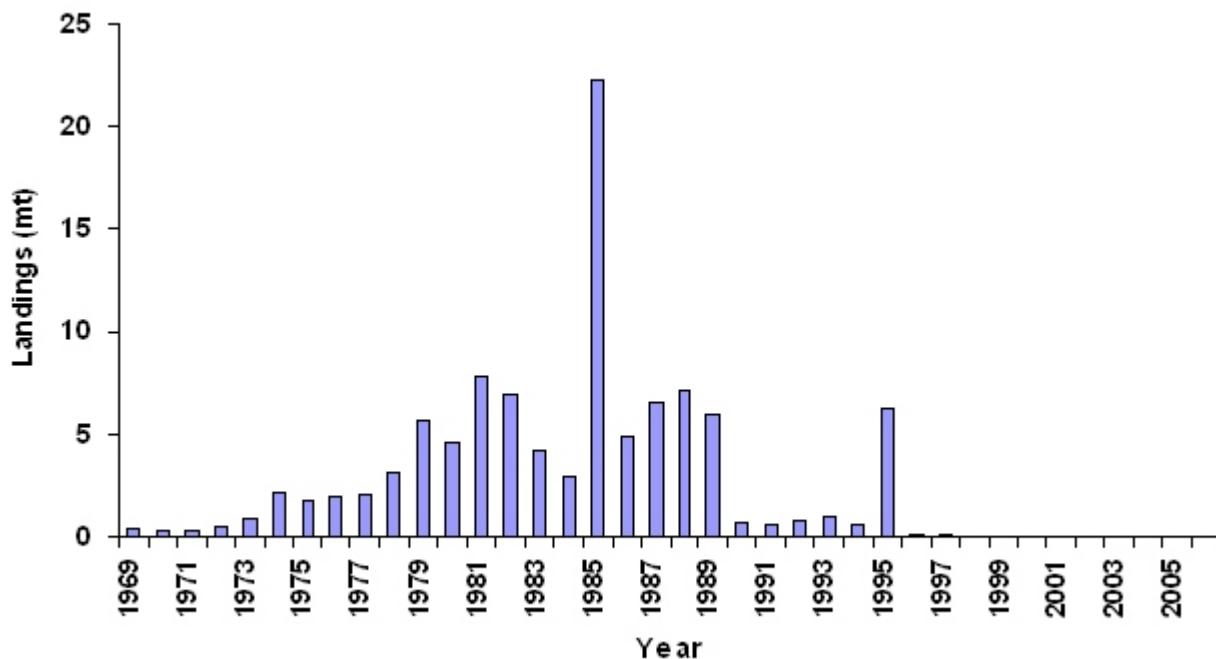
Figure 64. Estimated annual commercial landings (metric tons) of chameleon rockfish from California, 1969-2006.

　　　　　　　　　　　　　Canary rockfish
Scientific Name: *S. pinniger*
Similar Species: vermilion rockfish
Confusing Common Names: none
Principal Gear(s): trawl
Principal Region(s): northern and central California
Principal Market Category(ies): 250 - unspecified rockfish, 959 - rockfish, group red, 247 - canary rockfish, 956 - chilipepper/bocaccio
Sampled-Strata Index: Range: 0-0.0281 Mean: 0.0093

```
                     Landing Estimate Score
Sampled-Strata Index:          4
Misidentification:             2
Mandatory Sorting:             3
Percent Using Actual:          3
Market Category Anomaly:       3
Landing Anomaly:               4
Nominal Reliability:           4
Percentile Observed:           4
Total Score:                  27
```

Discussion:

1983-2006:

     The canary rockfish is an abundant species in the commercial
landings. It can be occasionally misidentified as vermilion rockfish
since one of the color morphs of vermilion rockfish is quite similar in
appearance. The strata in which it is typically sorted have been well
sampled. The canary rockfish market category (247) was not widely used
in the early years of the study and is still used inconsistently;
therefore, relying on just the landings in this market category will
result in serious underestimation of the total landings. The overall
pattern of estimated landings shows a fairly coherent pattern with few
anomalies (Figure 65). Landings generally declined since 1982, largely
due to decreased catches by both trawl and hook-and-line. In the early
1990s, hook-and-line landings rebounded somewhat; however, trawl catches
continued to decline. In 1999, this species was declared overfished and
landings were reduced to nearly zero. We feel our estimates of annual
landings for this species are generally reliable and the overall landing
estimate score (28) was among the highest for all rockfish species.
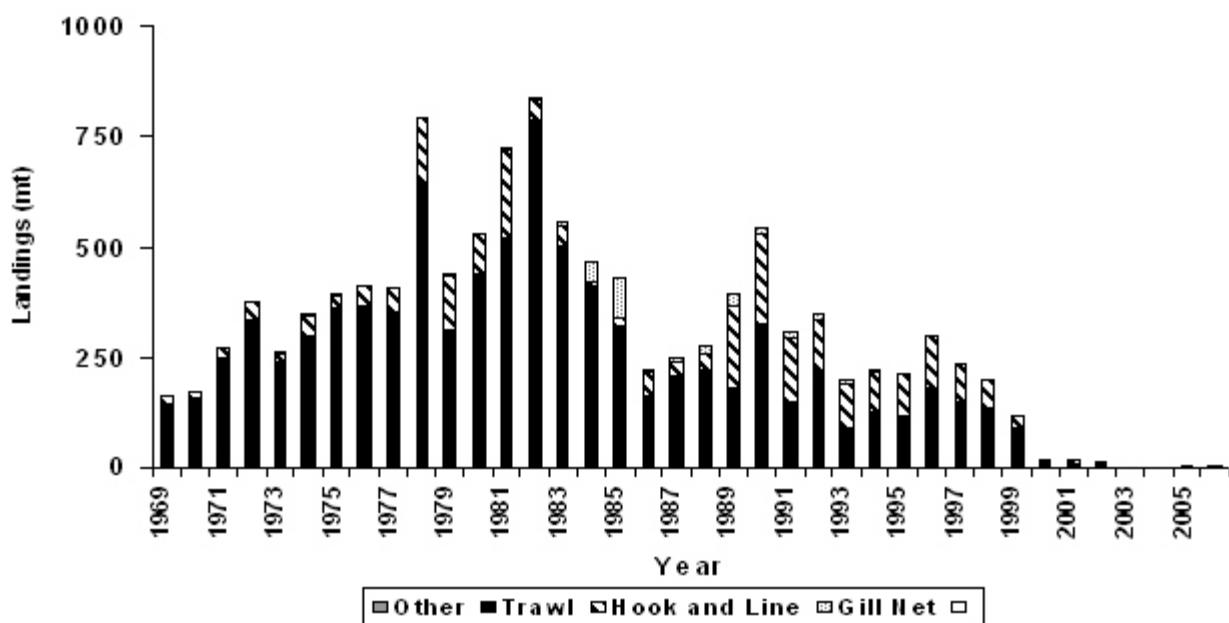
Figure 65. Estimated annual commercial landings (metric tons) of canary
rockfish by gear group from California, 1969-2006.

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1969-1982:
     Since sampling coverage for this species was very good, we feel the
ratio estimation method probably provided fairly reliable estimates of
landings prior to 1977 for the central area. Since the trend in
landings is reasonably coherent, we feel our landing estimates from 1978
through 1982 are generally reliable.

                         Redstripe rockfish
Scientific Name: *S. proriger*

Discussion:
     Only 395 individuals were observed by port samplers in all years
distributed among many strata. We therefore feel that, while actual
landings are probably low, our estimates are very unreliable.

                          Grass rockfish
Scientific Name: *S. rastrelliger*
Similar Species: brown rockfish
Confusing Common Names: gopher rockfish, kelp rockfish
Principal Gear(s): hook-and-line
Principal Region(s): Morro Bay and Santa Barbara
Principal Market Category(ies): 652 - grass rockfish
Sampled-Strata Index: Range: 0-0.0309 Mean: 0.0113

                      Landing Estimate Score
Sampled-Strata Index: 4
Misidentification: 3
Mandatory Sorting: 2
Percent Using Actual: 1
Market Category Anomaly: 5
Landing Anomaly: 5
Nominal Reliability: 5
Percentile Observed: 3
Total Score: 28

Discussion:
     Grass rockfish are caught in nearshore rocky reef areas. When the
nearshore live-fish fishery began in the early 1990s, their landings
began to increase. Port samples of the grass rockfish market category
indicate that nearly all fish landed in that category are grass
rockfish. Landings in the grass rockfish market category have a
coherent and reasonable pattern. The pattern of estimated annual
landings is also coherent(Figure 66). Prior to 1991, only five
individuals were observed by port samplers, supporting the extremely low
landing estimates. We feel our estimates of landings for this species
are very reliable.

                       Yellowmouth rockfish
Scientific Name: *S. reedi*

Discussion:
     Only 126 individuals were observed by port samplers in all years.
We therefore feel, that while actual landings are probably low, our
estimates are very unreliable.
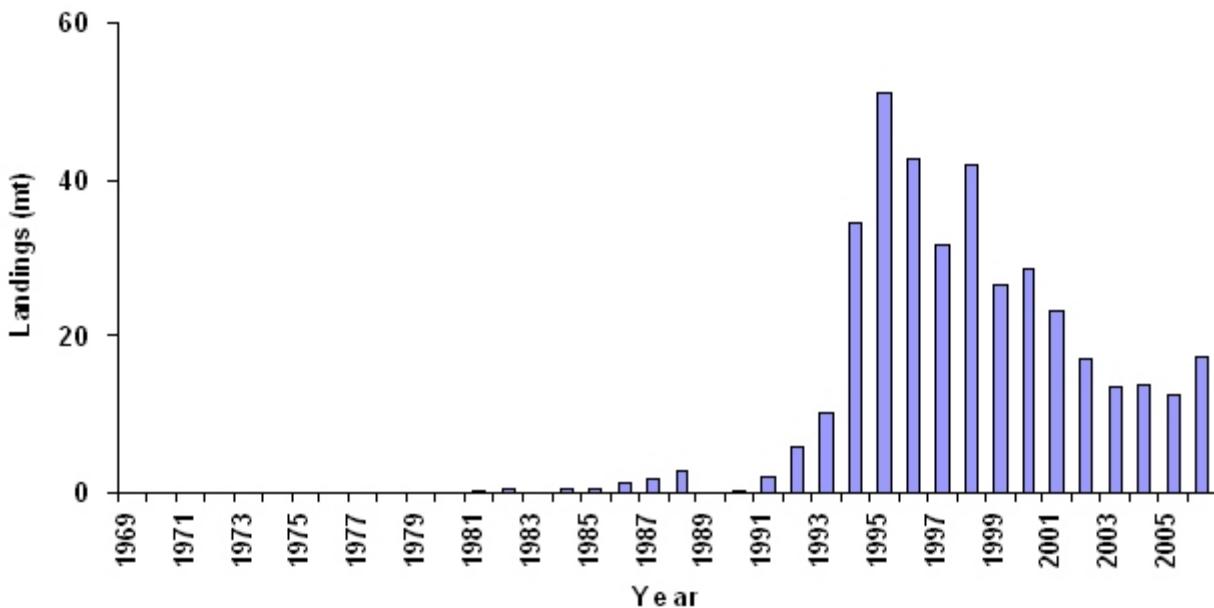
Figure 66. Estimated annual landings (metric tons) of grass rockfish
from California, 1969-2006.

                          Rosy rockfish
Scientific Name: *S. rosaceous*
Similar Species: rosethorn rockfish, swordspine rockfish
Confusing Common Names: none
Principal Gear(s): hook-and-line
Principal Region(s): San Francisco
Principal Market Category(ies): 959 - rockfish, group red, 250 -
unspecified rockfish, 960 - rockfish, group small, 268 - rosy rockfish
Sampled-Strata Index: Range: 0-0.0013 Mean: 0.0002

                    Landing Estimate Score
Sampled-Strata Index: 1
Misidentification: 2
Mandatory Sorting: 1
Percent Using Actual: 2
Market Category Anomaly: 1
Landing Anomaly: 1
Nominal Reliability: 1
Percentile Observed: 2
Total Score: 11

Discussion:
     The rosy rockfish is a common species in sport landings. Since it
is a small fish (36cm maximum total length) it is of low value to
commercial fishermen. This species can be easily misidentified and as a
result, many fish landed in the rosy rockfish market category (268)
could be rosethorn rockfish. Of the five port samples taken from the

rosy market category: no rosy rockfish were observed. The samples
consisted of rosethorn, aurora, and splitnose rockfish. The pattern of
estimated landings are extremely erratic (Figure 67). The overall
landing estimate score (11) is one of the lowest of all rockfish species
in this study. We feel that our landing estimates for this species are
generally unreliable; however, we believe the actual total landings are
quite low.
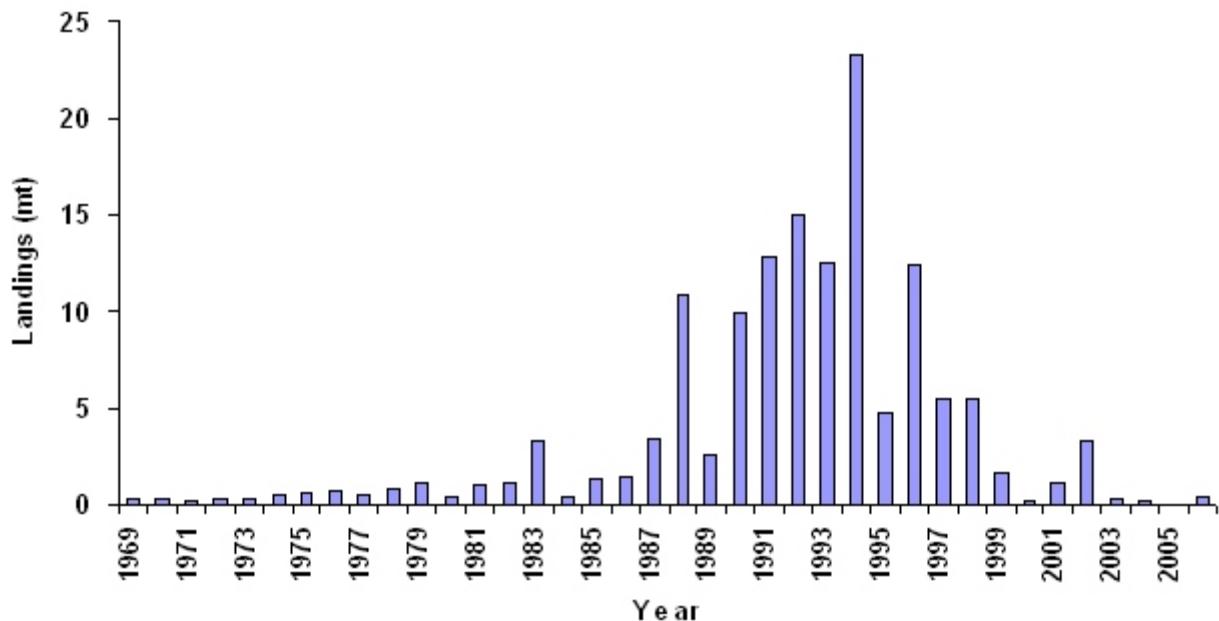
Figure 67. Estimated annual commercial landings (metric tons) of rosy
rockfish from California, 1969-2006.

                          Greenblotched rockfish
Scientific Name: *S. rosenblatti*
Similar Species: greenspotted rockfish
Confusing Common Names: none
Principal Gear(s): hook-and-line
Principal Region(s): southern California
Principal Market Category(ies): 959 - rockfish, group red, 250 -
unspecified rockfish
Sampled-Strata Index: Range: 0-0.0018 Mean: 0.0005

                     Landing Estimate Score
Sampled-Strata Index: 1
Misidentification: 1
Mandatory Sorting: 1
Percent Using Actual: 3
Market Category Anomaly: 5
Landing Anomaly: 1
Nominal Reliability: 3
Percentile Observed: 2
Total Score: 17

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Discussion:

     Greenblotched rockfish are most common in southern California and even then are relatively low in total abundance. They can be easily mistaken for greenspotted rockfish. The strata in which they occur have not been well sampled, and the overall pattern of their annual landings is highly erratic, reflecting the poor sampling and possible misidentification of this species (Figure 68). The overall landing estimate score of 17 is quite low. We feel our landing estimates for this species are generally unreliable; however, we feel that overall landings are likely to be low.
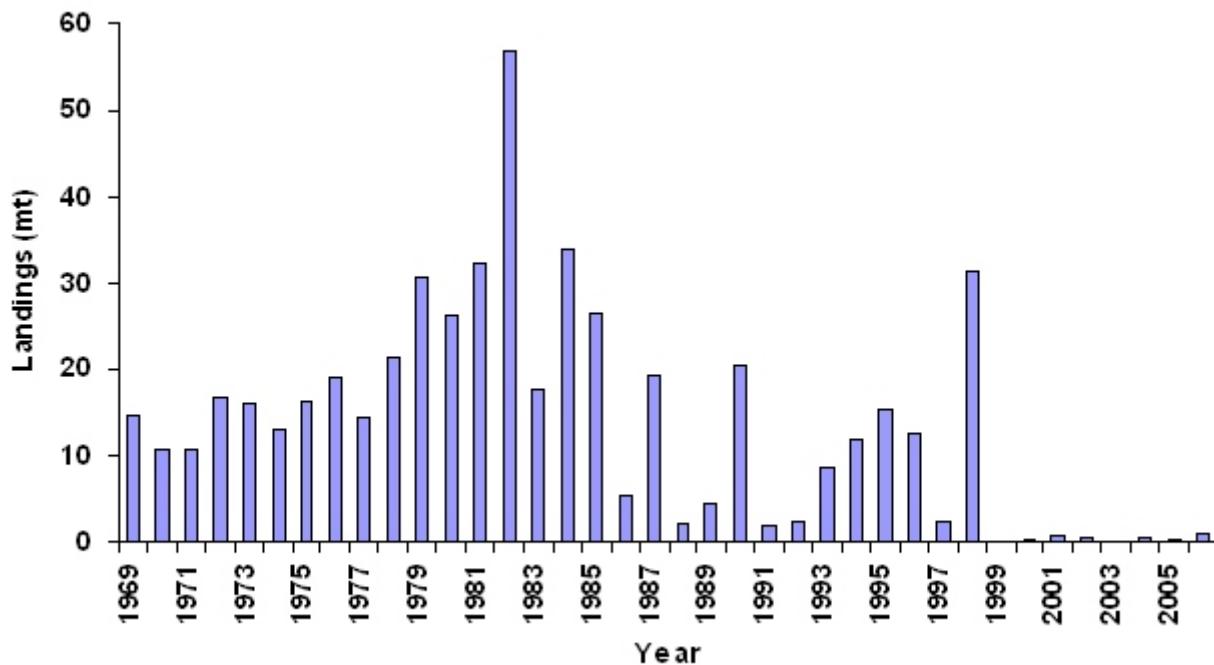
Figure 68. Estimated annual commercial landings (metric tons) of greenblotched rockfish from California, 1969-2006.

Yelloweye rockfish

Scientific Name: *S. ruberrimus*
Similar Species: vermilion rockfish
Confusing Common Names: none
Principal Gear(s): hook-and-line, trawl
Principal Region(s): northern and central California
Principal Market Category(ies): 265 - yelloweye rockfish, 959 - rockfish, group red, 250 - unspecified rockfish, 956 - chilipepper rockfish
Sampled-Strata Index: Range: 0-0.0049 Mean: 0.0012

```
                      Landing Estimate Score
Sampled-Strata Index:         2
Misidentification:            4
Mandatory Sorting:            2
Percent Using Actual:         2
Market Category Anomaly:      5
Landing Anomaly:              2
Nominal Reliability:          1
Percentile Observed:          3
Total Score:                 21
Discussion:
```

1983-2006

     Yelloweye rockfish are reasonably easy to identify, although inexperienced personnel can mistake them for vermilion rockfish. In addition, young specimens have a different coloration than adults which may cause them to be classified as unidentified rockfish.   Many of the landing estimates are not based on actual sampling, which could explain why they are highly erratic (Figure 69). Recent regulations enacted in 2000 effectively shut down the fishery. We feel our landing estimates prior to 1992 are unreliable, while those from 1992 through 2006 are believed to be generally reliable.
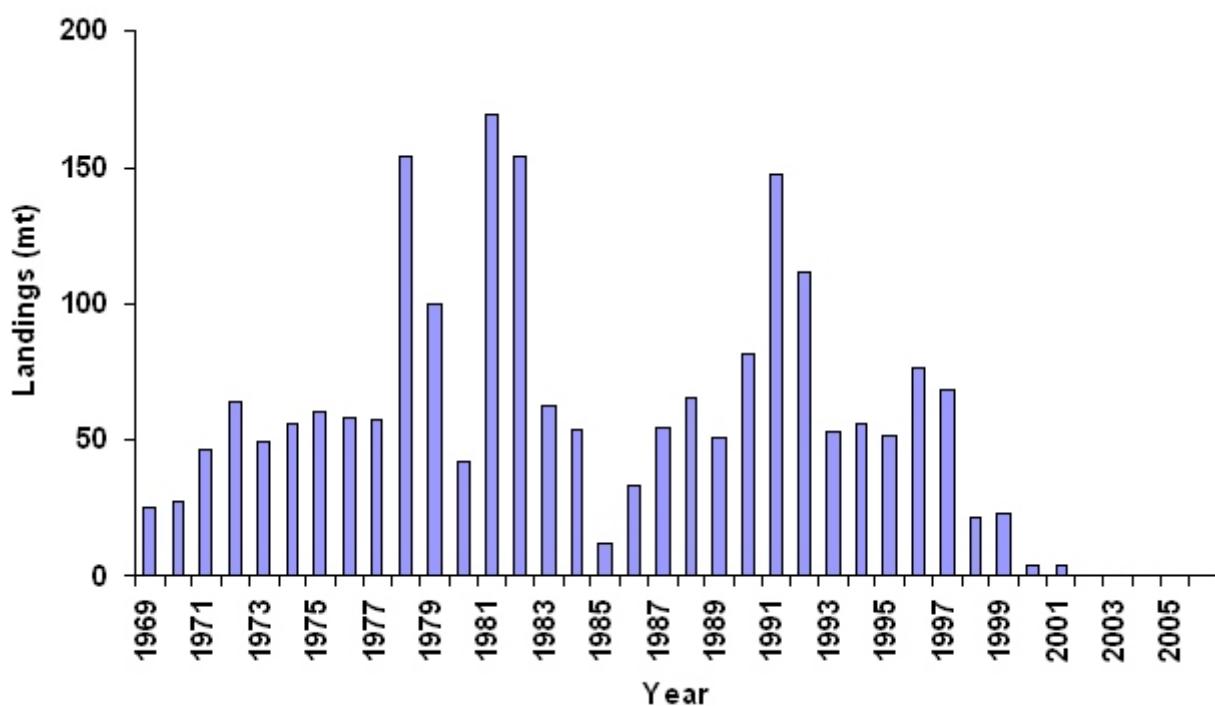

Figure 69. Estimated annual landings (metric tons) of yelloweye rockfish from California, 1969-2006.

1969-1982:

The yelloweye market category (265) had a different definition prior to about 1982, and although we cannot determine its exact definition, port samples from pre-1982 suggest the definition was similar to market category 959 (rockfish, group red). The overall pattern of landings of market categories into which yelloweye can be sorted is coherent; however, the pattern of annual landings is not coherent (Figure 69). The sampled index values suggest that the strata in which they are likely to occur have not been well sampled. The overall landing estimate score for this species (21) is fairly low. Given the problems associated with the redefinition of the yelloweye rockfish market category, we feel our landing estimates for this time period are generally unreliable.

Flag rockfish

Scientific Name: *S. rubrivinctus*
Similar Species: redbanded rockfish
Confusing Common Names: none
Principal Gear(s): hook-and-line
Principal Region(s): central and southern California
Principal Market Category(ies): 959 - rockfish, group red, 250 - unspecified rockfish
Sampled-Strata Index: Range: 0-0.0024 Mean: 0.0007

Landing Estimate Score

Sampled-Strata Index: 1
Misidentification: 3
Mandatory Sorting: 2
Percent Using Actual: 4
Market Category Anomaly: 5
Landing Anomaly: 3
Nominal Reliability: 2
Percentile Observed: 2
Total Score: 22

Discussion:

Flag rockfish rank fairly low in relative abundance in California's commercial fishery. The sampled-strata index indicates a very low level of effective sampling for this species. The overall pattern of annual landings shows a somewhat irregular profile with no ready explanation for the changes (Figure 70). We have no way to determine how pure the flag rockfish market category (657) is; however, landings in that market category are low. The total landing estimate score for flag rockfish is 22, and we feel that overall, the landing estimates for this species are only somewhat reliable for 1983 through 2006 and generally unreliable prior to 1983.
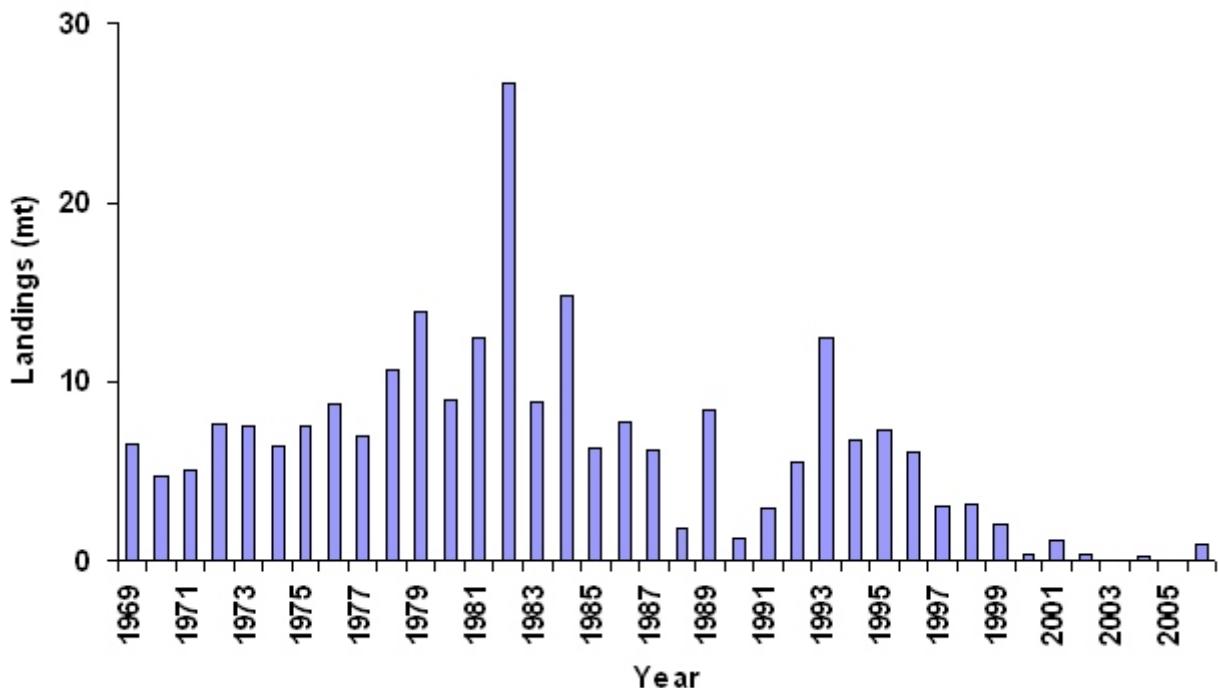
Figure 70. Estimated annual landings (metric tons) of flag rockfish from California, 1969-2006.

                          Bank rockfish
Scientific Name: *S. rufus*
Similar Species: widow rockfish, speckled rockfish
Confusing Common Names: red widow rockfish, widow rockfish
Principal Gear(s): trawl, gill net
Principal Region(s): central and southern California
Principal Market Category(ies): 250 - unspecified rockfish, 956 -
chilipepper/bocaccio, 663 - bank rockfish, 959 - rockfish, group red
Sampled-Strata Index: Range: 0.0063-0.1932 Mean: 0.0843

                      Landing Estimate Score
Sampled-Strata Index: 5
Misidentification: 3
Mandatory Sorting: 2
Percent Using Actual: 4
Market Category Anomaly: 2
Landing Anomaly: 5
Nominal Reliability: 4
Percentile Observed: 5
Total Score: 30

Discussion:
1983-2006:
     Bank rockfish can be confused with widow rockfish and speckled
rockfish, and common names assigned by fishermen further confuse the
issue. Since bank rockfish are very common and occur in well sampled
strata we feel the problem of misidentification by port samplers is

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generally low. The pattern of landings in the bank rockfish category
(663) is erratic; however, the pattern of estimated annual landings for
the species is coherent (Figure 71). Most landings from 1983 through
2006 are based on actual port samples. Port samples of the bank
rockfish market category suggest that few other species are mixed in
with the landings. The overall landing estimate score (30) is very high,
so we feel our estimates of landings for this species are very reliable.
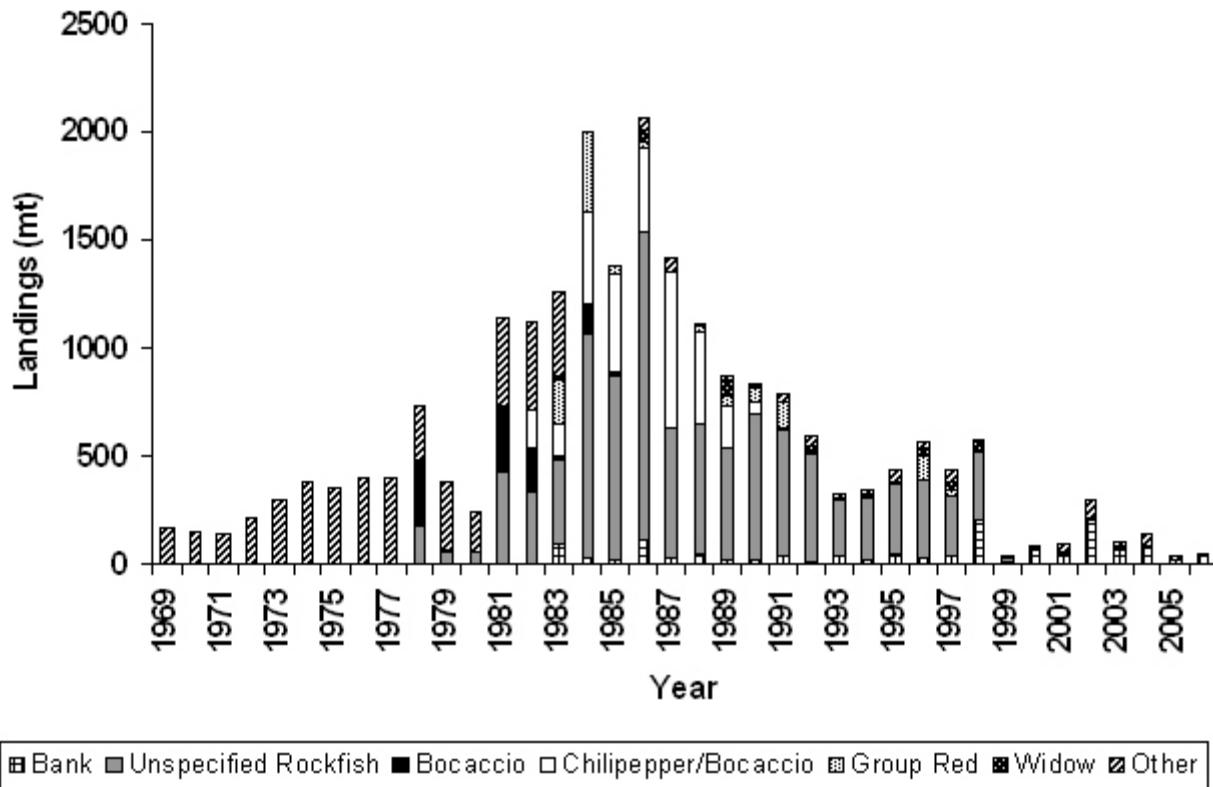

Figure 71. Estimated annual commercial landings (metric tons) of bank
rockfish by market category from California, 1969-2006.

1969-1982:
     Since sampling coverage of this species has been very good, and
since it is a very abundant species, we feel the ratio estimation method
probably provided reliable estimates prior to 1978. In addition, the
good sample coverage between 1978 and 1983 suggests that our landings
estimates from 1969 through 1982 are generally reliable.

                         Stripetail rockfish
Scientific Name: *S. saxicola*
Similar Species: sharpchin rockfish, halfbanded rockfish
Confusing Common Names: none
Principal Gear(s): trawl
Principal Region(s): northern and central California
Principal Market Category(ies): 960 - rockfish, group small, 250 -
unspecified rockfish, 961 - rockfish, group rosefish, 959 - rockfish,
group red
Sampled-Strata Index: Range: 0-0.0054 Mean: 0.0011

```
                        Landing Estimate Score
Sampled-Strata Index:          2
Misidentification:             3
Mandatory Sorting:             1
Percent Using Actual:          5
Market Category Anomaly:       5
Landing Anomaly:               2
Nominal Reliability:           3
Percentile Observed:           3
Total Score:                  24
```

Discussion:
1983-2006:

     The stripetail rockfish is a small fish (41cm maximum total length)
and is not considered desirable by the commercial fishery. It is quite
abundant in areas where the trawl fishery operates and as a result is a
common bycatch species. Since it is landed in small quantities as
incidental catch, few are present in any given sampled landing,
resulting in a low sampled-strata index. There is no evidence of
special sorting for this species and it is felt they are retained by
accident. The total landing estimate score is fairly high (24),
indicating how common it is as an incidental species in the sampled
strata. We feel our annual landing estimates from 1983 through 2006 for
this species are generally reliable (Figure 72).
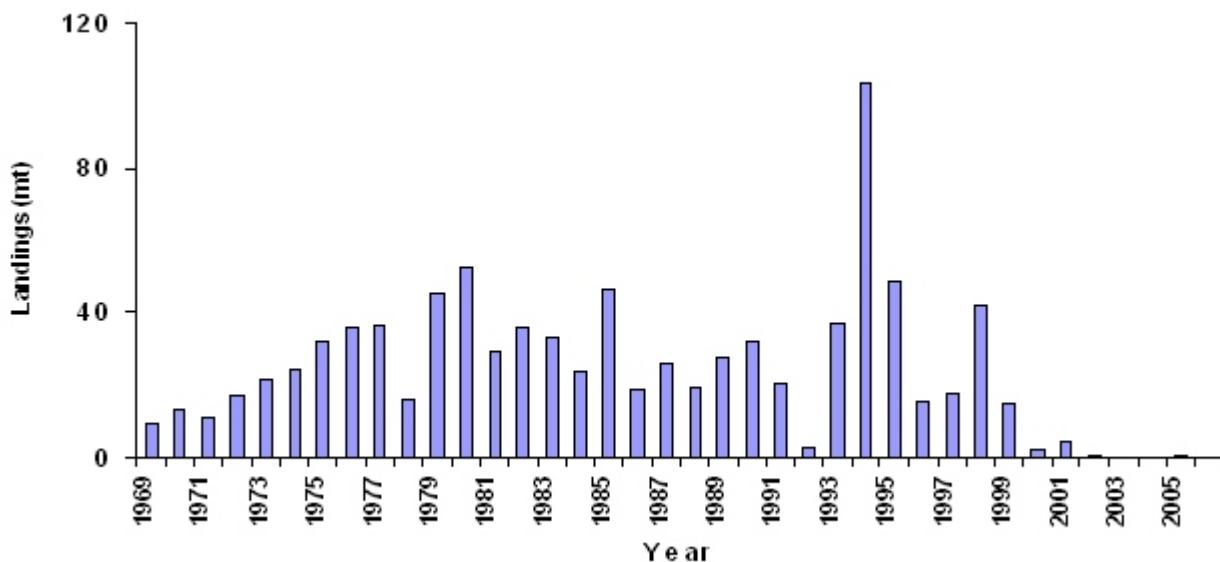
Figure 72. Estimated annual commercial landings (metric tons) for
stripetail rockfish from California, 1969-2006.

1969-1982:

     Since this species is common in the trawl fishery, and since the
strata in which it is landed are well sampled, we feel the ratio
estimation method probably provided reasonable estimates of the
landings. We therefore feel our estimates of annual landings from 1969-

95

1982 are generally reliable; however, it is understood that a large
number of stripetail are caught and discarded.

Halfbanded rockfish
Scientific Name: *S. semicinctus*

Discussion:
Only 397 individuals were observed by port samplers in all years.
We therefore feel that while actual landings are probably low, our
estimates are very unreliable.

Olive rockfish
Scientific Name: *S. serranoides*
Similar Species: yellowtail rockfish
Confusing Common Names: yellowtail rockfish
Principal Gear(s): hook-and-line, gill net
Principal Region(s): central and southern California
Principal Market Category(ies): 250 - unspecified rockfish, 956 -
chilipepper/bocaccio, 253 - bocaccio, 259 - yellowtail rockfish, 651 -
olive rockfish
Sampled-Strata Index: Range: 0-0.0180 Mean: 0.0026

Landing Estimate Score
Sampled-Strata Index:	2
Misidentification:	3
Mandatory Sorting:	2
Percent Using Actual:	3
Market Category Anomaly:	4
Landing Anomaly:	1
Nominal Reliability:	3
Percentile Observed:	2
Total Score:	20

Discussion:
1983-2006:
Olive rockfish can be misidentified as yellowtail rockfish. The
sampled-strata index value for this species is fairly low. Although the
pattern of landings of the principal market categories is relatively
stable, the pattern of estimated actual landings of this species is
erratic (Figure 73). Many of the landing estimates are not based on
actual port samples. The overall landing estimate score of 20 is fairly
low. We feel our olive rockfish landing estimates from 1983 through
2006 are only somewhat reliable, based largely on possible
misidentification with yellowtail rockfish and poor sample coverage.

1969-1982:
Given the erratic nature of the landing estimates, we do not feel
the ratio estimation method provided reliable estimates of landings.
This is exemplified by the fact that the highest landing estimates
between 1969 and 2006 occurred in 1974 and 1975 when the only estimate
of landings was the ratio estimation method. Therefore we feel that
landing estimates from 1969 through 1982 are generally unreliable.
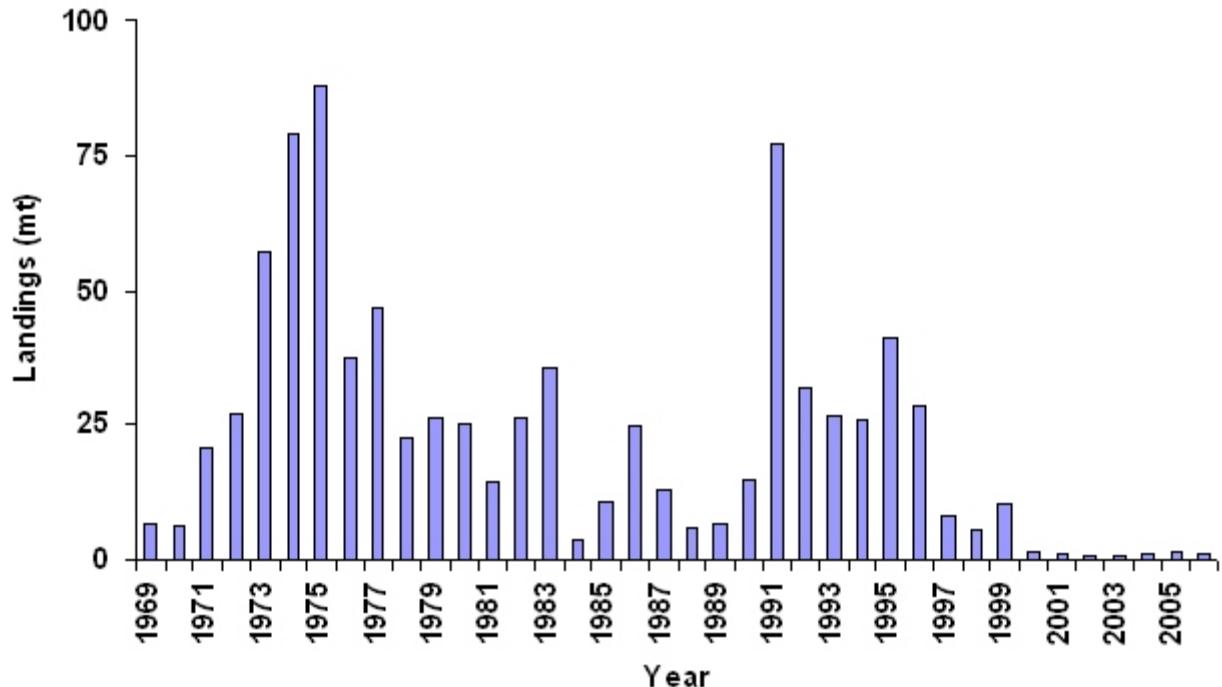
Figure 73. Estimated annual commercial landings (metric tons) of olive rockfish from California, 1969-2006.

                              Treefish
Scientific Name: *S. serriceps*
Similar Species: none
Confusing Common Names: gopher rockfish
Principal Gear(s): hook-and-line
Principal Region(s): central and southern California
Principal Market Category(ies): 658 - treefish, 250 - unspecified rockfish
Sampled-Strata Index: Range: 0-0.0249 Mean: 0.0027

                       Landing Estimate Score
Sampled-Strata Index: 3
Misidentification: 4
Mandatory Sorting: 1
Percent Using Actual: 2
Market Category Anomaly: 3
Landing Anomaly: 1
Nominal Reliability: 3
Percentile Observed: 2
Total Score: 19

Discussion:

The treefish is a fairly distinctive species of rockfish but is not particularly common. Most of the landing estimates are not based on actual port samples. Landings in the treefish market category are somewhat erratic; while, estimated actual landings are extremely erratic (Figure 74). Total landing estimates for the species are low, with annual estimated landings never exceeding 2 metric tons. The total landing estimate score was only 19. Overall, we feel our landing estimates are generally unreliable; however, we are fairly certain that actual total landings are low.
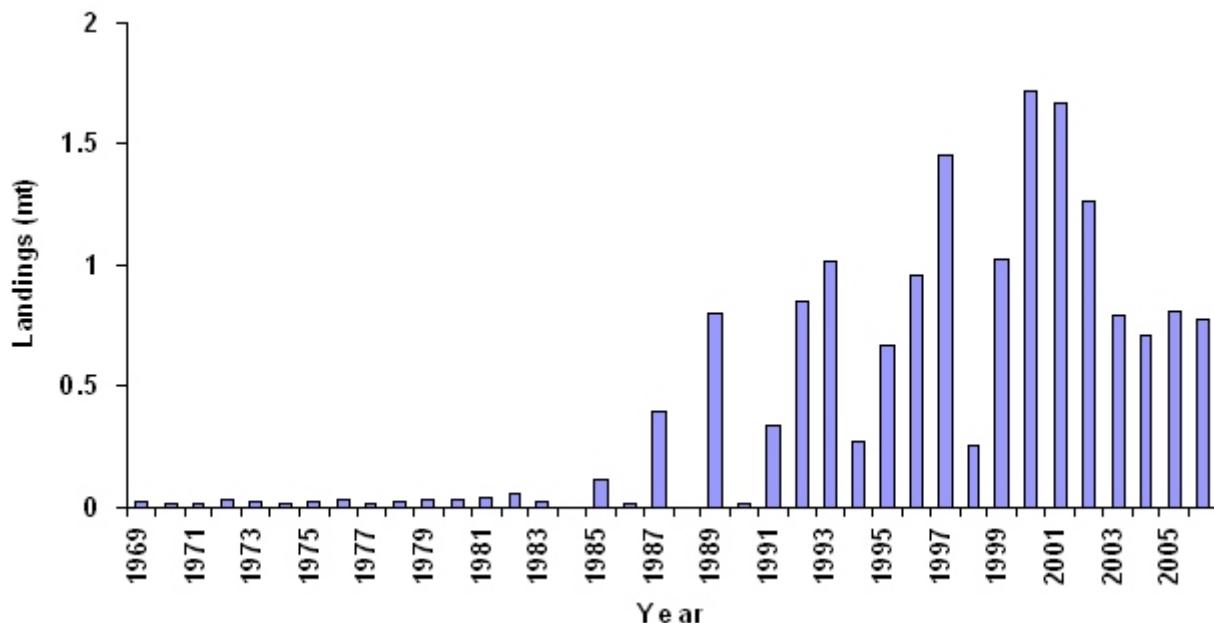

Figure 74. Estimated annual commercial landings (metric tons) of treefish from California, 1969-2006.

Pinkrose rockfish
Scientific Name: *S. simulator*

Discussion:

Only 10 individuals were observed by port samplers in all years. We therefore feel that actual landings are probably low, our estimates are very unreliable.

Honeycomb rockfish
Scientific Name: *S. umbrosus*

Discussion:

Only 35 individuals were observed by port samplers in all years. We therefore feel that actual landings are probably low, our estimates are very unreliable.

Pygmy rockfish
Scientific Name: *S. wilsoni*

Discussion:
     Only five individuals were observed by port samplers in all years.
We therefore feel that actual landings are probably low, our estimates
are very unreliable.

                        Sharpchin rockfish
Scientific Name: *S. zacentrus*
Similar Species: stripetail rockfish, Pacific ocean perch
Confusing Common Names: none
Principal Gear(s): trawl
Principal Region(s): northern California
Principal Market Category(ies): 960 - rockfish, group small, 250 -
unspecified rockfish, 961 - rosefish
Sampled-Strata Index: Range: 0-0.0126 Mean: 0.0037

                        Landing Estimate Score
Sampled-Strata Index: 3
Misidentification: 3
Mandatory Sorting: 1
Percent Using Actual: 5
Market Category Anomaly: 5
Landing Anomaly: 1
Nominal Reliability: 2
Percentile Observed: 3
Total Score: 23

Discussion:
1983-2006:
     Sharpchin rockfish are uncommon south of Fort Bragg. North of Fort
Bragg they generally occur in well sampled strata, and the sampled
strata index is in the 40-60th percentile range. The pattern of
estimated annual landings is extremely erratic (Figure 75). Most
sharpchin rockfish are not landed in their own market category, and we
have no information about how "pure" that market category is. The total
landing estimate score of 23 leads us to conclude that our annual
landing estimates are only somewhat reliable from 1983 through 2006.

1969-1982:
     Our estimates of total landings of sharpchin prior to 1983 are
nearly zero, which seems unlikely. The species is landed in relatively
well sampled strata; however, we feel the ratio estimation method may
not have provided reliable estimates. We therefore conclude that
landing estimates of this species prior to 1983 are only somewhat
reliable.

                              99
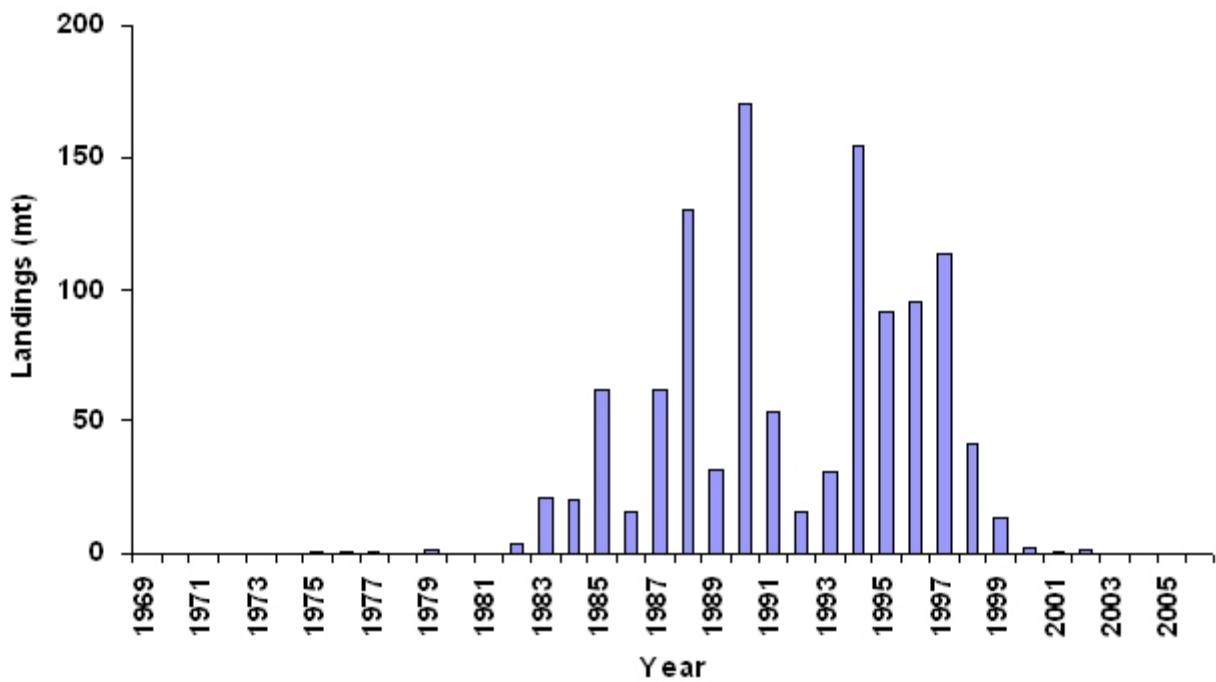
Figure 75. Estimated annual landings (metric tons) of sharpchin
rockfish from California, 1969-2006.

                         Unspecified rockfish
Scientific Name: *Sebastes* spp
Similar Species:
Confusing Common Names:
Principal Gear(s): all
Principal Region(s): all
Principal Market Category(ies): 250 - unspecified rockfish
Sampled-Strata Index: Not applicable

Discussion
     Despite considerable effort, a fraction of rockfish landings cannot
be reliably identified to species and are reported as unspecified
rockfish (Figure 76). On average, only 0.63% of all rockfish in a year
are left as unspecified after the expansion process has been performed.
Annual values of percent of rockfish called unspecified ranged from
0.15% to 2.03%. We do not consider this to be a large problem. In many
cases these fish were landed by unsampled gear types (most often diving
and trap). While it is possible that the unspecified rockfish market
category could contain large amounts of some minor rockfish species,
landing estimates for most of those species are not very reliable
anyway.
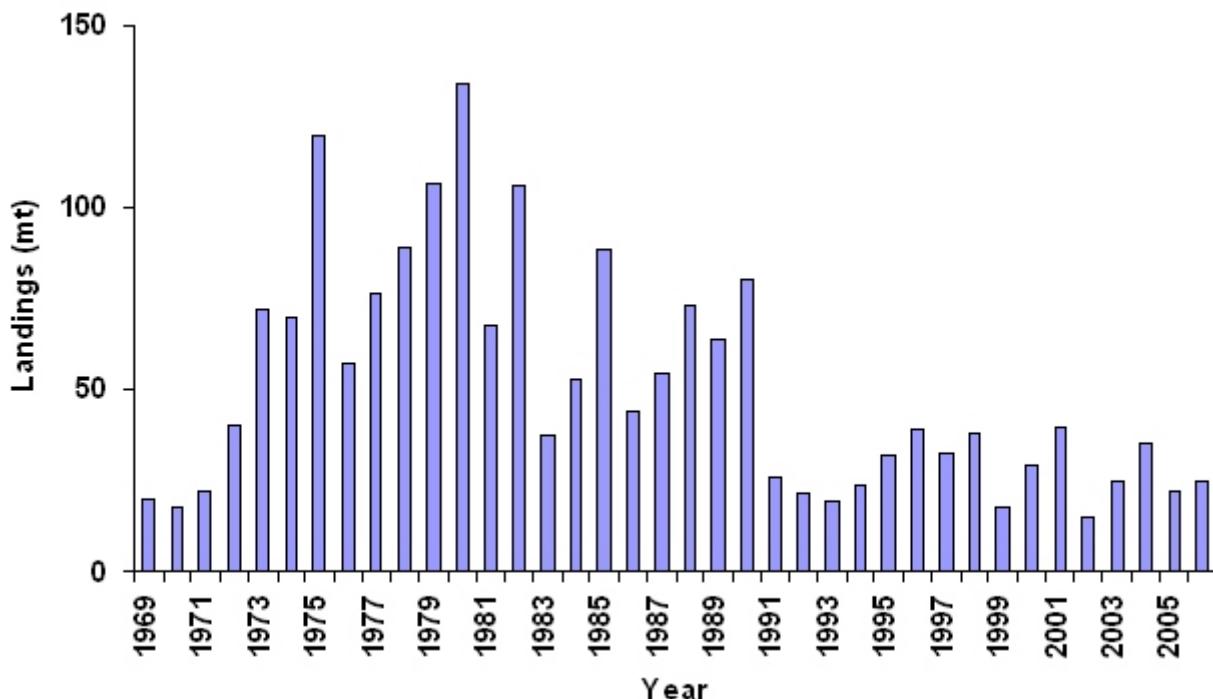
Figure 76. Estimated annual commercial landings (metric tons) of unspecified rockfish from California, 1969-2006.

Thornyheads

Scientific Names: *Sebastolobus alascanus* (shortspine thornyhead) and *S. altivelis* (longspine thornyhead)

Discussion:

The group thornyheads is primarily composed of two species, shortspine and longspine, which are very similar in appearance. Shortpsine thornyheads get much larger (75cm maximum total length) than longspine thornyhead (39cm maximum total length) (Love et al., 2002). Due in large part to the size difference, shortspine thornyhead constituted the bulk of the fishery prior to 1987 (Figure 77). After 1987, a foreign market developed for thornyheads which increased their total value substantially and landings increased sharply. In addition, longspine thornyheads became more abundant in the landings which is believed to be largely due to increased retention rather than increased targeting. To protect the resource, management measures were implemented in the mid 1990s which have heavily constrained the landings of the Dover sole/thornyhead/sablefish (DTS) complex. This has resulted in lower landings of thornyheads. Prior to 1995, thornyheads were landed in a single market category (262 - group thornyheads) with a few being mixed in with rockfish landings. From 1995 onwards, thornyheads were required to be sorted into two new market categories: 678 (longspine thornyhead) and 679 (shortspine thornyhead) (Figure 77). Due to difficulties in readily identifying the two species, landings in the longspine thornyhead market category are composed of about 8% shortspine

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thornyheads. The shortspine thornyhead market category, on the other hand, contains about 2% longspine thornyhead.
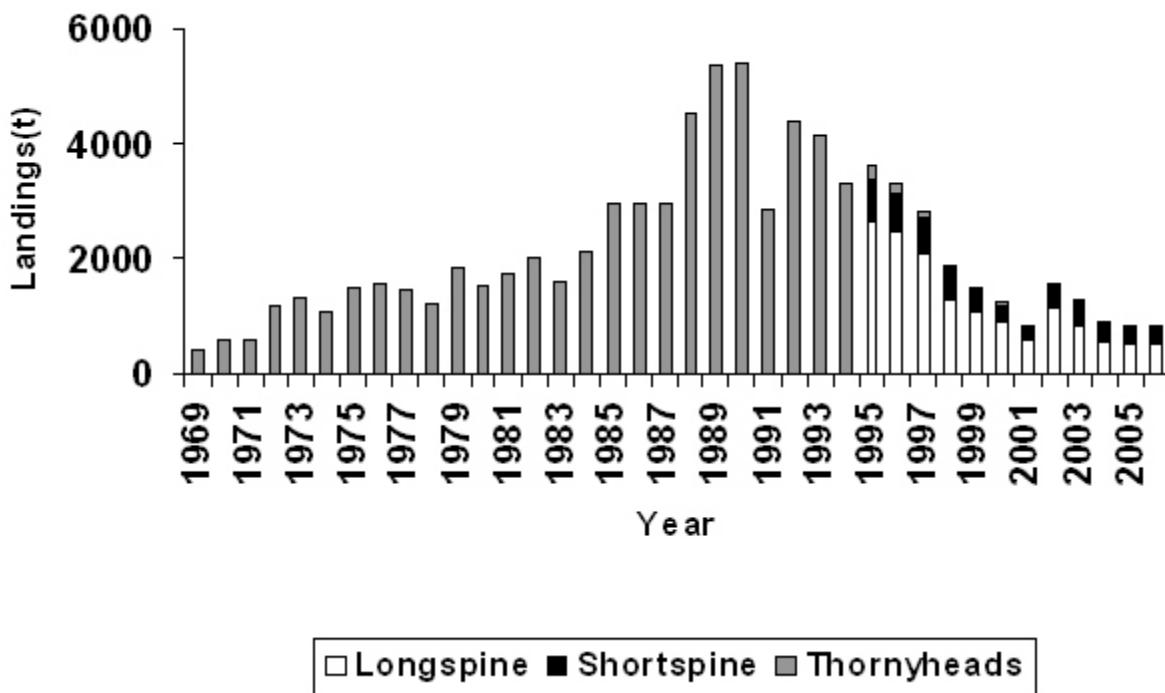

Figure 77. Estimated annual commercial landings (metric tons) of longspine thornyhead, shortspine thornyhead, and unspecified thornyhead from California, 1969-2006.

Port sampling of the thornyheads began in 1978; however, they were a low priority until the late 1980s when the foreign market developed. Nonetheless, enough port samples were taken prior to 1987 to obtain estimates of the species compositions for most gears and at most port complexes. As a result, most landing estimates are based on actual port samples (Figure 78). As with rockfish, it was sometimes necessary to use port samples from adjacent port complexes (borrowing) to estimate the species compositions; however, this generally did not constitute a large fraction of the landings. In cases where no port samples were taken, and borrowing could not be performed, landings were treated as nominal. Prior to 1995, when there was only a single thornyhead market category: treating landings as nominal resulted in calling the landings unspecified thornyheads. From 1995 forward, treating the landings as nominal resulted in all fish landed in the shortspine market category being called shortspine and all fish landed in the longspine market category being called longspine. Since port samples show that about 8% of the longspine market category is actually shortspine thornyhead, treating a landing as nominal longspine underestimates shortspine landings and overestimates the longspine landings. Some of this overestimate is corrected by the presence of shortspine thornyheads mixed in with longspine market category landings. Since treating landings as nominal is not common (Figure 78), this problem does not create a cause for concern.

It is important to realize the two species are very similar in appearance and misidentification by port samplers does affect the landing estimates. With adequate training, port samplers are able to correctly identify the two species. As a result, we feel our estimates of landings for thornyheads are generally reliable.
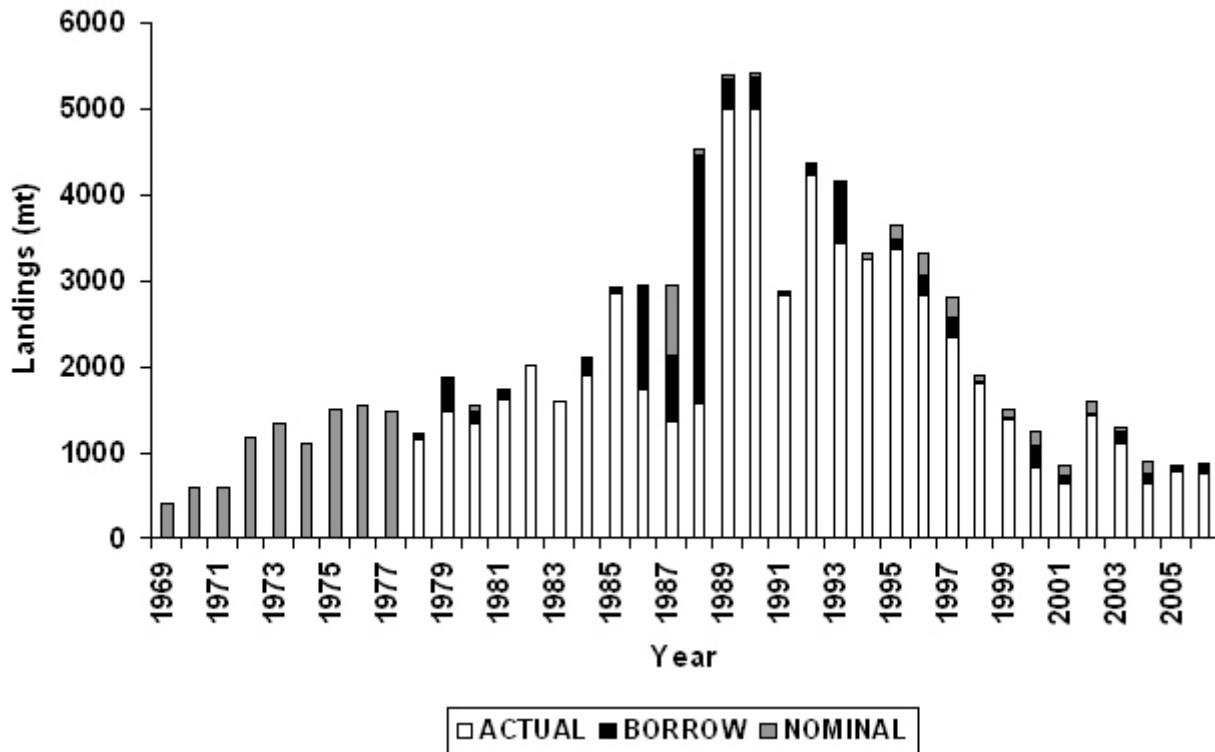

Figure 78. Amount of thornyhead landings based on actual port samples, borrowing of port samples from adjacent ports, or assuming the entire landing is Nominal (i.e... consists of the defined species for the market category).

Rockfish and Thornyhead Summary

In recent years, there has been some question about speciation in rockfish with suggestions that there are more species than currently recognized. This paper cannot address these issues. There are at least eight species which are affected at this time: blue rockfish, vermilion rockfish, copper rockfish versus whitebelly rockfish, bank rockfish versus red widow rockfish, gopher rockfish versus black-and-yellow rockfish. Love et al, (2002) address the issues regarding copper versus whitebelly, bank versus red widow, and gopher versus black-and-yellow. Genetic evidence now exists indicating that there are two species of blue rockfish (Burford, 2007). Genetic evidence also indicates that there are two species of vermilion rockfish (Hyde et el., 2008). In this paper, we use the species classification presented by Love et al.,

(2002) in which there is only one species of blue rockfish and one species of vermilion rockfish, copper and whitebelly rockfish are the same species, bank and red widow rockfish are the same species, and gopher and black-and-yellow rockfish are separate species.

Total landing estimate scores for rockfish ranged from a low of 11 to a high of 37 (Figure 79). The lowest possible score was eight, and the highest possible score was 40. Of the top ten most heavily landed species, nine of them were in the top ten total landing estimate scores, indicating the most important species also had the most reliable landing estimates.
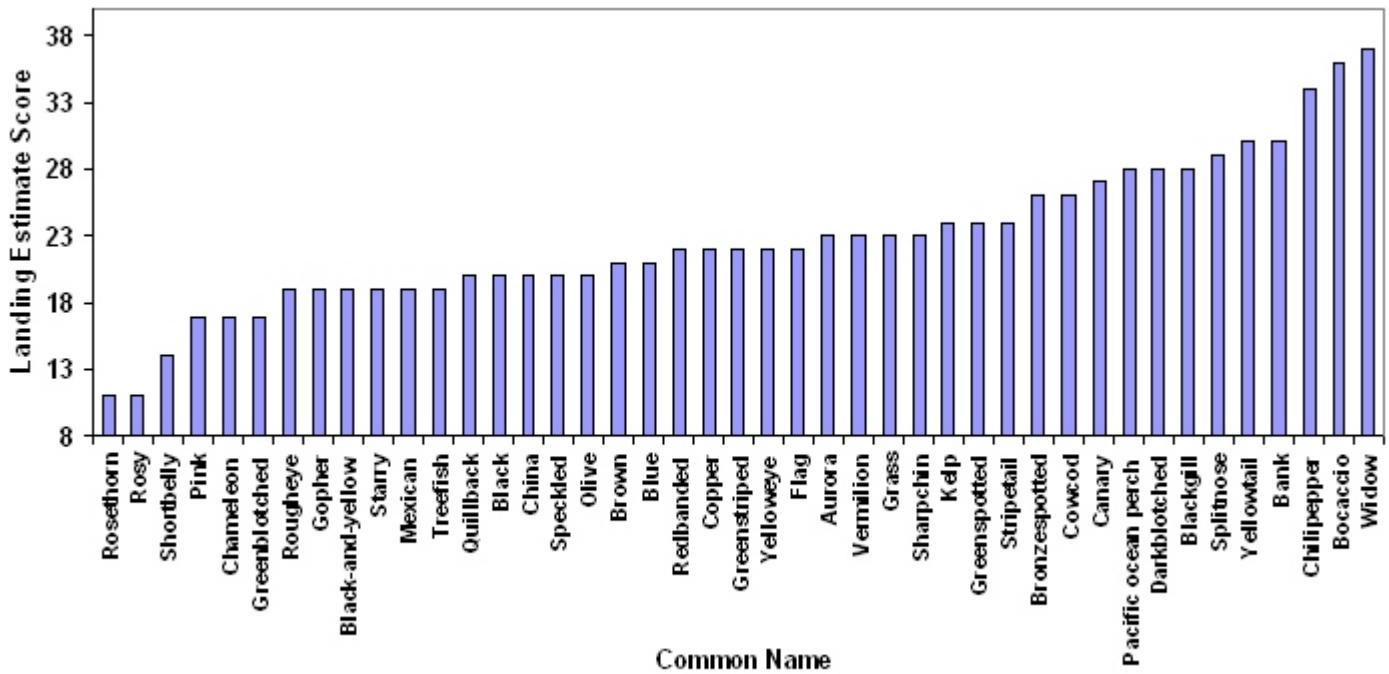

Figure 79. Plot of landing estimates scores for rockfish arranged from the lowest to the highest score. The minimum value possible is 8 and the maximum possible value is 40.

When the percent of all landing estimates for each species is plotted by percent estimated from actual samples, borrowing, assuming nominal, and the ratio estimation method a number of important issues can be seen (Figure 80). One of the most important issues, is that at least eight species (China, gopher, shortbelly, grass, blue, brown, kelp, and quillback rockfish) rely heavily on the assumption that the market category into which they are sorted is "pure" (Nominal). If this assumption is not correct, the landing estimates will be wrong. It is therefore important that this assumption be checked when possible. If the assumption is invalid, it may be possible to correct the landing estimate by adjusting it using species compositions from other years. Another thing that figure 80 shows is that more than 50% of total landings from five species (bronzespotted, cowcod, kelp, olive, and flag

rockfish) were estimated by the ratio method. In all five cases the
species were principally from southern California where no samples were
collected prior to 1983. For two species, black-and-yellow and kelp
rockfish, nearly 50% of the total landing estimates relied on borrowing.
If the species composition of the strata being borrowed from is similar
to the strata being estimated, there is no problem. Although every
effort is made to assure that this assumption is valid, there is still a
level of uncertainty. This uncertainty was reflected in the relatively
low landing estimate score for black-and-yellow rockfish. Kelp rockfish
on the other hand, had an average score largely due to other factors
included in the landing estimate score.
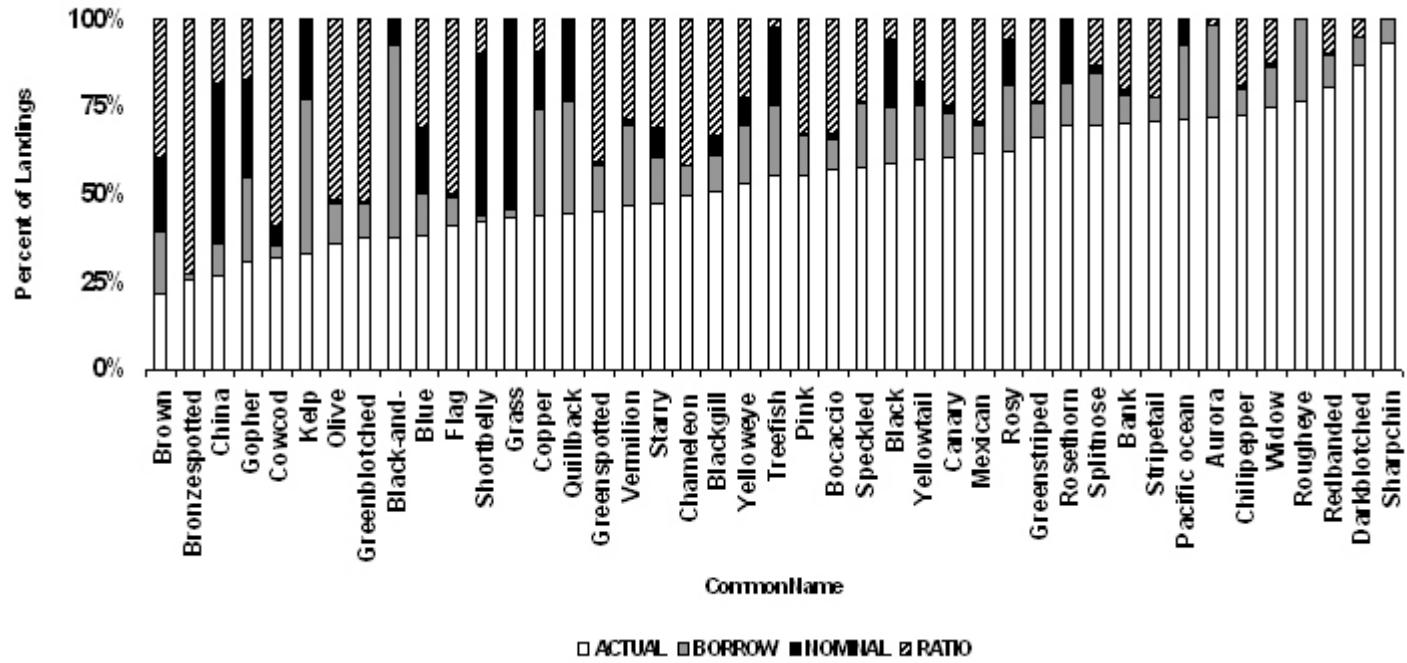
Figure 80. Plot of percentage of landing estimates for rockfish that
rely on actual samples, borrowing of species compositions, nominal
(treating market category as pure), and ratio estimation method. All
years from 1969 through 2006 are included. Species are sorted from
lowest percentage based on actual samples to highest.

        There were a wide range of values for the sampled-strata index
(Figure 81). Widow rockfish had the highest values indicating the
strata it was likely to be present in were well sampled as would be
expected for a species which had a mandatory sort for much of the study
period. Other species having high values were bocaccio, chilipepper,
bank, splitnose, darkblotched, and yellowtail: all of which are very
abundant. On the other hand, several common species had low scores
including: greenstriped, greenspotted, stripetail, and cowcod which
suggests that some important strata have not been adequately sampled.
Since the sampled strata index was only one measure of reliability, the
low scores from some species are not a good reason to discount the
reliability of their landing estimates.

One feature of the landing estimates is the "spikiness" of the landings for some species. The spiking can be real or false. Spikes in the landings of splitnose rockfish can be real: e.g., in some years splitnose rockfish are very abundant in the landings. Unfortunately the presence of spikes in landings of other species can be an indication of inadequate sampling. There is often no way to be certain of whether the spikes are real or an artifact of sampling. When landings are estimated, little effort is made to resolve spikes. If a large spike is detected, we will examine the port sample data and correct any errors we detect; however, usually we cannot resolve the issue. We feel that the end user of the data can decide how to handle the apparent spikes by smoothing the data or using it and perhaps employing sensitivity analyses.
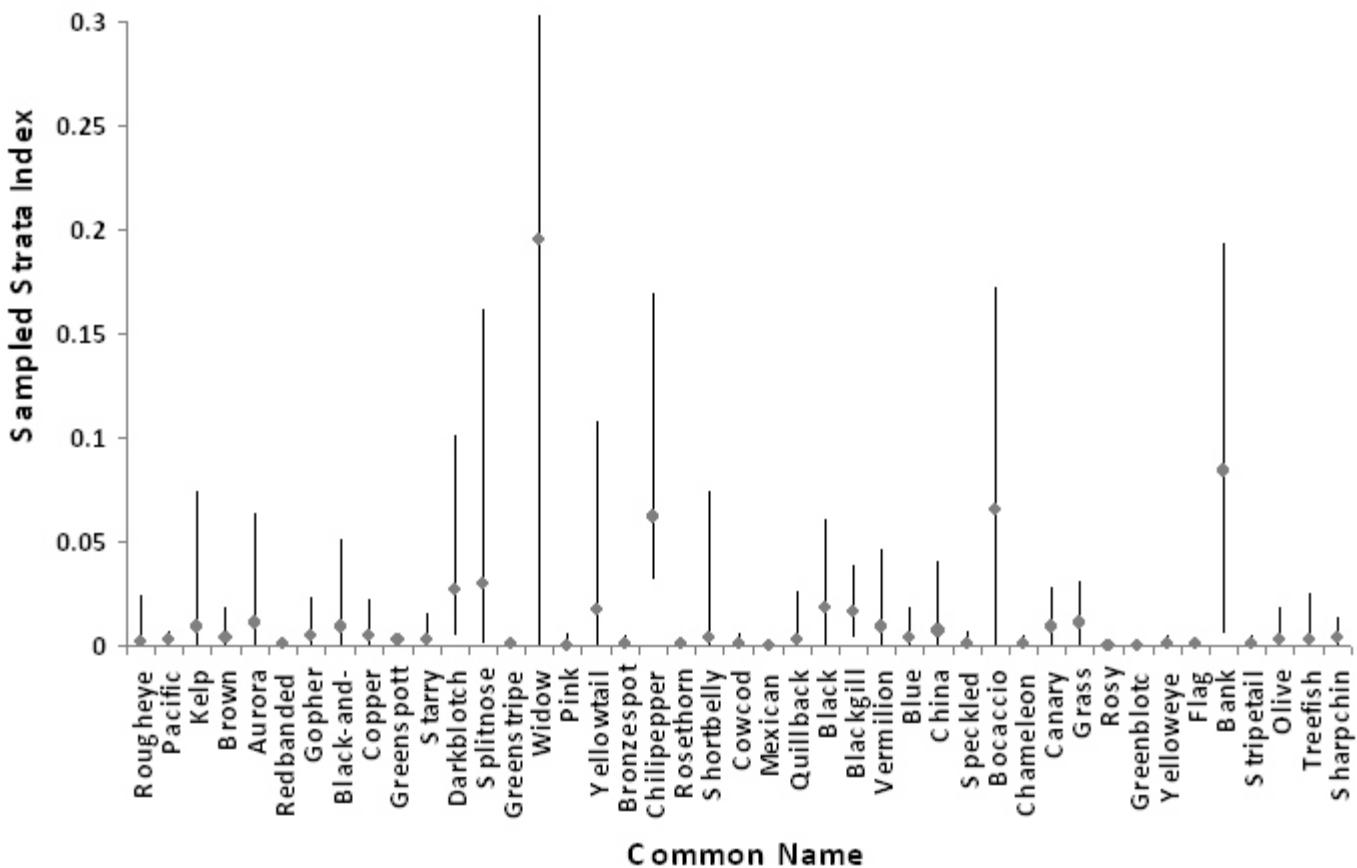
Figure 81. Plot of sampled-strata indices for rockfish. The dot represents the mean value for all years from 1978 through 2006. The bars indicate the minimum and maximum values. Note that the actual maximum value for widow rockfish is 0.72 and is not shown on this figure to allow the minor species values to be more clearly shown. The maximum possible value for the sampled-strata index is 1.00.

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Sablefish

Scientific Name: *Anoplopoma fimbria*

Discussion:

Sablefish are an extremely valuable component of California's groundfish fishery. All sablefish are landed under a single market category (190) and sampling shows that nearly all fish landed in the market category are, in fact, sablefish. Sablefish are caught by all gear types. Annual landings since 1990 have been heavily constrained by regulations (Figure 82). Most port complexes contribute to the sablefish commercial landings. We feel our landing estimates for this species are very reliable.
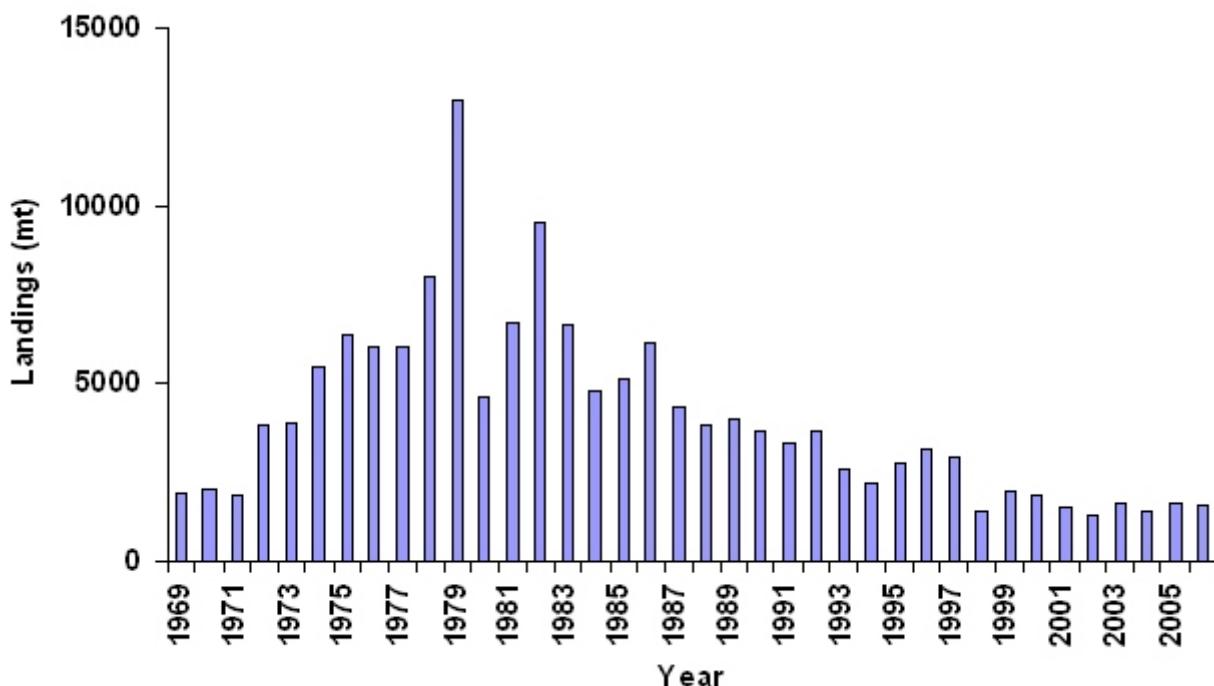
Figure 82. Estimated annual commercial landings (metric tons) of sablefish from California, 1969-2006.

Finescale codling

Scientific Name: *Antimora microlepis*

California does not have a separate market category for this species even though it is included in the GFMP. As a result, there are no reported landings for this species in California.

Pacific rattail

Scientific Name: *Coryphaenoides acrolepis*

Discussion:

Rattails (grenadiers) are all landed under a single market category (198) in California, and no species composition data are available. Landings increased through the mid 1990s, peaking in 1996, and have

since tapered off (Figure 83). Both trawl and hook-and-line gear
contributed to the landings. In the early years, most of the grenadier
were landed on the north coast; however, in recent years a pilot fishery
in Monterey accounted for most of the landings. Our landing estimates
are based solely on landing receipts and, in the absence of species
composition data, we can not say the landings are 100% Pacific rattail
since other species may be present. We therefore feel our estimated
landings of this species are only somewhat reliable.
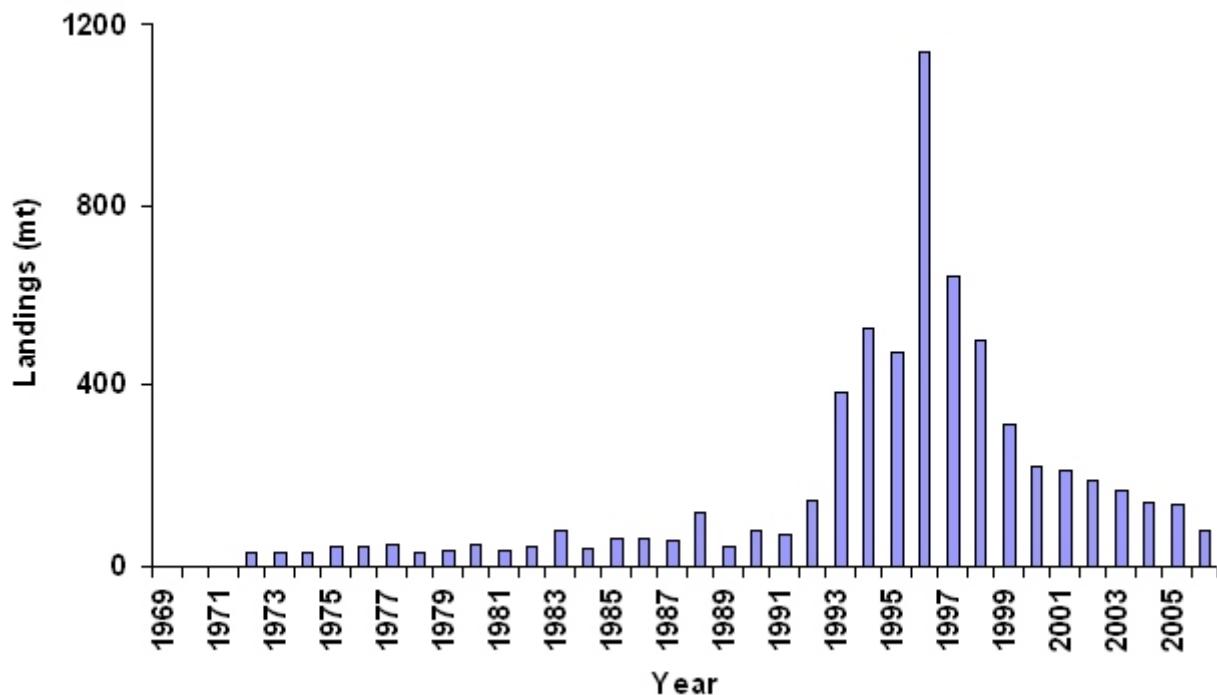
Figure 83. Estimated annual commercial landings (metric tons) of
grenadier from California, 1969-2006.

                        Pacific cod
Scientific name: *Gadus macrocephalus*
Discussion:
     Large landings of Pacific cod occurred only in 1987 (Figure 84)
when about 65 metric tons were landed by trawl gear at the three north
coast port complexes (Crescent City, Eureka, and Fort Bragg). All
Pacific cod landings are estimated directly from landing receipts. It
is quite possible that small quantities are landed in other market
categories such as Miscellaneous Fish (999). Although we believe
landings are small, our actual estimates are believed to be only
somewhat reliable.
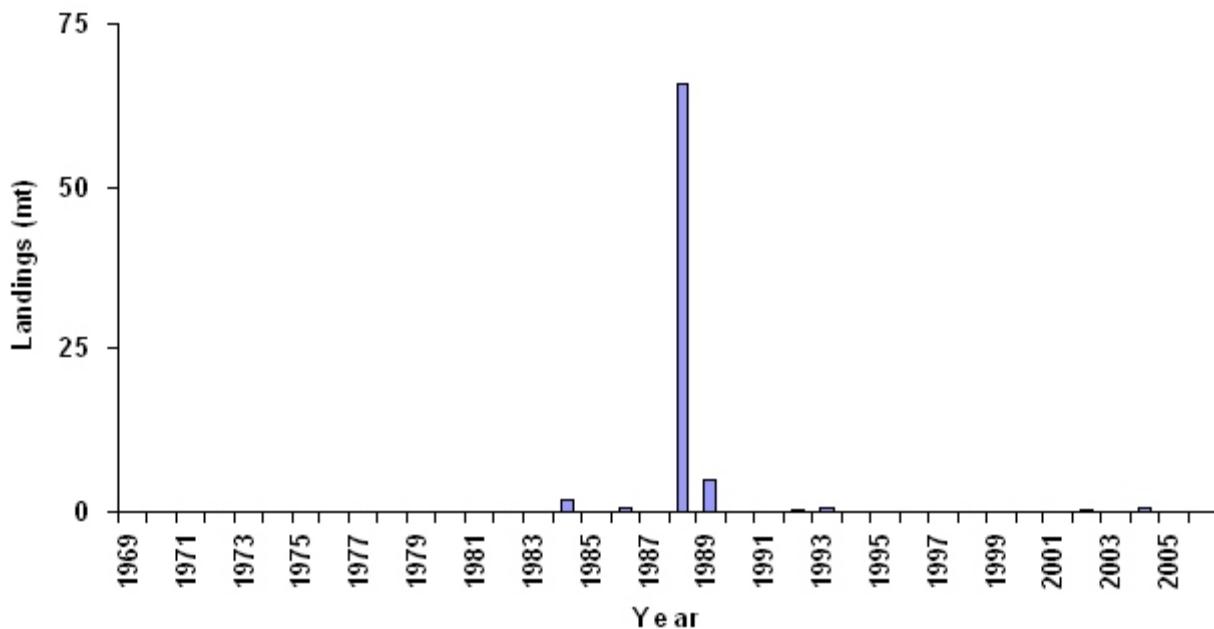
Figure 84. Estimated annual commercial landings (metric tons) of
Pacific cod from California, 1969-2006.

                          Kelp greenling
Scientific name: *Hexagrammos decagrammus*
Discussion:
     Kelp greenling are landed primarily by fish traps and hook-and-line
gear. Landings were highest in recent years (Figure 85). Kelp greenling
are a highly valued component of the live-fish fishery. Most landings
occur in central and northern California. In 2001, landings were
regulated to protect the resource. A total of 523 port samples from the
kelp greenling market category were taken, and all the fish in the port
samples were kelp greenling. Since the samples indicate landings in the
kelp greenling market category are pure, and since kelp greenling rarely
get mixed in with other species, we feel our landing estimates are very
reliable.

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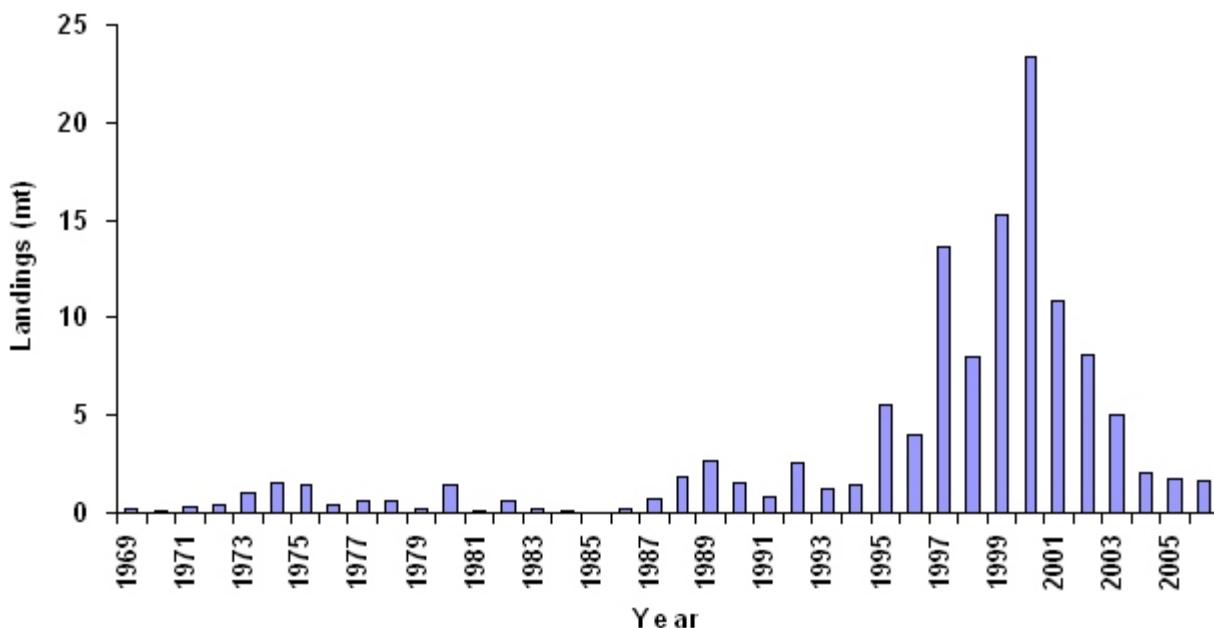
Figure 85. Estimated annual commercial landings (metric tons) of kelp greenling from California, 1969-2006.

Pacific whiting

Scientific name: *Merluccius productus*

Discussion

Pacific whiting have been an important component of California's groundfish fishery since the mid 1980s (Figure 86). Prior to 1969, California had large landings, but all evidence suggests that the landings did decline in the 1970s and early 1980s. Landings are estimated directly from landing receipts. Virtually all whiting are caught by trawl, with the vast majority landed in Eureka and Crescent City. Prior to 1979, almost no landings were reported. It is possible that whiting were landed either in the trawled fish for animal food or miscellaneous fish market categories (992 and 999, respectively). For 1980 through 2006, we feel our landing estimates are very reliable since most occur in a single market category and that market category normally contains only whiting (based on actual port sampling). Prior to 1980, we feel our estimates are generally unreliable and should not be used.
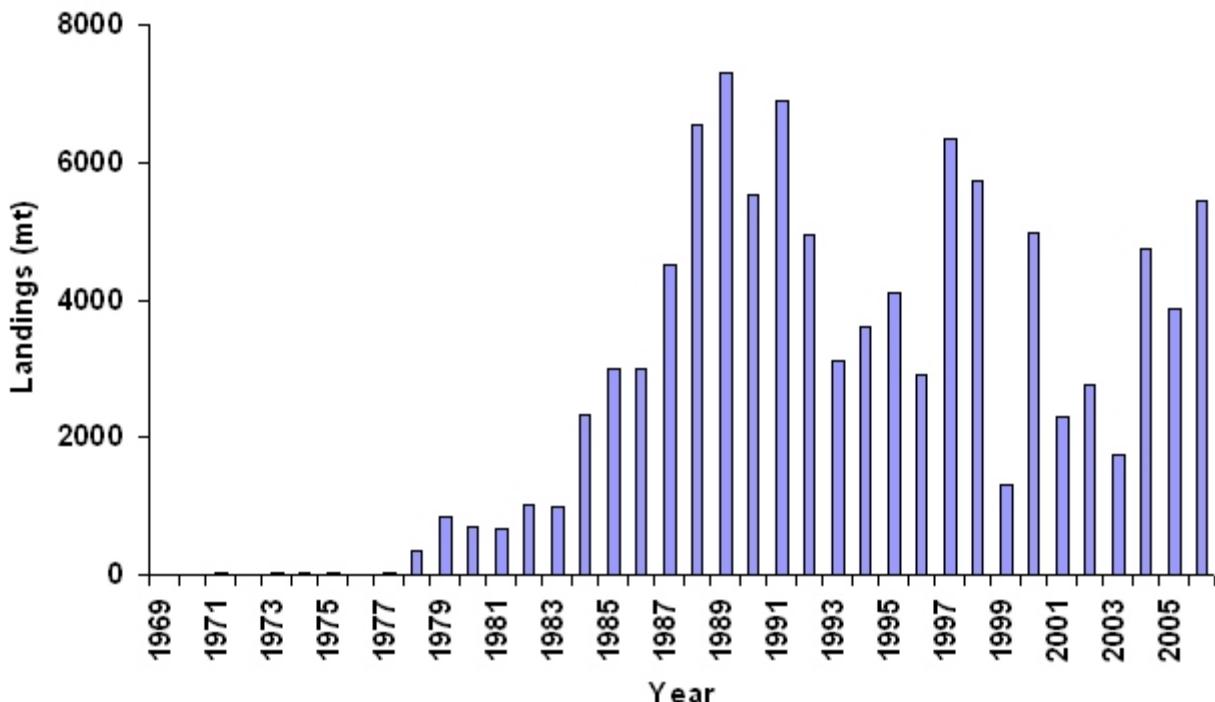
Figure 86. Estimated annual commercial landings (metric tons) of Pacific whiting from California, 1969-2006.

Lingcod

Scientific Name: *Ophiodon elongatus*

Discussion:

　　Landing estimates for lingcod are based mainly on landings made in the lingcod market category (195) (Figure 87). A small quantity of lingcod are mixed with rockfish, and this fraction (less than 1% of total landings) is estimated by the expansion process used for rockfish. About 75% of lingcod are caught by trawl gear and landed at all port complexes. We feel landing estimates for this species are very reliable.
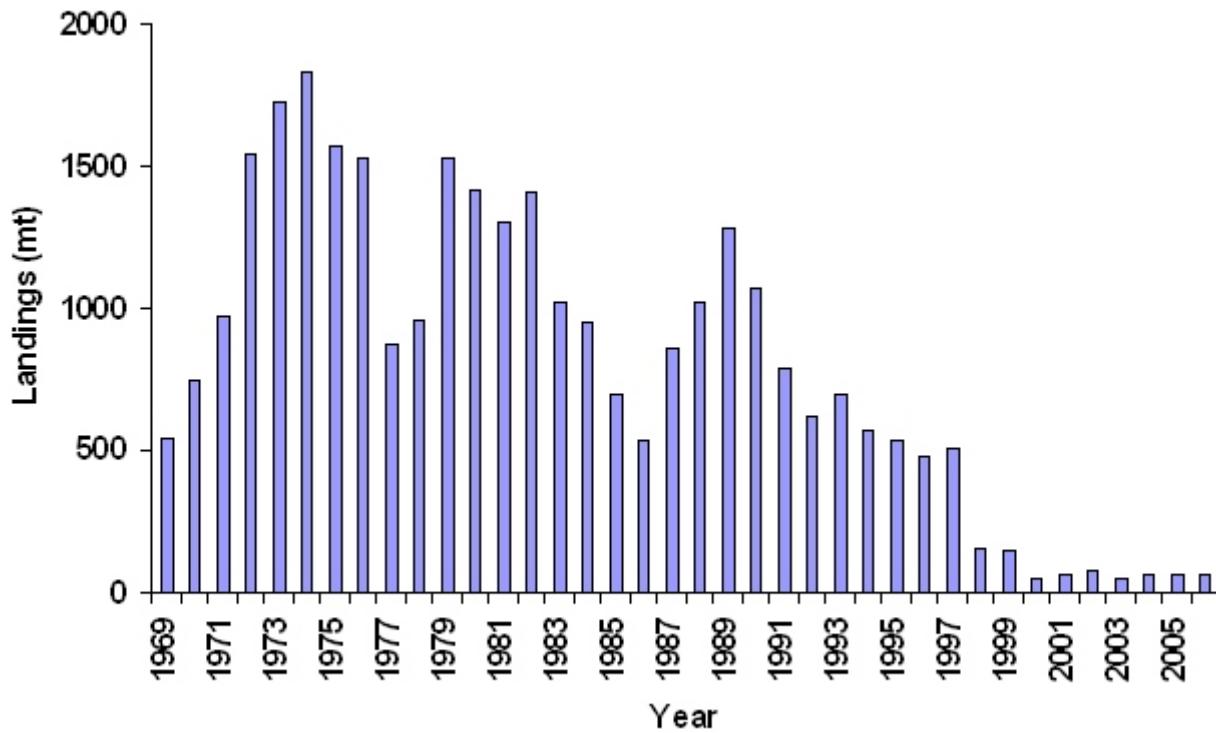
Figure 87. Estimated annual commercial landings (metric tons) of lingcod from California, 1969-2006.

                        California Sheephead
Scientific name: *Semicossyphus pulchur*

Discussion:
      Although not technically a groundfish, sheephead are landed with other groundfish in southern California (particularly the nearshore species). In the early 1990s, landings increased as part of the nearshore live-fish fishery (Figure 88). Most landings are made by trap with lesser amounts caught by hook-and-line gear. Virtually all sheephead are landed in southern California. Landings are estimated from landing receipts, and we feel our landing estimates are very reliable since few other species are mixed in with the landings based on actual port samples.

                        California scorpionfish
Scientific name: *Scorpaena guttata*
Discussion:
      Large landings of scorpionfish were made in the early 1970s, declined through the 1980s, increased through the 1990s, and then declined to low levels in the 2000s largely due to regulatory measures (Figure 89). Scorpionfish are landed primarily by hook-and-line gear although gill net, trawl, and trap gears also contribute to the landings. Virtually all scorpionfish are landed in southern California. Market samples taken in 1999 indicate the scorpionfish market category

consists entirely of scorpionfish; however, there is no way to be
certain that this has always been true, since no port samples exist
prior to 1999. We feel our estimates of scorpionfish landings are
generally reliable. It should be noted that Miller and Lea (1972) call
this species the spotted scorpionfish.
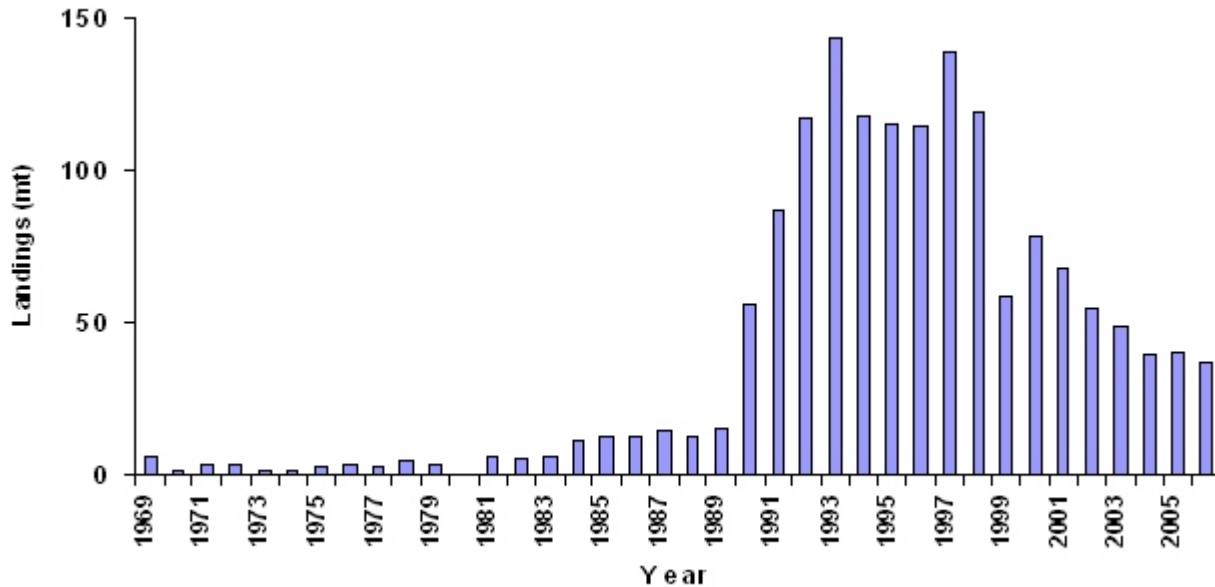
Figure 88. Estimated annual commercial landings (metric tons) of
California sheephead from California, 1969-2006.
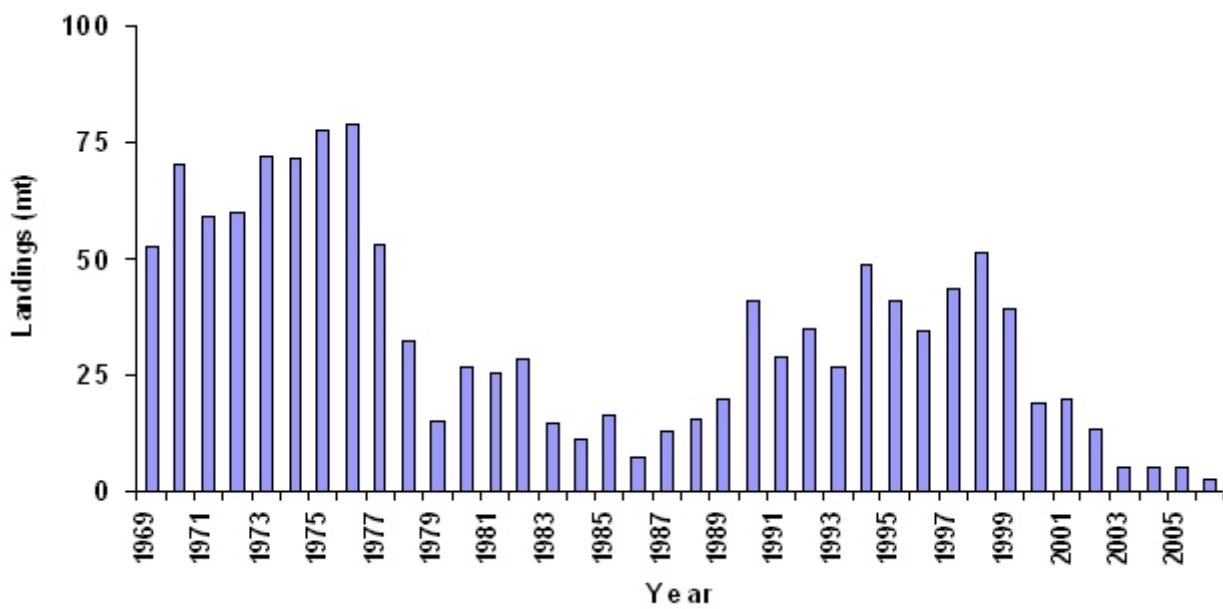
Figure 89. Estimated annual commercial landings (metric tons) of
California scorpionfish from California, 1969-2006.

Cabezon
Scientific name: *Scorpaenichthys marmoratus*

Discussion:

This species is most often caught by trap and hook-and-line gears in central California. Landings have increased in recent years as part of the nearshore live-fish fishery (Figure 90). Landings are estimated from the landing receipts and 1,446 port samples collected since 1994. These port samples indicate that the landings in the cabezon market category (261) are composed entirely of cabezon and therefore we feel our landing estimates are very reliable.
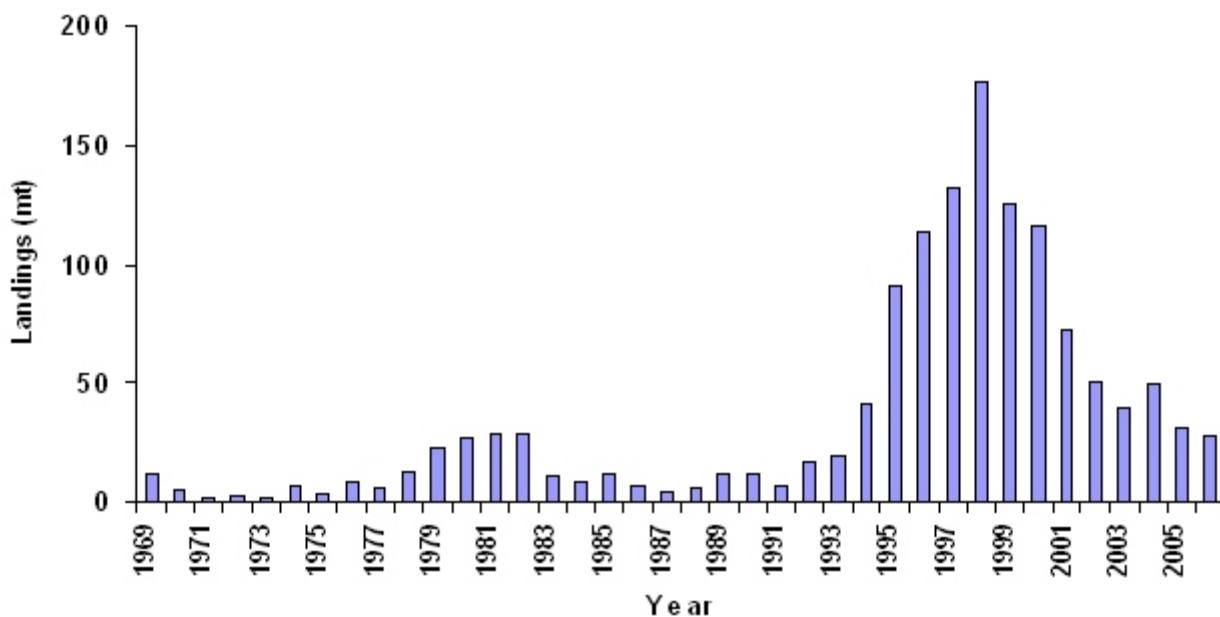
Figure 90. Estimated annual commercial landings (metric tons) of cabezon from California, 1969-2006.
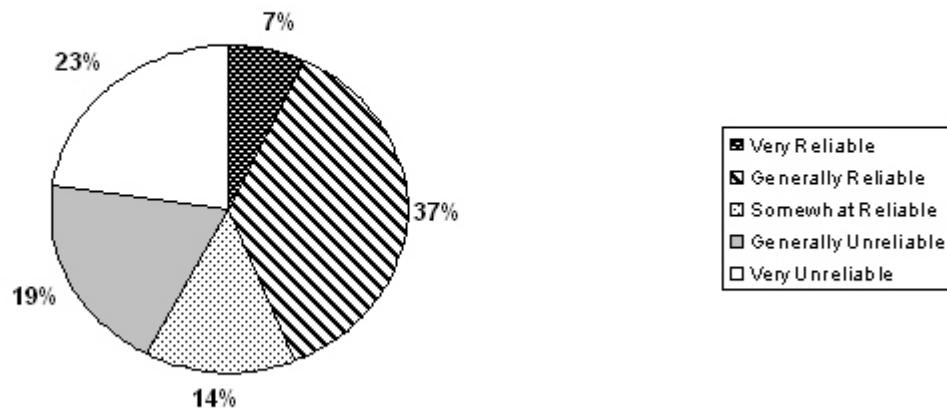
Other Species Summary

Landing estimates of other groundfish species are considered to be reliable for the most part. Species composition port sample data exists for several of these species and they indicate that landings in the market categories are generally pure for the species. The two exceptions are grenadiers and finescale codling for which the estimates are nonexistent for all practical purposes.

SUMMARY

Landing estimates for most groundfish are at least generally reliable (Table 2). Landing estimates for 32% of the 58 species of rockfish (including thornyheads) are considered at least somewhat reliable (Figure 91a). Landing estimates for 20% of the 32 other (non-rockfish) species are considered to be at least somewhat reliable (Figure 91b). As noted previously, reliability for many of these species can be improved.

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A

B
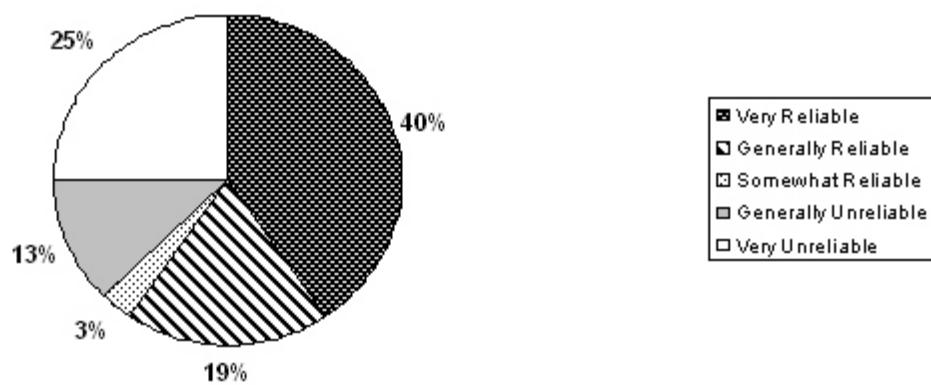
Figure 91. Pie chart showing the percent of species by level of
reliability for rockfish (includes thornyheads) (Panel A), and all other
species (Panel B). N=56 for rockfish and 32 for all other species.

Table 2. Summary of the reliability of commercial landing estimates for all California groundfish. Sampled Index and Reliability Scores are described in the text and are relative indicators for rockfish sampling and estimation. The Final Evaluation represents our best estimate of the reliability for the entire time period 1969-2006.

|			FINAL EVALUATION	
COMMON NAME	INDEX	SCORE	1969-1982	1983-2006
ELASMOBRANCHS				
Angel shark	NA	NA	Very reliable	Very reliable
Leopard shark	NA	NA	Very reliable	Very reliable
Soupfin shark	NA	NA	Generally reliable	Generally reliable
Spiny dogfish	NA	NA	Generally reliable	Generally reliable
Thresher shark	NA	NA	Generally unreliable	Generally unreliable
Big Skate	NA	NA	Very unreliable	Very unreliable
California skate	NA	NA	Very unreliable	Very unreliable
Longnose skate	NA	NA	Very unreliable	Very unreliable
Spotted ratfish	NA	NA	Very unreliable	Very unreliable
FLATFISH				
California halibut	NA	NA	Very reliable	Very reliable
Pacific halibut	NA	NA	Very reliable	Very reliable
Starry flounder	NA	NA	Generally unreliable[1]	Generally unreliable[1]
Arrowtooth flounder	NA	NA	Generally unreliable[1]	Generally unreliable[1]
Pacific sanddab	NA	NA	Very reliable[2]	Very reliable[2]
Longfin sanddab	NA	NA	Very unreliable	Very unreliable
Speckled sanddab	NA	NA	Very unreliable	Very unreliable
Turbots, spp	NA	NA	Very unreliable	Very unreliable
Dover sole	NA	NA	Very reliable	Very reliable
Rex sole	NA	NA	Generally unreliable[3]	Generally unreliable[3]
English sole	NA	NA	Very reliable	Very reliable
Petrale sole	NA	NA	Very reliable	Very reliable
Sand sole	NA	NA	Somewhat reliable	Somewhat reliable
ROCKFISH AND THORNYHEADS				
Thornyhead, longspine	NA	NA	Generally reliable	Generally reliable
Thornyhead, shortspine	NA	NA	Generally reliable	Generally reliable
Aurora	0.0111	23	Somewhat reliable	Somewhat reliable
Bank	0.0843	30	Generally reliable	Very reliable
Black	0.0180	19	Generally unreliable	Generally unreliable
Black-and-yellow	0.0088	19	Generally unreliable	Generally unreliable
Blackgill	0.0162	28	Generally reliable	Generally reliable
Blue	0.0041	18	Generally unreliable	Generally unreliable

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Table 2. Continued...

COMMON NAME	INDEX	SCORE	1969-1982	1983-2006
Bocaccio	0.0648	36	Generally reliable	Very reliable
Bronzespotted	0.0011	25	Generally reliable	Generally reliable
Brown	0.0045	20	Generally unreliable	Somewhat reliable
Calico	NA	NA	Very unreliable	Very unreliable
Canary	0.0093	27	Somewhat reliable	Generally reliable
Chameleon	0.0006	17	Somewhat reliable	Somewhat reliable
Chilipepper	0.0617	34	Generally reliable	Very reliable
China	0.0073	19	Generally unreliable	Generally unreliable
Copper	0.0048	22	Somewhat reliable	Somewhat reliable
Cowcod	0.0015	26	Generally reliable	Generally reliable
Darkblotched	0.0270	28	Somewhat reliable	Generally reliable
Flag	0.0007	22	Generally unreliable	Somewhat reliable
Gopher	0.0047	19	Generally unreliable	Generally unreliable
Grass	0.0113	28	Very reliable	Very reliable
Greenblotched	0.0005	17	Generally unreliable	Generally unreliable
Greenspotted	0.0026	24	Generally reliable	Generally reliable
Greenstriped	0.0009	20	Generally unreliable	Generally unreliable
Halfbanded	NA	NA	Very unreliable	Very unreliable
Honeycomb	NA	NA	Very unreliable	Very unreliable
Kelp	0.0091	24	Generally unreliable	Generally reliable
Mexican	0.0003	19	Generally unreliable	Generally unreliable
Olive	0.0026	20	Generally unreliable	Somewhat reliable
Pacific ocean perch	0.0026	28	Somewhat reliable	Generally reliable
Pink	0.0004	17	Generally unreliable	Generally unreliable
Pinkrose	NA	NA	Very unreliable	Very unreliable
Pygmy	NA	NA	Very unreliable	Very unreliable
Quillback	0.0033	20	Generally unreliable	Generally unreliable
Redbanded	0.0011	22	Somewhat reliable	Generally reliable
Redstriped	NA	NA	Very unreliable	Very unreliable
Rosethorn	0.0006	11	Very unreliable	Very unreliable
Rosy	0.0002	11	Generally unreliable	Generally unreliable
Rougheye	0.0017	19	Generally unreliable	Somewhat reliable
Sharpchin	0.0037	23	Somewhat reliable	Somewhat reliable
Shortbelly	0.0040	14	Generally unreliable	Generally unreliable
Shortraker	NA	NA	Very unreliable	Very unreliable
Silvergray	NA	NA	Very unreliable	Very unreliable

Table 2. Continued...

| | | | FINAL EVALUATION | |
COMMON NAME	INDEX	SCORE	1969-1982	1983-2006
Speckled	0.0013	20	Somewhat reliable	Somewhat reliable
Splitnose	0.0301	29	Somewhat reliable	Generally reliable
Squarespot	NA	NA	Very unreliable	Very unreliable
Starry	0.0032	19	Somewhat reliable	Somewhat reliable
Stripetail	0.0011	24	Generally reliable	Generally reliable
Swordspine	NA	NA	Very unreliable	Very unreliable
Tiger	NA	NA	Very unreliable	Very unreliable
Treefish	0.0027	19	Generally unreliable	Generally unreliable
Vermilion	0.0089	23	Generally reliable	Generally reliable
Widow	0.1948	37	Somewhat reliable	Very reliable
Yelloweye	0.0012	21	Generally unreliable	Generally reliable
Yellowmouth	NA	NA	Very unreliable	Very unreliable
Yellowtail	0.0169	29	Generally reliable	Generally reliable
OTHER SPECIES				
Cabezon	NA	NA	Very reliable	Very reliable
California sheephead	NA	NA	Very reliable	Very reliable
Finescale codling	NA	NA	Very unreliable	Very unreliable
Kelp greenling	NA	NA	Very reliable	Very reliable
Lingcod	NA	NA	Very reliable	Very reliable
Pacific cod	NA	NA	Generally reliable	Generally reliable
Pacific rattail	NA	NA	Somewhat reliable	Somewhat reliable
Pacific whiting	NA	NA	Generally unreliable	Very reliable
Sablefish	NA	NA	Very reliable	Very reliable
California scorpionfish	NA	NA	Generally reliable	Generally reliable

1. If a correction is applied for landings made in the unspecified market category, the landing estimate evaluation score would be considered generally reliable.
2. Assuming landings in the unspecified sanddab market category are included
3. Reliability would be improved by correcting for the fraction in the Dover sole landings.

Rockfish

When the reliability estimates for rockfish are examined in more detail, we find that the most reliable estimates are from the late 1970s through 2000 (Figure 92a). The ratio estimation method is largely responsible for the lower reliability before 1978. The reduction in very reliable estimates after 2000 is due in large part to regulation-induced restrictions of landings of species like bocaccio, widow rockfish and others which were considered very reliable earlier on. During the time when rockfish landings were highest (1980-1998) the vast majority of the rockfish landings were considered to be generally reliable or better (Figure 92b).

A

B
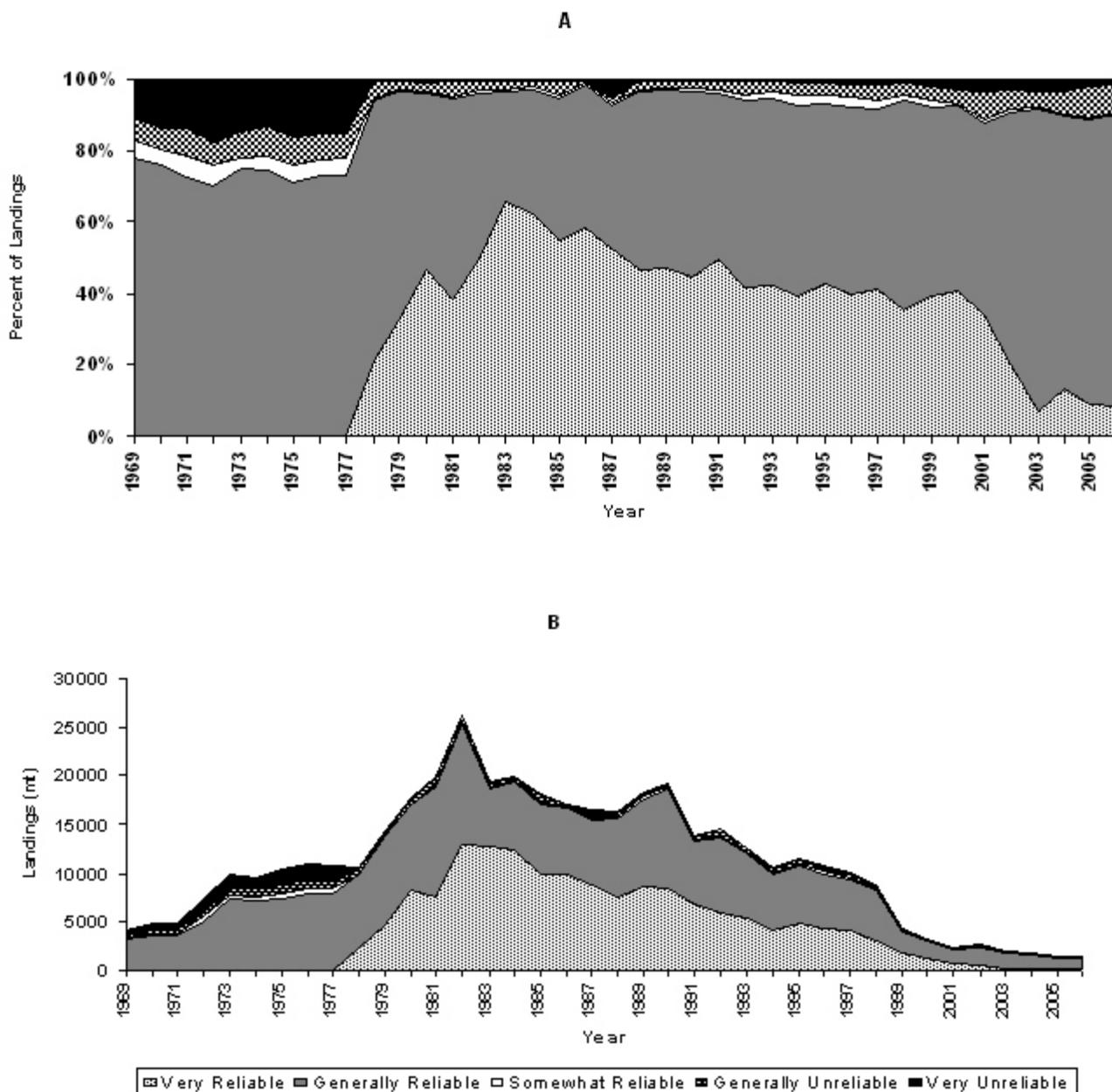
Figure 92. Plot of the rockfish landing estimates by estimated level of reliability from 1969 through 2006. Panel A shows the plot as a percent of all landings, Panel B shows the plot as by total landings (metric tons). This plot includes thornyheads.

In the northern area, the least reliable estimates are from 1969-1978; this is largely due to the reliance on the ratio estimation method (Figure 93a). After 1978, overall landings were well estimated. The peak in landings in 1983 coincides with large landings of widow rockfish and, to a lesser extent, bocaccio. The decline in landings after 1983 was due to increased restrictions on the widow rockfish fishery. The surge in rockfish landings from 1987 through 1990 was largely due to increased landings of thornyheads and darkblotched rockfish. Landing estimates for the two species of thornyheads and darkblotched rockfish are considered generally reliable; hence, the fraction of rockfish considered to be generally reliable increased. After 1990, rockfish landings declined in the north, in large part due to increased restrictions on longspine thornyheads and widow rockfish.

In the central area, the ratio estimation method may have been more reliable than in the northern area, and as a result, the reliability of the landing estimates from 1969 through 1977 are somewhat better than for northern California (Figure 93b). As with the northern area, the magnitude of the landings through the mid 1980s was largely driven by landings of widow rockfish and bocaccio, for which the landing estimates are considered to be very reliable. During the 1990s, rockfish landings in central California declined substantially due to increased regulatory restrictions on bocaccio and widow rockfish and other species. By 2000, an increasing fraction of the rockfish fishery was composed of species for which estimates were less reliable due to identification problems and the inability to fully sample all strata in the live-fish fishery.
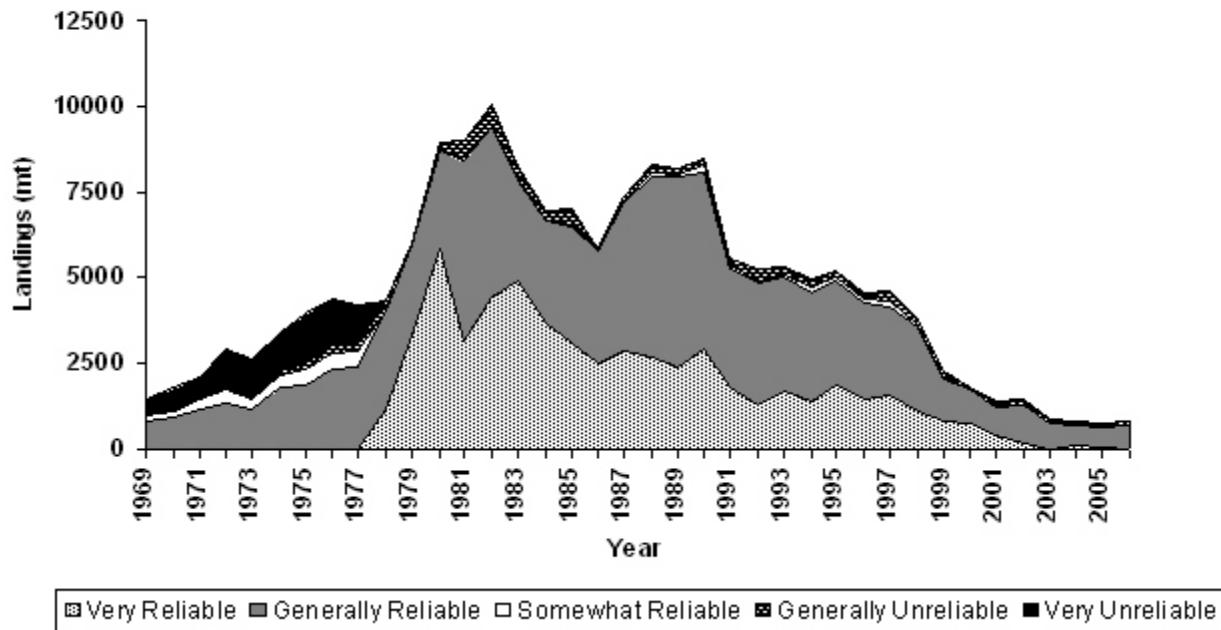
In the southern area, total rockfish landings were driven in large part by landing fluctuations of bocaccio, chilipepper, blackgill, bank, and cowcod rockfish (Figure 93c). In general, rockfish landing estimates are less reliable for southern California than for the rest of the state due to a lower level of sampling. The majority of rockfish landing estimates in southern California are considered to be generally reliable.

Non-rockfish Species

When the reliability estimates for the non-rockfish species are examined in more detail, we find that the most reliable estimates are from 1969 through the mid-1980s (Figure 94a). From the mid 1980s there is an increasing trend to have fewer landing estimates classified as very reliable. This due in large part to Pacific whiting making up a larger fraction of the landings. Pacific whiting, sablefish, and Dover sole are largely responsible for the overall changes in landings of this group (Figure 94b).

In northern California, the effect of changes in Pacific whiting, sablefish, and Dover sole landings heavily affect the overall landings and level of reliability of the species-specific estimates (Figure 95a). As sablefish and Dover sole landings declined from 1990 through 2006, the average level of reliability also declined, since Pacific whiting made up a larger fraction of the total landings and landing estimates for this species are only considered to be generally reliable.

A

B
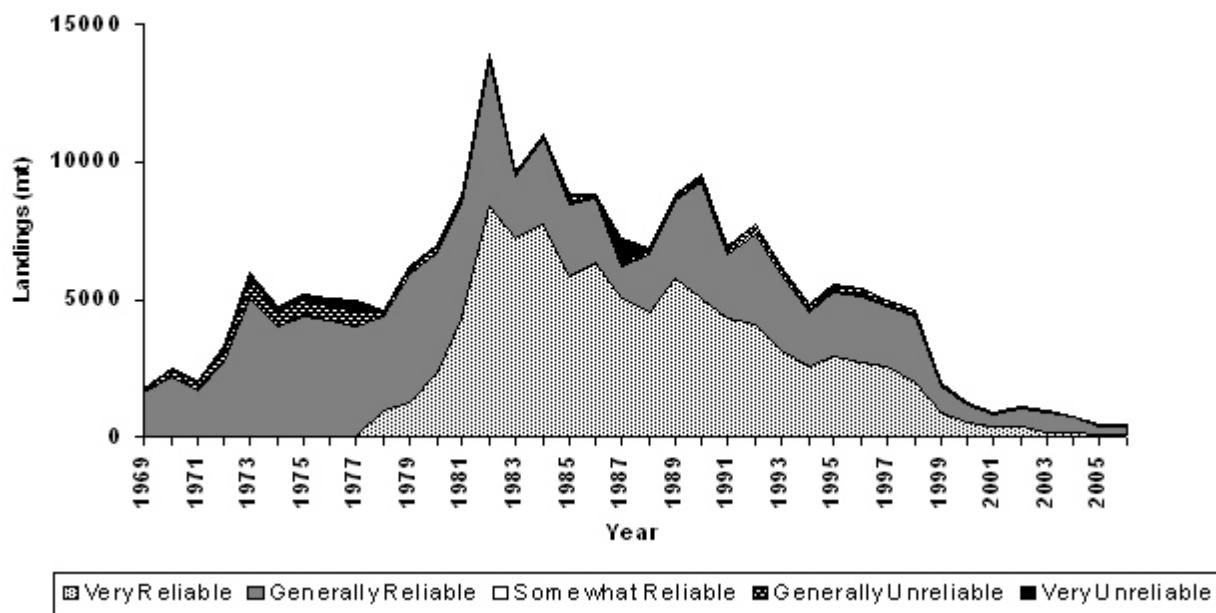
Figure 93. Plot of the rockfish landing estimates by the level of reliability for three areas: Panel A shows northern California (Crescent City, Eureka, and Fort Bragg), Panel B shows central California (Bodega Bay, San Francisco, Monterey, and Morro Bay), Panel C shows southern California (Santa Barbara, Los Angeles, and San Diego).

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C
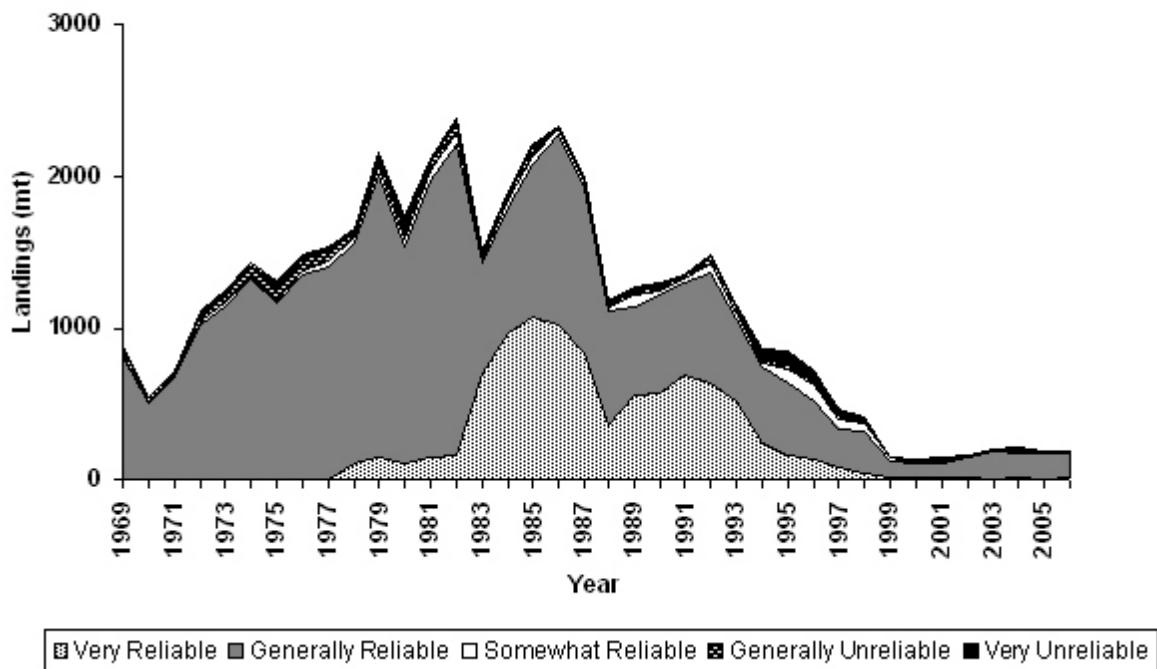
Figure 93. Plot of the rockfish landing estimates by the level of
reliability for three areas: Panel A shows northern California (Crescent
City, Eureka, and Fort Bragg), Panel B shows central California (Bodega
Bay, San Francisco, Monterey, and Morro Bay), Panel C shows southern
California (Santa Barbara, Los Angeles, and San Diego).

     In central California, the overall landings are also largely driven
by sablefish and Dover sole; however, Pacific whiting are of minor
importance (Figure 95b). Most of landings classified as very unreliable
in the 1970s are due to the use of the unspecified flounder market
category. During the late 1980s most of the landings classified as very
unreliable were due to landings in the unspecified skate market
category.

122
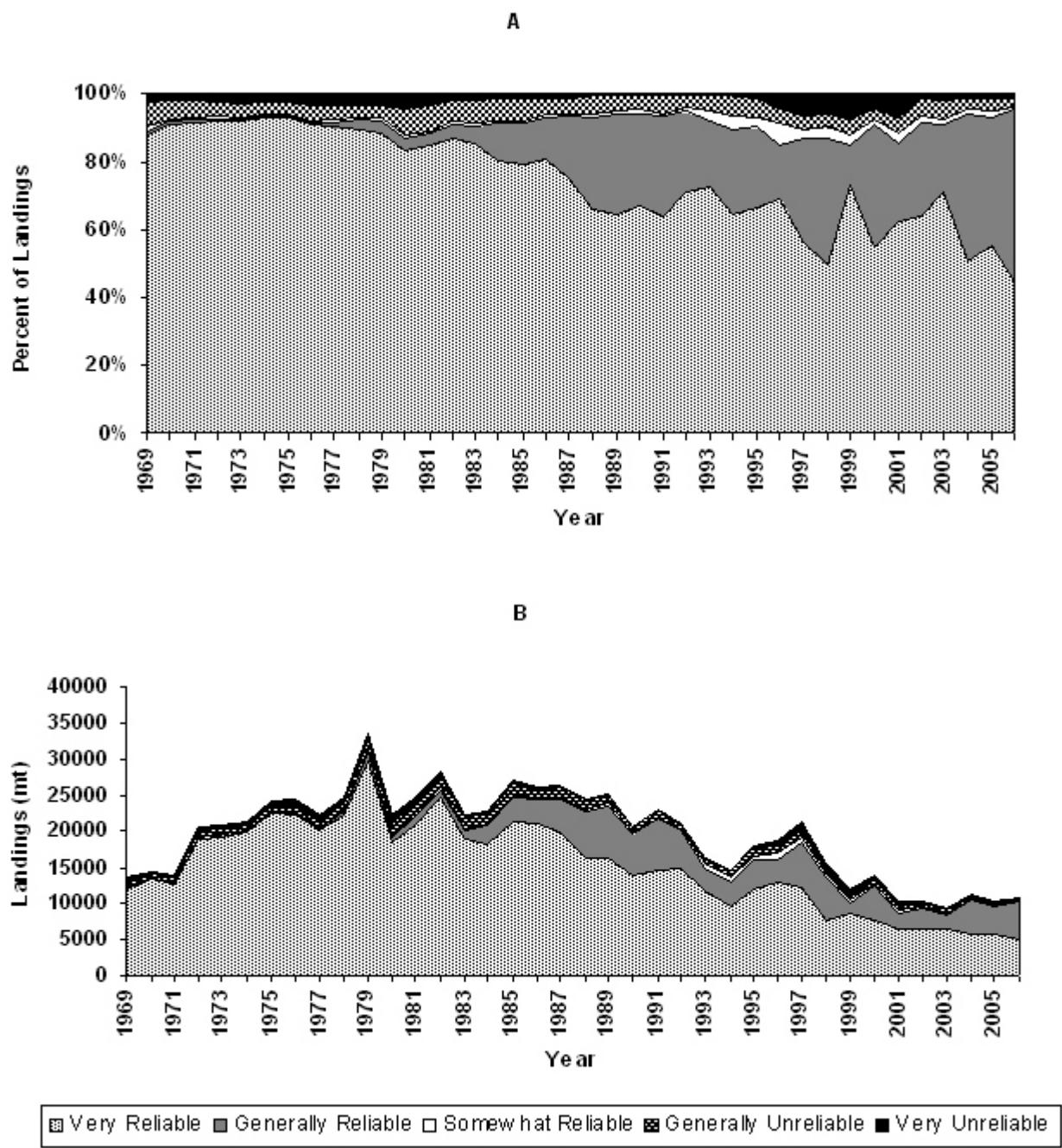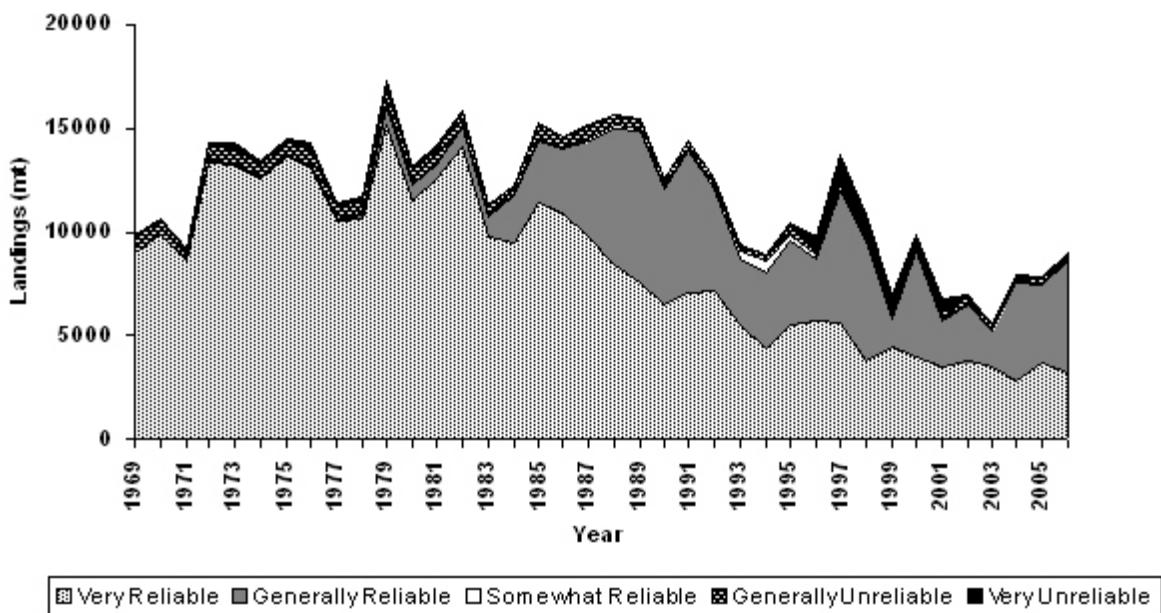
Figure 94. Plot of other non-rockfish species landing estimates by estimated level of reliability from 1969 through 2006. Panel A shows the plot as a percent of all landings, Panel B shows the plot by total landings (metric tons).

A

B
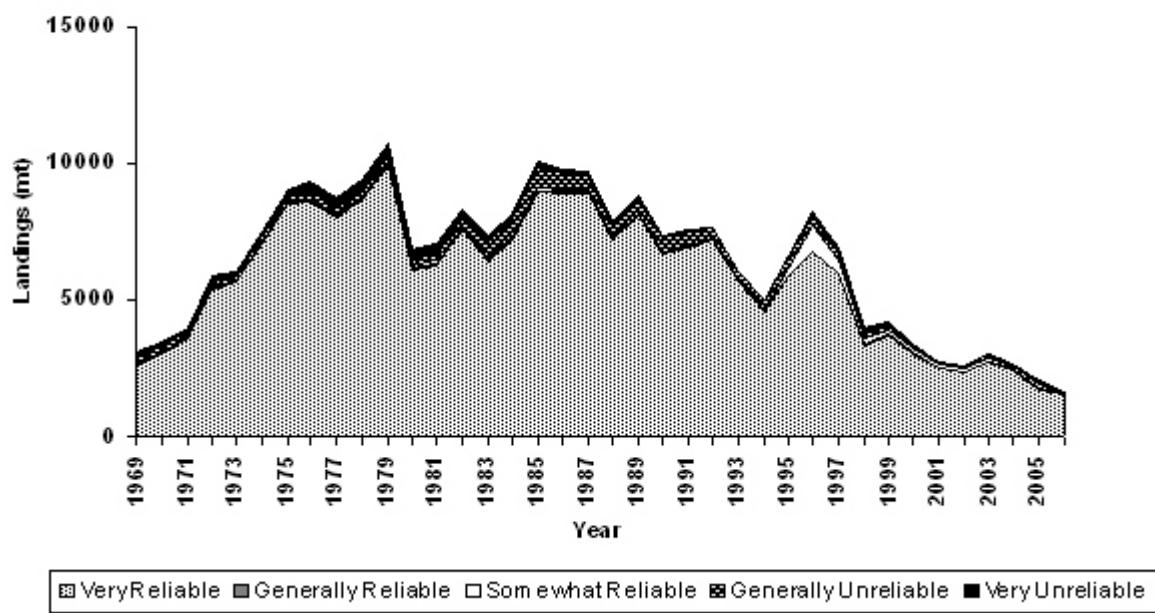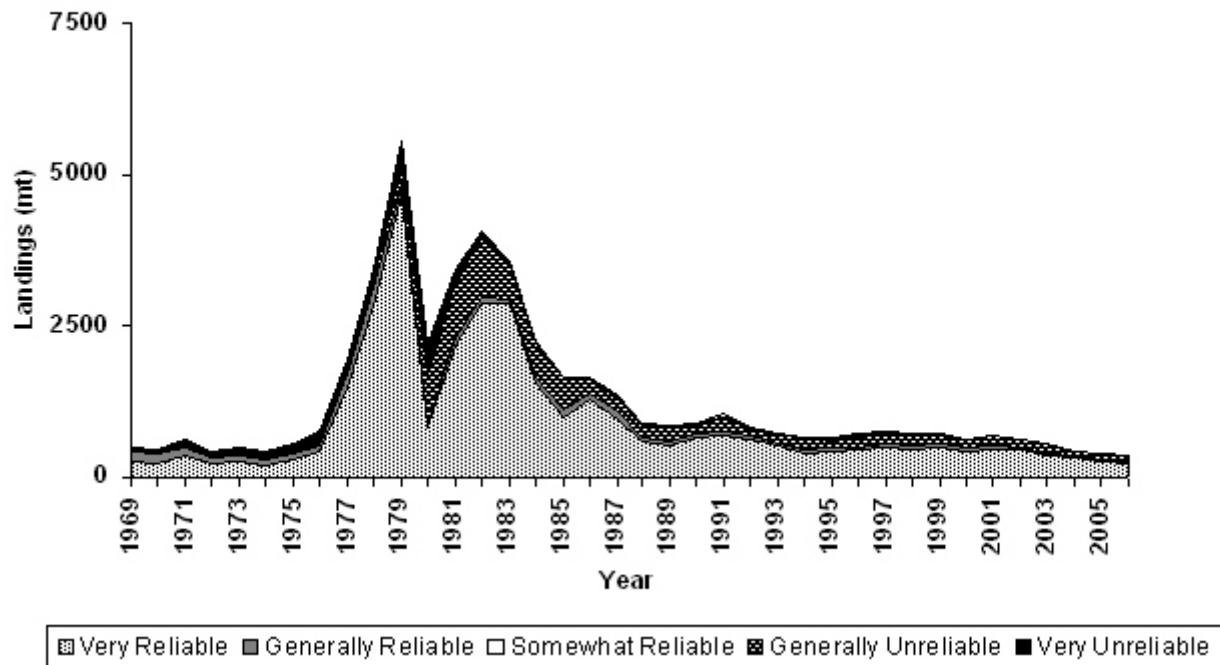
Figure 95. Plot of other species (non-rockfish) landing estimates by the level of reliability for three areas: Panel A shows northern California (Crescent City, Eureka, and Fort Bragg), Panel B shows central California (Bodega Bay, San Francisco, Monterey, and Morro Bay), Panel C shows southern California (Santa Barbara, Los Angeles, and San Diego).

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Figure 95 cont. Plot of other species (non-rockfish) landing estimates by the level of reliability for three areas: Panel A shows northern California (Crescent City, Eureka, and Fort Bragg), Panel B shows central California (Bodega Bay, San Francisco, Monterey, and Morro Bay), Panel C shows southern California (Santa Barbara, Los Angeles, and San Diego).

In southern California, the large changes in landings from 1979 through 1985 were due in large part to sablefish landings (Figure 95c). From 1969 through 1976, landings of unspecified flatfish and turbots was responsible for a large fraction of the landings to be classified as very unreliable. From 1980 through 2006, the landings classified as generally unreliable were mostly thresher shark. We felt that the landing estimates of thresher sharks were generally unreliable since there are three species of thresher sharks and we were not confident that they were sorted properly into the correct market categories. When considered as a group, and landings from the three species of thresher shark are pooled, the overall estimates of thresher sharks landings can be considered to be generally reliable.

CONCLUSION

This study represents the first time that the data collected by the California Cooperative Groundfish Survey and the species-specific landing estimates have ever been rigorously examined. We examined port sample data, landing receipts, and expanded landing estimates to identify errors and weaknesses in the data. We did not attempt to explain landing trends unless it was required to determine the

reliability of the landing estimates. We also did not consider the issue of discards or selectivity since those subjects are beyond the scope of this paper.

Estimation of species-specific landings is a dynamic process. Between 1978 and 2006, a total of 32,273 port samples were collected with a total of 943,770 fish examined. The number of people involved in collecting the data is surprisingly large when the fishermen, dealers, samplers, and data managers are considered. In this process, errors inevitably occur. Moreover, the data used in this report come from a 36-year period, and data management has changed dramatically during that time period.

In the process of preparing this paper, we detected several problems with data and landing estimates. Two of the problems were serious enough to cause us to immediately fix the landing estimates. In one case, a rockfish market category (265) was redefined in 1982. As a result, landing estimates for several species were seriously flawed prior to 1983. In addition to correcting the landing estimates, we developed a new procedure to estimate the landings in unsampled years. In another case, market category 253 (bocaccio) was changed to 956 (chilipepper/bocaccio) in 1979 by CDFG personnel. This change meant that the port samples for market category 253 were not used by the expansion program, and since no port samples existed for market category 956, the landing estimates were seriously flawed. We corrected this by forcing the expansion program to use the 62 port samples from market category 253. This resulted in much more reliable landing estimates for 1979.

The fact that we found landing estimates for many species to be unreliable is understandable given the complex and dynamic nature of California's groundfish fishery. Users of the data can, in many cases, improve the reliability of the landing estimates through further analysis and by eliminating data which are unreliable. In addition, by performing sensitivity analyses, the user can determine how much any given value is influencing the results of a particular study.

Our major recommendations for improvement of the landing estimates are as follows:
1. The definition of a market category should never be changed.
2. Port sampling for elasmobranchs should be done. (A pilot program was initiated in 2008.)
3. More species composition sampling of the flatfish market categories should be performed, and these port samples should be applied to the landings retroactively.
4. Better error checking of all data should be done.
5. More port samplers should be employed.
6. Port samplers should be allowed to sample any landing. (mandatory port sampling)
7. Duplicate codes should be eliminated.
8. Gear and port codes should be more clearly defined.

We hope that this study is of value to users of the landing estimates. Many of our results will be used to further improve our

estimates of landings as well as to better manage the data as we move forward.

Sources of Data

Landing data can be obtained from the CALCOM data system in two ways: through our website at http://128.114.3.187 or using Open Database Connectivity (ODBC) connections. The range of data available through the website is limited; while ODBC connections allow the user to access all data using a large variety of software packages. To obtain access to the data contact either Don Pearson (don.pearson@noaa.gov) or Brenda Erwin (berwin@dfg.ca.gov). You may be asked to sign a confidentiality agreement. Complete documentation is also available from them.

Another source of the data is from the PacFIN database. Access to the PacFIN database can be obtained by contacting the managers at Pacfin@psmfc.org.

ACKNOWLEDGMENTS

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Appendix A California Port Complexes

PORT COMPLEX	NOTES
Crescent City	
Eureka	Includes Fields Landing
Fort Bragg	
Bodega Bay	
San Francisco	Includes Halfmoon Bay
Monterey	Includes Moss Landing and Santa Cruz
Morro Bay	Includes Avila and San Simeon
Santa Barbara	Includes Ventura and Oxnard
Los Angeles	Includes all the greater Los Angeles area
San Diego	Includes all areas from Oceanside south

Appendix B California Commercial Gear Groups

GEAR GROUP	NOTES
Hook-and-line	Includes troll, vertical hook-and-line, set line, drift line, and other gears having hooks
Trap	Includes all types of fish and invertebrate trap gear
Trawl	Includes midwater and bottom trawl
Gill net	Includes drift and trammel net
Other	Includes seine, diving, and other gears

```
            Appendix C - The Species Composition Expansion Process

        The best way to explain how expansions are done is by showing an
    example.  In this example, we assume two samples were taken from a
    strata (gear, port, market category, condition, and quarter).  Each
    sample consists of two clusters (subsamples).  A landing weight for the
    strata from the trip is obtained by the port sampler.  In addition, a
    total weight for each species within each cluster is recorded by the
    sampler.

    SAMPLE DATA:
        Sample #1                              Sample #2
        Landed Weight: 1,550 lbs               Landed Weight: 2,575 lbs
                                  Cluster 1
        Species A: 35 lbs                        Species A: 10 lbs
        Species B: 10 lbs                     Species B: 40 lbs
        Species C:  5 lbs
        Cluster Weight: 50 lbs                   Cluster Weight: 50 lbs
                                  Cluster 2
        Species A: 25 lbs
                                     Species B: 40 lbs
        Species C: 20 lbs
        Cluster Weight: 45 lbs                   Cluster Weight: 40 lbs

    Total Weight of strata (from receipts):  55,750 lbs

    CALCULATIONS:
      Within Sample Calculations:
        Sample #1:  Species A weight = 35 + 25 = 60 lbs
                    Species B weight = 10 lbs
                    Species C weight = 5 + 20 = 25 lbs
                    Total Cluster Weight = 50 + 45 = 95 lbs
        Sample #2:  Species A weight = 10 lbs
                    Species B weight = 40 + 40 = 80 lbs
                    Total Cluster Weight = 50 + 40 = 90 lbs

      Expanded to sampled landing weights:
        Sample #1:  Species A:  (60/95) * 1,550 = 978.9 lbs
                    Species B:  (10/95) * 1,550 = 163.2 lbs
                    Species C:  (25/95) * 1,550 = 407.9 lbs
        Sample #2:  Species A:  (10/90) * 2,575 = 286.1 lbs
                    Species B:  (80/90) * 2,575 = 2,288.9 lbs

      Sum Of Sampled Landings: 1,550 + 2,575 = 4,125 lbs

      Sum of expanded to sampled landing weights:
        Species A:  978.9 + 286.1 = 1,265.0 lbs
        Species B:  163.2 + 2,288.9 = 2,452.1 lbs
        Species C:  407.9 lbs

      Expansion factor (Total Landings/Sampled landings):
        55,750/4,125 = 13.5
```

```
Final Landing Estimates:
  Species A:  1,265.0 * 13.5 = 17,077.5 lbs
  Species B:  2,452.1 * 13.5 = 33,103.4 lbs
  Species C:  407.9 * 13.5   =  5,506.7 lbs
```

```
                 Appendix D - Sample Effort Distribution
YEAR       FLATFISH        ROCKFISH        THORNYHEAD OTHER
1969         190
1970          80
1971          95
1972         160
1973         154
1974         154
1975          92
1976         115
1977         178
1978         132          217                 51         6
1979          61          195                 29         5
1980         288          346                 16        42
1981         246          316                  5
1982         191          434                 24        25
1983         203          666                 80        32
1984         144          772                 91        15
1985         187        1,033                108         6
1986         160          865                 34       116
1987         133          673                 22       175
1988         110          491                  2       116
1989         152          527                 26       122
1990         108          491                 29       126
1991         147          517                 39       104
1992         133          999                 44
1993          85        1,246                 55       296
1994          70        1,229                 72       223
1995          97        1,007                129       252
1996          94        1,267                122       432
1997          88        1,037                114       313
1998          90          944                 78       266
1999          83        1,216                134       520
2000          74        1,153                 93       690
2001         106          913                 87       432
2002         144          573                190       220
2003         212          325                154       191
2004         147          416                 91       201
2005         210          437                146       263
2006         322          621                215       406
```

Notes: Prior to 2003, flatfish samples were for age, sex, and length only. Flatfish samples for species composition began in 2003. No port samples were taken in southern California from 1978-1982, and 1993-1994. Numbers are number of samples. A sample usually consists of two clusters (e.g... subsamples).

RECENT TECHNICAL MEMORANDUMS

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