

Results of California Department of Fish and Game
Spot Prawn Trawl and Trap Fisheries
Bycatch Observer Program 2000-2001

prepared by

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Executive Summary

In 1999 trap fishermen and environmental groups testified at a Fish and Game Commission (Commission) meeting that they were concerned about high levels of bycatch in the spot prawn trawl fishery. Environmental representatives requested that the Commission consider adopting regulations that would phase out the spot prawn trawl fishery by 2004 and convert spot prawn trawl permits to spot prawn trap permits. Also in 1999 the Department reported to the Commission the results of six observed spot prawn trawl tows in March 1999, including the ratio of weight of finfish bycatch to weight of spot prawns (7.4 to 1). Based primarily on the above factors, the Commission initially directed the Department to develop, as part of a package of regulatory proposals for the spot prawn trap and trawl fisheries, a proposal to phase out the spot prawn trawl fishery and convert trawl permits to trap permits.

Subsequently the Department recommended that, instead of phasing out the spot prawn trawl fishery, information on the relative amount and type of bycatch in the trawl and trap fisheries be determined through an on-board observer program.

An observer fee structure was proposed and adopted, and an observer program was in effect for all vessels landing spot prawns from July 14, 2000 to March 31, 2001. Vessels were required to purchase and possess a spot prawn observer fee permit in order to take and land spot prawns. Funds from the program were used to support on board observers and to digitize and analyze the data. Some fishing trips were observed after the requirement for the observer fee had expired.

A total of 86 spot prawn trawl tows (71 from northern California-based vessels and 15 from southern California-based vessels) was observed on nine vessels during the period September 26, 2000 to September 19, 2001. Observed vessels fished from the ports of Fort Bragg, San Francisco, Monterey, Morro Bay, and Ventura.

For northern California trawl vessels, the top five finfish species observed in the bycatch, in decreasing frequency of occurrence, were Pacific hake (whiting), Dover sole, sablefish, English sole, and splitnose rockfish, comprising 53.9% of all fishes by weight. Twenty-eight species of rockfishes were observed, comprising 28.1% by weight of all fishes. The weight ratio of total finfish bycatch to total spot prawn catch from all tows combined was 7.5 to 1. The ratio of total rockfish bycatch to total spot prawn catch was 2.1 to 1.

For southern California trawl vessels, the top five finfish species observed in the bycatch, in decreasing frequency of occurrence, were Pacific sanddab, Pacific hake, slender sole, shortbelly rockfish, and Dover sole, comprising 83.1% of all fishes by weight. Fifteen species of rockfishes were observed, comprising 8.8% by weight of all fishes. The ratio of total finfish bycatch to total spot prawn catch from all tows combined was 17.7 to 1. The ratio of total rockfish bycatch to total spot prawn catch was 1.5 to 1.

The ratio of total trawl bycatch, including invertebrates, to spot prawn catch was 8.8 to 1 in northern California and 20.6 to 1 in southern California.

The National Marine Fisheries Service has determined the following rockfish species to be overfished and require rebuilding: bocaccio, canary, cowcod,

darkblotched, widow, and yelloweye. Bocaccio, cowcod, darkblotched, and widow rockfishes were observed in multiple tows, and yelloweye and canary each were observed in a single tow. In general, the relative abundance of overfished rockfish species was low compared with other finfishes. However, expansions by weight of finfishes from observed tows to all spot prawn tows, based on the ratio of total to observed spot prawn landings, indicated that the estimated total bycatch of overfished rockfishes was significant in terms of allowable catch levels (optimum yields) established by the Pacific Fishery Management Council (Council). Other overfished species observed in the sampled catch including Pacific hake (whiting) and lingcod.

Results from these trawl observations relative to bycatch levels were consistent with the few previous studies conducted. That is, the total observed bycatch in the trawl fishery was more than four times that of spot prawns by weight.

A total of 27 trap vessels paid the required observer fee, and 23 of these landed spot prawns during the period in which the observer fee was required. Passage was secured on 16 of these 23 vessels for observations of bycatch. An additional vessel that had not paid the fee was sampled after the fee requirement period had expired. A total of 262 spot prawn trap strings (88 from northern California vessels and 174 from southern California vessels) was observed from 16 vessels during the study. Observed vessels fished out of the ports of Monterey, Morro Bay, Channel Islands Harbor, Ventura, Terminal Island, Newport Beach, Dana Point, Oceanside, and San Diego.

For northern California trap vessels, the top five finfish species observed in the bycatch, in decreasing frequency of occurrence, were sablefish, rosethorn rockfish, greenblotched rockfish group, spotted cusk eel, and filetail catshark, comprising 77.7% of all fishes by weight. Seventeen species of rockfishes were observed, comprising 25.5% by weight of all fishes. The ratio of total finfish bycatch to total spot prawn catch from all strings combined was 0.15 to 1. The ratio of total rockfish bycatch to total spot prawn catch was 0.04 to 1.

For southern California trap vessels, the top five finfish species observed in the bycatch, in decreasing frequency of occurrence, were lingcod, greenblotched rockfish group, threadfin sculpin, sablefish, and swell shark, comprising 66.4% of all fishes by weight. Twenty-two species of rockfishes were observed, comprising 32.5% by weight of all fishes. The ratio of total finfish bycatch to total spot prawn catch from all strings combined was 0.22 to 1. The ratio of total rockfish bycatch to total spot prawn catch was 0.07 to 1.

The ratio of total trap bycatch, including invertebrates, to spot prawn catch was 1.0 to 1 in northern California and 2.0 to 1 in southern California. Most invertebrates and many fish species other than rockfishes could be returned to the water alive.

Overfished rockfish species were observed infrequently, and expansions of observed bycatch data to all trap strings yielded relatively low total estimated bycatch weights for these species.

In northern California, the relative amount of bycatch for all finfishes and rockfishes was 50 and 52 times greater, respectively, in the trawl fishery compared with the trap fishery. In southern California, the relative amount of bycatch for all fishes and rockfishes was 80 and 21 times greater, respectively, in the trawl fishery compared with the trap fishery.

A series of management options was developed. These were driven by an overall concern in general for the level of bycatch in the trawl fishery and two primary factors relating to overfished rockfishes: 1) there is a need to reduce bycatch of those federally managed rockfishes which are considered to be overfished and require rebuilding; and 2) the impacts of bycatch from the spot prawn trawl fishery are not being accounted for in the management of groundfish species:

Option 1. (Trawl Permit Moratorium) Immediately establish a moratorium on the issuance of new spot prawn trawl vessel permits.

Option 2a. (Observer Program) Require that all spot prawn trawl vessels cooperate with the federal observer program as a condition of their permit; and/or

Option 2b. (Observer Program) Implement a mandatory state observer program for all spot prawn trawl vessels and require cooperation as a condition of their permit.

Option 3. (Restricted Access) Proceed with the development of a restricted access spot prawn trawl fishery program, including the provision of no transferability of restricted access trawl permits, and the establishment of a capacity goal for the trawl fishery (separate from the trap fishery, which has its own).

Option 4a. (Trawl Prohibition with Trap Conversion) Prohibit spot prawn trawling and convert all spot prawn restricted access trawl permits (assuming a program is in place) to restricted access trap permits.

Option 4b. (Trawl Prohibition) Prohibit spot prawn trawling.

Option 5. (Bycatch Reduction and Requirement of Experimental Gear Permit) Convene a bycatch reduction committee, including several of the trawlers who demonstrated the lowest bycatch ratios from 2000-01 observations, to work on developing management recommendations to reduce bycatch in this fishery. Provide for Experimental Gear Permits to allow some spot prawn trawl vessels to continue to fish, but with rigid grid excluders. Require an industry-funded observer to be on-board during these deployments. If the vessel is double-rigged (i.e. tows two nets simultaneously), require one of the nets to have a rigid grid excluder. This would allow some fishing to continue inside 150 fathoms south of Point Reyes or 250 fathoms north of Point Reyes.

Option 6. (Buyout) Establish a fishery buyout program for spot prawn trawl vessels.

Option 7. (Closed Areas) Establish additional closed areas for spot prawn trawling where bycatch of overfished species is relatively high.

Option 8. (Depth Restriction) Establish a minimum depth restriction of 150 fathoms south of Point Reyes or 250 fathoms north of Point Reyes for spot prawn trawling, except for vessels possessing an Experimental Gear Permit. Require a vessel monitoring system (VMS) for vessels without an Experimental Gear Permit to insure compliance with this regulation.

Option 9. (Seasonal Closure) Increase the closed season for spot prawn trawling from 3 months to 6 months.

Option 10. (Roller Gear Restrictions) Prohibit the use of large (greater than 8-inch diameter) roller gear.

Option 11. (Landing Requirements) Require all spot prawn trawl vessels to land all bycatch. This option could also require the installation and operation of deck video cameras during trawling operations to ensure all bycatch is retained.

Option 12. (Groundfish FMP Amendment) Include discard estimates of overfished species in Council management plans. A table of recommended bycatch mortality estimates is provided in the text.

Option 13. No Additional Restrictions to the Trap Fishery)

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Appendix 1.2. Summary of other fishes, by weight, in observed spot prawn trawl tows from northern California, based on location of tow, 2000-2001, with calculated expansions to entire fleet for a 1-year period. (Total estimated pounds with 95% bounds are expanded in Column 7 for boats that were sampled, based on ratio of their total spot prawn landings to landings from observed tows during the 1-year sampling period. Total estimated pounds are further expanded for all vessels in fishery based on ratio of total spot prawn landings to total landings of observed vessels)

Appendix 1.3 Summary of all rockfishes and lingcod, by weight, in observed spot prawn trawl tows from southern California, based on location of tow, 2000-2001, with calculated expansions to entire fleet for a 1-year period. (Total estimated pounds with 95% bounds are expanded in Column 7 for boats that were sampled, based on ratio of their total spot prawn landings to landings from observed tows during the 1-year sampling period. Total estimated pounds are further expanded for all vessels in fishery based on ratio of total spot prawn landings to total landings of observed vessels)

Appendix 1.4. Summary of other fishes, by weight, in observed spot prawn trawl tows from southern California, based on location of tow, 2000-2001 with calculated expansions to entire fleet for a 1-year period. (Total estimated pounds with 95% bounds are expanded in Column 7 for boats that were sampled, based on ratio of their total spot prawn landings to landings from observed tows during the 1-year sampling period. Total estimated pounds are further expanded for all vessels in fishery based on ratio of total spot prawn landings to total landings of observed vessels)

Report on California Department of Fish and Game Spot Prawn Trawl and Trap Fishery
Bycatch Observer Program 2000-2001
prepared by Paul N. Reilly and John Geibel July 2002

Introduction and Background

Trawl fishery

The spot prawn trawl fishery in California is characterized by a relatively small number of vessels compared with other fisheries and until the mid 1980s was largely confined to southern California. During the last 10 years approximately 20-50 vessels statewide made landings each year, but each of these vessels did not make landings every year. Fishing effort and landings were substantial in the early 1980s and declined during the second half of the decade. A resurgence in fishing effort and catch occurred during the 1990s, culminating in all-time record annual landings in 1997 of approximately 566,000 pounds (Table 1). In 1998 landings were at a comparable level and from 1999 landings declined steadily to approximately 202,000 pounds in 2001. In 2000 and 2001, 39 and 43 trawl vessels, respectively, landed spot prawns in California. Among these vessels, only 22 and 21, respectively, landed more than 1,000 pounds each. The estimated ex-vessel value of the spot prawn trawl fishery in 2001 was approximately \$1.4 million.

The spot prawn trawl fishery has provided significant income to its participants. From 1997 to 2001, a total of 45 vessels landed at least 1,000 pounds of spot prawns in at least one of those years. Based on an average ex-vessel value of approximately \$7.00 per pound during the period, the following categorizes the cumulative revenue generated by each of those vessels into groups:

Number of vessels by cumulative ex-vessel revenue during 1997-2001

< \$20,000	\$20,000 - 100,000	\$100,000 - 500,000	> \$500,000
6	15	14	10

Trap fishery

The spot prawn trap fishery in California is also characterized by a relatively small number of vessels compared with other fisheries and until the mid 1980s was largely confined to northern California. Since 1985 the majority of vessels have operated in southern California. During the last 10 years approximately 40-70 vessels statewide made landings each year, but each of these vessels did not make landings every year. Annual landings peaked in 1990-91 between 250,000 and 260,000 pounds, and during the last five years have averaged about 190,000 pounds (Table 2). In 2000 and 2001, 41 and 43 trap vessels, respectively, landed spot prawns in California, mostly in southern California. Among these vessels, only 21 and 24, respectively, landed more than 1,000 pounds each. The estimated ex-vessel value of the spot prawn trap fishery in 2001 was approximately \$1.9 million.

Commission testimony

In 1999 trap fishermen and environmental groups testified at a Fish and Game Commission (Commission) meeting that they were concerned about high levels of bycatch in the spot prawn trawl fishery. Environmental representatives requested that the Commission consider adopting regulations that would phase out the spot prawn trawl fishery by 2004 and convert spot prawn trawl permits to spot prawn trap permits. Also in 1999 the Department reported to the Commission the results of six observed spot prawn trawl tows in March 1999, including the ratio of bycatch weight to spot prawn weight (see Previous Studies below in trawl results section). Based primarily on the above factors, the Commission initially directed the Department to develop, as part of a package of regulatory proposals for the spot prawn trap and trawl fisheries, a proposal to phase out the spot prawn trawl fishery and convert trawl permits to trap permits.

Subsequently the Department recommended that, instead of phasing out the spot prawn trawl fishery, information on the relative amount and type of bycatch in the trawl and trap fisheries be determined through an on board observer program.

Definition of bycatch and discard

Fish and Game Code Section 90.5 defines bycatch as "fish or other marine life that are taken in a fishery but which are not the target of the fishery.". Bycatch includes discards. Fish and Game Code Section 91 defines discards as "fish that are taken in a fishery but not retained because they are of an undesirable species, size, sex, or quality, or because they are required by law not to be retained.". This report will focus on total bycatch estimates but will also discuss estimates of discards in the trawl fishery.

Observer program

In early 2000, the Department proposed a one-year observer program with the goal of observing 10% of all spot prawn trawl vessel trips, and two trips on each spot prawn trap vessel during July 2000 through June 2001. This proposal was adopted by the Fish and Game Commission on May 4, 2000. To fund the program, the implementing regulations imposed an observer fee of \$250 for each trap vessel, and either \$250, \$500, or \$1,000 for each trawl vessel based on recent landings. Vessels were required to possess a spot prawn observer fee permit in order to land spot prawns in California during the period July 14, 2000 to March 31, 2001. The observer program was designed to obtain information on the composition and magnitude of bycatch in spot prawn fisheries in order to improve management, particularly in relation to gear specifications. Funds were used to support on board observers and to digitize and analyze the data. Some fishing trips were observed after the requirement for the observer fee had expired.

Fishing Regulations

A summary of the spot prawn trawl regulations is provided in Table 3. The fishery is presently open-access. Spot prawn trawl regulations require that trawl nets have either a functional finfish excluder with a minimum surface area of 36 square

inches or a double-walled codend with mesh size at least 3 inches. Among the nine vessels sampled, seven had fisheye type finfish excluders and the other two had the larger mesh codends.

A summary of the spot prawn trap regulations is provided in Table 4. On April 1, 2002 the spot prawn trap fishery became restricted access with a two-tiered permit structure. At least 30 trap vessels were eligible for restricted access permits.

Methods, Results, and Previous Studies- Trawl Fishery Observations

Sampling procedures

Samplers were provided with a list of those trawl vessels in their port area that had paid the observer fee. Samplers attempted to contact each vessel on the list until a trip was secured, then repeated the process for any subsequent trips. Not all vessel owners provided access to samplers even though they had paid the fee. Thus the samples were not random, but they represent the first substantial data set obtained by the Department on bycatch in spot prawn trawl tows.

The sampling unit was the trawl tow. Some tows were in the same general location during a single trip, and the same general locations may be re-visited often during the year. After the catch from a tow was placed on the deck and the spot prawns removed by the crew, the observer attempted to take a random sample of the bycatch by shoveling a portion into a tub. The sampler subsequently estimated the proportion of the tow in the sample by either visual estimation or by asking the crew to place the remainder of the sample into a similar tub before discarding it and to count the number of tubs. The proportion of the tow sampled ranged from 1/2 to 1/24. In some cases certain species were culled by the crew, either to retain for sale or to return to sea quickly, before the observer obtained a sample. These were noted by the observer and estimated weights, as provided by the crew, were added to the total bycatch weight estimate. These were considered to be "select" species and their weights were not expanded by the proportion of the tow sampled. All finfishes in the sample were separated by species or by the lowest taxon possible and an aggregate sample weight was obtained for each species or taxon. In each sample, numbers of individuals by species were only counted if all individuals were measured, which did not always occur. Individual lengths were obtained if time allowed. Invertebrates in the bycatch were weighed as an aggregate at minimum. Some samplers quantified them by counts or weights based on general taxa. Samplers noted the condition of each bycatch species relative to its ability to survive if returned to sea. In most cases this was obvious because few individuals among the primary invertebrate and finfish bycatch species showed any signs of activity with the exception of fishes such as sablefish and lingcod. Examples of many species were brought back for subsequent verification of species identity. Some organisms for which species identification could not be confirmed are reported as a higher taxon.

Expansion of sample weights of bycatch to estimated tow weight of bycatch

Total estimated weight of each species in each observed tow was calculated by multiplying the sample weight by the number of samples that would have

constituted the entire tow; i.e., if the observer took a 1/10 sample, each sample weight of a species was multiplied by 10 to obtain estimated total weight for that species in the tow. The estimated weights in the sampled catch for each species are reported in column 2 of Tables 6-7 and 9-10.

It should be noted that, although estimated total weights by species of bycatch are reported to the nearest 0.1 pounds in some of the tables, the precision of the estimated weights was compromised by the difficulty of using a hanging balance on a moving vessel.

Expansion of all estimated tow weights of bycatch to estimated total bycatch weight in fishery

The expansions of total estimated tow weights to total annual weights were done in a two-stage approach. In the first stage, the estimated bycatch weights from observed tows were expanded only by the proportion of spot prawn landings these estimates represented for the vessels observed. These estimates are reported in column 7 of Tables 6, 7, 9, and 10. In the second stage, estimated bycatch weights were expanded by the ratio of all spot prawn landings from all vessels in the fleet during that one-year period to those landings from the observed vessels. These estimates are reported in the last column of Tables 6, 7, 9, and 10. The 95% confidence bounds were used in the first stage expansion only, since they reflect the variability among observed tows. In the final expansion only single point estimates are provided for each species. The 95% confidence bounds are also estimates because a formal, randomized sampling design was not possible. The confidence intervals for those species encountered less frequently may be asymmetrical, because in cases when the lower confidence bound was less than the total sampled weight, the sampled weight was used as the lower bound. This is a reflection of the high variability in catch which was characteristic of many of the bycatch species.

The above expansions were calculated based on port of landing, with all ports to the north of Point Conception considered as northern California. However, some observed tows from vessels landing north of Point Conception occurred south of Point Conception. Since the Pacific Fishery Management Council (Council) allocates groundfish based on area of catch, the data were also analyzed based on location of tow (see Appendixes 1-4). The expansions using port of landing are based on the total spot prawn trawl landings for the one-year period October 1, 2000 to September 31, 2001, which roughly corresponds to the period during which observations were obtained. These expansions are provided as general estimates of the total bycatch. Total spot prawn trawl landings during this period were 153,800 pounds for all ports north of Pt. Conception and 45,800 pounds for all ports south of Pt. Conception.

Results

A total of 28 trawl vessels paid the required observer fee, and 24 of these landed spot prawns during the period in which the observer fee was required. Four of the twenty-four vessels each landed less than 200 pounds of spot prawns in 2000-2001 combined and were not among those sampled. Passage was secured on nine of the remaining 20 vessels for observations of bycatch (Table 5). A total of 86 spot prawn

trawl tows was observed on these nine vessels during the period September 26, 2000 to September 19, 2001 by Department observers. Observed vessels fished from the ports of Fort Bragg, San Francisco, Monterey, Morro Bay, and Ventura.

Average depth of the 86 observed tows ranged from approximately 75 to 155 fathoms (see below). Seventy-one percent of all observed tows were in 120 fm or greater and 38% of all observed tows were in 130 fm or greater. For vessels fishing from southern California (Ventura), all observed tows were in 110 fm or greater. With one exception, all observed tows in depths less than 100 fm were from vessels fishing out of the ports of Monterey, San Francisco, and Fort Bragg.

Summary of observed spot prawn tow depths

Ave. tow depth (fm)	Number of tows	Ave. tow depth (fm)	Number of tows
70-79	2	130-139	13
80-89	10	140-149	12
90-99	4	150-159	7
100-109	1	160-169	0
110-119	8	170-179	1
120-129	28		

Northern California

A total of 71 tows was observed from seven different vessels during eight trips. A summary of all fish species observed in the bycatch is presented in Tables 6 (rockfishes and lingcod) and 7 (other fishes). Included for each species or taxon are estimated total weight in all observed tows, estimated total weight per 1000 pounds of spot prawns caught, and mean weight per tow.

The top five finfish species observed in the bycatch, in decreasing frequency of occurrence, were Pacific hake (whiting), Dover sole, sablefish, English sole, and splitnose rockfish, comprising 53.9% of all fishes by weight. Twenty-eight species of rockfishes plus unspecified rockfishes were observed, comprising 28.1% by weight of all fishes. The ratio of total finfish bycatch to total spot prawn catch from all tows combined was 7.5 to 1. Among the nine trips observed, this ratio ranged from 2.5 to 1 to 20.9 to 1. The ratio of total rockfish bycatch to total spot prawn catch was 2.1 to 1. Among the nine trips observed, this ratio ranged from 0.4 to 1 to 5.0 to 1. The ratio of total bycatch, including invertebrates, to spot prawn catch was 8.8 to 1. Invertebrates were not always separated by general taxa and quantified by weight. From Monterey to Fort Bragg, the primary groups of invertebrates observed were urchins and various sea stars, with lesser amounts of pleurobranchs (sea slugs), and sea cucumbers. Organisms less frequently observed included, octopus, crabs, tunicates, sea anemones, squid, clams, and brachiopods. In the Morro Bay area, urchins were the dominant invertebrate group, with highly variable occurrences of squid, octopus, pink shrimp, ridgeback prawns, galatheid crabs, rock crabs, box crabs, king crabs, sea cucumbers, pleurobranchs, sponges, and anemones. The observed weight ratio of non-spot prawn invertebrates to spot prawns was 1.6 to 1. Invertebrates other than

crabs and octopus generally did not survive the tows.

Among the rockfishes, species frequently observed other than splitnose included shortbelly, sharpchin, stripetail, chilipepper, and greenstriped. Among those species of concern, lingcod were observed at the rate of 214.7 pounds per 1,000 pounds of spot prawns (most lingcod were in a condition that indicated survival was likely upon return to sea), bocaccio were observed at the rate of 58.2 pounds per 1,000 pounds of spot prawns, cowcod were observed at the rate of 15.0 pounds per 1,000 pounds of spot prawns, yelloweye rockfish were observed at the rate of 0.5 pounds per 1,000 pounds of spot prawns, and one canary rockfish (not in the sampled catch) was observed. It is estimated that the observed tows represented 2.5% of all trawl spot prawn landings north of Point Conception during the 12-month sampling period.

Expansions of observed catches by species from observed tows to that from all trawl tows in northern California for the period October 2000-September 2001 are provided, with 95% upper and lower bounds for the first stage expansions, in Tables 6 and 7. The between tow variability is so great for many of the less frequently-encountered species, in particular rockfishes, that the upper and lower bounds are often more than two orders of magnitude apart. Again, these are provided as general estimates of the bycatch only, and are influenced by many factors, including the experience of the vessel operator and the presence of an observer on board.

Estimates of total discards

Estimates of total discards in the spot prawn trawl fishery for the one-year period are provided for those species in which actual landings occurred in association with spot prawns (Table 8). In these cases the total annual landings for the period October 2000-September 2001 were subtracted from the expanded total bycatch estimates to obtain total discard estimates. In some cases, since market categories which contain multiple species are used to report landings, we could not determine total pounds landed by species. Thus there may be additional inaccuracies associated with the discard estimates for marketable species.

A high percentage of the estimated total bycatch of most species was discarded, with a few exceptions. Approximately 15% of the estimated total bycatch of chilipepper was landed, and approximately 46% of the estimated total bycatch of petrale sole was landed. In most cases the total reported landing weights are far less than our total estimated bycatch weights for a particular species. This would indicate that we are not underestimating the total bycatch in our expansions. The few exceptions to this (blackgill rockfish, rock sole, starry flounder) are likely due to the high variability associated with their infrequent occurrence.

Length frequency distributions

Length frequency histograms are provided for rockfish species in which at least 10 individuals were measured (Figures 1-14), based on port of landing. For 13 of those 16 species plus unspecified rockfish (exceptions were bocaccio, cowcod, widow, and bank) the majority of individuals were less than 250 mm (9.8 inches) total length. For those rockfishes in which average length of females at 50% sexual maturity was available (indicated by a dashed vertical line), most species (a notable exception was

shortbelly) showed a majority of individuals at lengths below this value.

Length frequency histograms for other species in which at least 10 individuals were measured also indicated a high percentage of relatively small fish.

Southern California

A total of 15 tows was observed from two different vessels. A summary of all fish species observed in the bycatch, with estimated total weight is presented in Tables 9 (rockfishes and lingcod) and 10 (other fishes). The top five finfish species observed in the bycatch, in decreasing frequency of occurrence, were Pacific sanddab, Pacific hake (whiting), slender sole, shortbelly rockfish, and Dover sole, comprising 83.1% of all fishes by weight. Fifteen species of rockfishes plus unspecified rockfishes were observed, comprising 8.8% by weight of all fishes. The ratio of total finfish bycatch to total spot prawn catch from all tows combined was 17.7 to 1. Among the four trips observed, this ratio ranged from 5.1 to 1 to 23.8 to 1. The ratio of total rockfish bycatch to total spot prawn catch was 1.5 to 1. Among the four trips observed, this ratio ranged from 0.6 to 1 to 5.4 to 1. The ratio of total bycatch, including invertebrates, to spot prawn catch was 20.6 to 1. Invertebrates were separated by general taxa and quantified by weight. Urchins and market squid comprised 46% and 39% by weight, respectively, of observed invertebrates. Pleurobranchs (sea slugs), pink shrimp, and king crab each comprised from 4% to 5%. Octopus, sea stars, and sea cucumbers were observed infrequently. The observed weight ratio of non-spot prawn invertebrates to spot prawns was 2.9 to 1. Invertebrates other than crabs and octopus generally did not survive the tows.

Among the rockfishes, species frequently observed other than shortbelly included stripetail, halfbanded, chilipepper, and greenstriped. Among those species of concern, lingcod were not observed, bocaccio were observed at the rate of 27 pounds per 1,000 pounds of spot prawns, and one cowcod, no canary, and no yelloweye rockfish were observed. It is estimated that the observed tows represented 1.0% of all trawl spot prawn landings south of Point Conception during the 12-month sampling period.

Expansions of observed catches by species from observed tows to that from all trawl tows in southern California for the period October 2000-September 2001 are provided, with 95% upper and lower bounds for the first stage expansions, in Tables 9 and 10. The between tow variability is so great for many of the less frequently-encountered species, in particular rockfishes, that the upper and lower bounds are often more than two orders of magnitude apart.

Estimates of total discards

Expanded estimates of discards are provided for those species in which actual landings occurred in association with spot prawns (Table 8). We calculated estimates of the amount of total discards in the fishery by subtracting the total landing weights associated with spot prawns for the October 2000-September 2001 period from the total bycatch estimates. This could not be done with complete accuracy as the market categories do not always correspond to species, but we used our knowledge of sampled market categories to assign species in some cases

A high percentage of the estimated total bycatch of most species was discarded, with the exception of rockfishes, which were observed relatively infrequently. In most cases the total reported landing weights are far less than our total estimated bycatch weights for a particular species. This would indicate that we are not underestimating the total bycatch in our expansions. The few exceptions to this (thornyheads, petrale sole, lingcod) are likely due to the high variability associated with their infrequent occurrence.

Length frequency distributions

Length frequency histograms are provided for rockfish species in which at least 10 individuals were measured (see Figures 15-21). For the four species plus unspecified rockfish shown, the majority of individuals were less than 250 mm (9.8 inches) total length. The average length of females at 50% sexual maturity is indicated by a dashed vertical line. Most shortbelly and halfbanded rockfishes measured were at lengths above this value, while most chilipepper and stripetail rockfish measured were at lengths below this value.

Occurrence of overfished rockfish species

The National Marine Fisheries Service (NMFS) has determined the following rockfish species to be overfished and require rebuilding: bocaccio, canary, cowcod, darkblotched, widow, and yelloweye. Bocaccio, cowcod, darkblotched, and widow rockfishes were observed in multiple tows, and yelloweye and canary each were observed in a single tow. The summary of their occurrence in observed tows (Table 11) includes extrapolations of numbers and weights from the tow sample to the entire tow. In all cases where only a single fish is reported, this represents the entire tow. In some cases for cowcod and bocaccio, the numbers are not extrapolated but indicate all fish that were selected from the tow and kept. In other cases, a combination of methods was used. For example, the occurrence of 9 cowcod in tow 65 represents the expansion of 1 small fish from a 1/8 sample plus one large fish which was selected from the tow by the crew and kept prior to the sample. In general, overfished species of rockfish were a small component of the total bycatch.

The total estimated bycatch of bocaccio in the spot prawn trawl fishery for the one-year period of observations was approximately 10,000 pounds. Total estimated directed catch of bocaccio from recreational and commercial fishing in California combined was approximately 348,000 pounds in 2000 and 152,000 pounds in 2001. These figures are derived from adding Department landing statistics for the commercial fishery to Pacific States Marine Fisheries Commission estimates of total recreational catch. The latter is reported in numbers but an average length of the observed catch is also reported. We converted this average length to average weight using a known length-weight relationship. Although the estimated bycatch of bocaccio in the spot prawn trawl fishery is less than 10 percent of the total directed catch of bocaccio in 2001, the total allowable catch for 2003 set by the Council for all fisheries will likely be approximately 12,000 pounds and thus the estimated bycatch is much more significant.

A bycatch estimate from the spot prawn trawl fishery has not been used in previous allocations of the catch of bocaccio by the Council.

Occurrence of lingcod and Pacific hake

Lingcod is considered overfished by the NMFS and Pacific hake (whiting) is in the process of being declared overfished. While Pacific hake ranked number one and two in frequency of occurrence of finfish bycatch species in northern and southern California, respectively, the estimated total catches (approximately 268,000 pounds and 210,000 pounds, respectively) are relatively insignificant compared with the approximately 11 million pounds (5,500 tons) landed in 2000 in California. Lingcod frequently were observed but were often in a condition that indicated a probable high rate of survival when returned to the water; the crew usually returned lingcod to the water very soon after the catch was placed on the deck.

The total estimated bycatch of lingcod in the spot prawn trawl fishery for the one-year period of observations was approximately 33,000 pounds. Total estimated directed catch of lingcod in California from recreational and commercial fishing combined was approximately 589,000 pounds in 2000 and 517,000 pounds in 2001. These figures are derived from adding Department landing statistics for the commercial fishery to Pacific States Marine Fisheries Commission estimates of total recreational catch. The latter is reported in numbers but an average length of the observed catch is also reported. We converted this average length to average weight using a known length-weight relationship. The estimated bycatch of lingcod in the spot prawn trawl fishery is less than 10 percent of the estimated total directed take. A bycatch estimate from the spot prawn trawl fishery has not been used in previous allocations of the catch of lingcod by the Council.

Analysis of possible factors affecting bycatch rate

A series of individual regressions was conducted in an attempt to determine if one or more variables associated with each trawl tow specifically contribute to relatively higher catches of bycatch of rockfishes. In each analysis the ratio of total estimated weight of all rockfishes to total weight of spot prawns in a particular tow was regressed against each of the following variables: 1) type of net rigging (single or double); 2) diameter of largest roller gear; 3) mesh size in body of net; 4) mesh size in cod end; 5) footrope length; 6) presence or absence of fish excluder; 7) tow duration; 8) tow speed; 9) average depth of tow, and 10) latitude of tow. Although no relationships were statistically significant (the highest R-squared value was only 0.56 for mesh size in body of net, the slope of the curves did indicate some relationships between rockfish bycatch ratio and tow variables. The following relative factors would tend to produce lower ratios of rockfish to spot prawns: decreased tow speed, decreased tow time, and increased body mesh size.

Comparison of trawl fishing effort and sampling effort

In the year 2000 (2001 logs are not yet available) trawl fishermen reported landings on logs submitted from 96 different blocks (see Appendix 5 for DFG block charts). Observations of bycatch were made from 24 different blocks during the 2000-2001 period. However, since a fisherman may fish in more than one block on a particular trip but is only required to report one block number on his trawl logs, a

better statistic for comparison of the representation of observed effort with actual fishing effort during this study would be to consider adjacent block numbers (the four blocks which are immediately either to the north, south, east or west) as well. In so doing, in 2000, 26.9% of all landings reported on trawl logs were from reported block numbers which were not the same as or not adjacent to blocks in which bycatch was observed. Approximately half of this amount originated from blocks south of the Santa Barbara Channel Islands, in which no observations were obtained. The conclusion can be drawn that the observations of trawl bycatch were fairly representative of the areas in which spot prawn trawling traditionally occurs, with the exception of the area south of the Santa Barbara Channel Islands.

Observed vessels as representative of the entire fleet

The nine trawl vessels on which bycatch observations were obtained accounted for 15% of all spot prawn trawl landings in months during which sampling occurred in 2000 and 61% of all spot prawn trawl landings in months during which sampling occurred in 2001. Although 38 and 40 trawl vessels, respectively, each landed spot prawns in 2000 and 2001, only 22 and 20 vessels (58 and 50%), respectively, each landed at least 1,000 pounds of spot prawns in 2000 and 2001. Observations were obtained on eight and seven of those latter vessels, respectively (36 and 35%). The sampled fleet had an above average catch of spot prawns compared to the rest of the fleet, but the degree to which the bycatch from the sampled vessels is representative of the entire fleet cannot be determined from the available data.

Previous Studies

Northern California

In late 1981 the Department chartered a commercial spot prawn trawl vessel and made a series of nine tows off Point Sal (San Luis Obispo County). A total of 855 pounds of spot prawns was taken. The weight ratio of all fishes to spot prawns was 20.2 to 1. The dominant non-rockfish species were Pacific hake, slender sole, rex sole, sablefish, and plainfin midshipman. The weight ratio of all rockfishes to spot prawns was 7.4 to 1, with the overwhelming majority being shortbelly and stripetail rockfishes. Approximately 270 pounds of bocaccio and 15 pounds of cowcod (one fish) were taken.

In the spring of 1982 the Department observed six spot prawn trawl tows off Point Sal (San Luis Obispo County) using experimental gear, including at least two tows using a 4.5-inch mesh in the cod-end (larger than traditional mesh size). The total weight of all fishes was recorded but not by species. The weight ratio of all fishes to spot prawns was 4.4 to 1, near the low end of the observed range in 2000-01. The dominant species observed included plainfin midshipman, rex sole, slender sole, Dover sole, shortbelly rockfish, and stripetail rockfish. Some marketable bocaccio were observed as well as single-tow occurrences of canary rockfish and cowcod.

In March 1999 six trawl tows targeting spot prawns were observed by Department biologists in the Monterey area. The net contained two fisheye type excluders. Observed ratio of weight of fish to weight of spot prawns was 7.4 to 1, fairly

similar to the average ratio observed for all northern California trawl tows observed in 2000-01. Primary non-rockfish fish species observed were Dover sole, rex sole, slender sole, Pacific hake and skates. Observed ratio of rockfish weight to spot prawn weight was 0.6 to 1, within the range of observations in 2000-01 but near the low end. The primary rockfish species were splitnose and aurora.

Southern California

In June-July 1998 the National Marine Fisheries Service conducted some experimental studies in the Santa Barbara Channel, Tanner Bank, and off San Nicolas Island with a chartered commercial prawn trawler. The vessel was double rigged to fish two nets side by side, either with or without a fisheye-type excluder or with or without a Nordmore grid excluder (solid series of bars within a frame). There appeared to be a much greater variability in the ratio of total fish bycatch to spot prawns due to location than due to the presence or absence of each of the excluders.

For tows with and without the Nordmore grid, which were conducted off San Nicolas Island and at Tanner Bank, weight ratios of total fish to spot prawns averaged 2.1 to 1 without the grid and 1.4 to 1 with the grid. Pacific hake, various flatfishes, and rattfish were the dominant non-rockfish species. The ratios of rockfishes to spot prawns averaged 1.3 to 1 without the grid and 0.7 to 1 with the grid. The primary rockfish species included shortbelly, splitnose, stripetail, and cowcod. Of note was the absence of cowcod in tows with the grid, whereas in tows without the grid they were the third most abundant rockfish.

For tows with and without the fisheye excluder, which were conducted in the Santa Barbara Channel, the weight ratios of total fish to spot prawns averaged 8.0 to 1 without the excluder and 6.6 to 1 with the excluder. Argentines, Pacific hake, various flatfishes, and sculpins were the dominant non-rockfish species. The ratios of rockfishes to spot prawns averaged 1.6 to 1 without the grid and 1.2 to 1 with the grid. The primary rockfish species in the catch included shortbelly, splitnose, and stripetail. No cowcod were observed.

Washington

In 1999 and 2000 the Washington Department of Fish and Wildlife made observations of the bycatch from two trawl trips targeting spot prawns. The observed ratios of weight of bycatch to weight of spot prawns, which the vessel operators indicated were typical, were 1.1 and 0.7 for rockfishes, 3.5 and 2.7 for all fishes, and 7.1 and 3.5 for all bycatch.

Southern California bycatch in the ridgeback prawn trawl fishery

Ten research cruises on Department vessels were conducted in the Santa Barbara Channel from 1982 to 1989 in part to determine numbers of non-target species associated with ridgeback and spot prawn trawl tows. In all cases ridgeback prawns were numerically dominant (ca. 43,980) compared with spot prawns (ca. 1,450) due to the depth of tows, and weights were not determined for any species. The numerical ratio of all fish to ridgeback and spot prawns was 3.9 to 1 and ranged from 0.2 to 1 to 16.6 to 1 for a particular cruise. There was considerable variability in the

predominant fish species, but white croaker, midshipman sp., queenfish, pink surfperch, and Dover sole were encountered frequently among non-rockfishes. The numerical ratio of all rockfish to ridgeback and spot prawns was 2.1 to 1 and ranged from 0.01 to 1 to 11.0 to 1 for a particular cruise. Shortbelly rockfish were by far the most numerically abundant species, accounting for at least 70% of all rockfishes (in some cases rockfish were not identified to species), followed by bocaccio, chilipepper, and stripetail. Approximately 98% of the more than 7,800 bocaccio were observed in 1985 and undoubtedly reflected the strong 1983 year class. A total of 38 cowcod was identified from all tows.

In May 1999 Department staff observed four trawl tows targeting ridgeback prawns in the Santa Barbara Channel. Total weights of fish in the bycatch were underestimated due to the practice of "unzipping" a portion of the net before it was brought on board, primarily to release Pacific hake, which were quickly consumed by birds. It was noted that the bycatch of Pacific hake is seasonal and can be significant. Four tows yielded 735 pounds of ridgeback prawns and 412 pounds of fish. A minimum of 100 additional pounds of hake was released from the tow. Thus the minimum ratio of fish to ridgeback prawns was 0.7 to 1, which is low compared to our 2000-01 spot prawn study.

Methods, Results, and Previous Studies- Trap Fishery Observations

Sampling procedures

Samplers were provided with a list of those trap vessels in their port area that had paid the observer fee. Samplers attempted to contact each vessel on the list until a trip was secured, then repeated the process for any subsequent trips. In general vessel owners were cooperative when passage was requested.

The sampling unit was the trap string, which consisted of generally from 10 to 25 traps attached by a line. The observer's goal was to obtain an aggregate weight of all invertebrates from each string observed, and aggregate weights for each species of fish observed in a string. If all traps in a string could not be sampled, sample weights of the bycatch were multiplied by the appropriate factor to obtain estimated total weights of bycatch organisms by string. Individual lengths of fishes were obtained. Samplers noted the condition of each bycatch species relative to its ability to survive if returned to sea. The vessel operator provided the observer with an estimated total weight of spot prawns from each string. Examples of many species from the bycatch were brought back for subsequent verification of species identity. Some organisms for which species identification could not be confirmed are reported as a higher taxon.

It should be noted that, although estimated total weights by species of bycatch are reported to the nearest 0.1 pounds, the precision of these estimated weights was compromised by the difficulty of using a hanging balance on a moving vessel.

Expansion of all estimated weights of bycatch to estimated total bycatch weight

in fishery

The expansions of total estimated weights in observed strings to total annual weights were done in a two-stage approach. In the first stage, the estimated bycatch weights from observed strings were expanded only by the proportion of spot prawn landings these estimates represented for the vessels observed. These estimates are reported in column 7 of Tables 12 and 13. In the second stage, estimated bycatch weights were expanded by the ratio of all spot prawn landings by all vessels in the fleet during that one-year period to those landings from the observed vessels. These estimates are reported in the last column of Tables 12 and 13. The 95% confidence bounds were used in the first stage expansion only, since they reflect the variability among observed strings. In the final expansion only single point estimates are provided for each species. The 95% confidence bounds are also estimates because a formal, randomized sampling design was not possible. The confidence intervals for those species encountered less frequently may be asymmetrical, because in cases when the lower confidence bound was less than the total sampled weight, the sampled weight was used as the lower bound. This is a reflection of the relatively high variability in the catch which was characteristic of many of the bycatch species.

Summaries of bycatch species by estimated total weight are provided for northern and southern California, based on whether the port of landing was north or south of Point Conception. Unlike the trawl fishery, there were no vessels landing their catch at ports north of Point Conception that fished south of Point Conception. The expansions are based on the total spot prawn trap landings for the one-year period September 1, 2000 to August 31, 2001, which roughly corresponds to the period during which observations were obtained (notable exception was one trip observed in December 2001). Total spot prawn trap landings during this period were 23,500 pounds for all ports north of Pt. Conception and 134,400 pounds for all ports south of Pt. Conception. These expansions are provided as general estimates of the total bycatch.

Results

A total of 27 trap vessels paid the required observer fee, and 23 of these landed spot prawns during the period in which the observer fee was required. Passage was secured on 16 of these 23 vessels for observations of bycatch. An additional vessel which had not paid the fee was sampled after the fee requirement period had expired. A total of 262 spot prawn trap strings was observed during the study. Observed vessels fished out of the ports of Monterey, Morro Bay, Channel Islands Harbor, Ventura, Terminal Island, Newport Beach, Dana Point, Oceanside, and San Diego.

Northern California

A total of 88 strings was observed from four different vessels. A summary of all fish species observed in the bycatch, with estimated total weight, is presented in Table 12. The top five finfish species observed in the bycatch, in decreasing frequency of occurrence, were sablefish, rosethorn rockfish, greenblotched rockfish group, spotted cusk eel, and filetail cat shark, comprising 77.7% of all fishes by weight. The greenblotched rockfish group included three species of rockfish (greenblotched,

greenspotted, and pink, and is lumped together because field identification to species is problematic- R.N. Lea, pers. commun.) Seventeen species of rockfishes were observed, comprising 25.5% by weight of all fishes. The ratio of total finfish bycatch to total spot prawn catch from all strings combined was 0.15 to 1. The ratio of total rockfish bycatch to total spot prawn catch was 0.04 to 1. The ratio of total bycatch, including invertebrates, to spot prawn catch was 1.01 to 1. All invertebrates arrived at the surface alive. Although no attempt was made to quantify weights of invertebrates by species or higher taxon, frequency of occurrence was recorded by general taxon. Sea stars (comprised of at least four species) were the most frequently observed invertebrate, occurring in approximately 80% of all strings. Other commonly observed invertebrates included red rock crab, *Cancer productus*, a large pleurobranch (sea slug), galatheid crabs, and urchins. These were observed in approximately 25 to 50% of all strings. Octopus, box crabs, and hermit crabs were observed in 8 to 16% of all strings, and less frequently observed invertebrates included decorator crabs, brittle stars, feather stars, sea cucumbers, one Dungeness crab, and one brown rock crab. The observed weight ratio of non-spot prawn invertebrates to spot prawns was 0.9 to 1.

Frequency of occurrence of overfished species

Among those species of concern considered overfished by the NMFS, lingcod were observed at the rate of 4.4 pounds per 1,000 pounds of spot prawns (most lingcod were in a condition that indicated survival was likely upon return to sea), yelloweye rockfish were observed at the rate of 0.6 pounds per 1,000 pounds of spot prawns, cowcod were observed at the rate of 0.2 pounds per 1,000 pounds of spot prawns, and no Pacific hake or bocaccio, canary, darkblotched, and widow rockfishes were observed. A summary of catch locations of overfished rockfish species is presented in Table 14. It is estimated that landings from the observed strings represented approximately 4.6% of all trap spot prawn landings north of Point Conception during the September 2000 to August 2001 period.

Length frequency distributions

Length frequency histograms are provided for species in which at least 10 individuals were measured (see Figures 22-24). For 7 of those 9 species (exceptions were sablefish and spotted cusk-eel) the majority of individuals were less than 250 mm (9.8 inches) total length.

Southern California

A total of 174 strings was observed from 13 different vessels. A summary of all fish species observed in the bycatch, with estimated total weight, is presented in Table 13. The top five finfish species observed in the bycatch, in decreasing frequency of occurrence, were lingcod, greenblotched rockfish group, threadfin sculpin, sablefish, and swell shark, comprising 66.4% of all fishes by weight. Twenty-two species of rockfishes were observed, comprising 32.5% by weight of all fishes. The ratio of total finfish bycatch to total spot prawn catch from all strings combined was 0.22 to 1. The ratio of total rockfish bycatch to total spot prawn catch was 0.07 to 1. The ratio of total

bycatch, including invertebrates, to spot prawn catch was 2.02 to 1. All invertebrates arrived at the surface alive. In most cases, invertebrates were weighed by taxon from each string. Approximately 64% by weight of all observed invertebrates were urchins, primarily the fragile urchin. Decapod crabs (primarily box, king, and galatheid crabs, with some red rock crabs) comprised approximately 12% by weight. A large pleurobranch (sea slug) and octopus comprised 12% and 11%, respectively, by weight of the sampled catch. In contrast to northern California, sea stars were infrequently observed. The higher proportion of sea urchins in southern California traps is undoubtedly linked to longer soak times, typically 3-4 days. The observed weight ratio of non-spot prawn invertebrates to spot prawns was 1.8 to 1.

Frequency of occurrence of overfished species

Among those species considered to be overfished, lingcod were observed at the rate of 37 pounds per 1,000 pounds of spot prawns (most lingcod were in a condition that indicated survival was likely upon return to sea), bocaccio were observed at the rate of 4 pounds per 1,000 pounds of spot prawns, cowcod were observed at the rate of 3 pounds per 1,000 pounds of spot prawns, and no Pacific hake or yelloweye, canary, darkblotched, and widow rockfishes were observed. A summary of catch locations of overfished rockfish species is presented in Table 14. It is estimated that landings from the observed strings represented approximately 1.5% of all trap spot prawn landings south of Point Conception during the September 2000 to August 2001 period.

Length frequency distributions

Length frequency histograms are provided for species in which at least 10 individuals were measured (see Figures 25-30). For 7 of those 16 species (exceptions were chilipepper, greenstriped rockfish, lingcod, red brotula, spotted cusk eel, and sablefish) the majority of individuals were less than 250 mm (9.8 inches) total length.

Comparison of trap fishing effort and sampling effort

In the years 2000 and 2001 trap fishermen reported landings on logs submitted from 50 and 49 different blocks, respectively (see Appendix 5 for DFG block charts).

Observations of bycatch were made from 26 different blocks. However, since a fisherman may fish in more than one block on a particular trip but is only required to report one block number on his trap logs, a better statistic for comparison of the representation of observed effort with actual fishing effort during this study would be to consider adjacent block numbers (the four blocks which are immediately either to the north, south, east or west) as well. In so doing, in 2000 only 12.5% of all landings reported on trap logs were from reported block numbers which were not the same as or not adjacent to blocks in which bycatch was observed. Of these 12.5% of reported landings, at least 8.9% were reported from an incorrect block number (859 which is San Diego Bay). Thus it is more likely than not that this fishing effort was from blocks similar to or adjacent to those in which bycatch observations occurred. In 2001 only 3.2% of all landings reported on trap logs were from reported block numbers which were not the same as or not adjacent to blocks in which bycatch was observed. Of these 3.2% of reported landings, at least 1.3% were reported from an incorrect block number

(859 which is San Diego Bay). Again, it is more likely than not that this fishing effort was from blocks similar to or adjacent to those in which bycatch observations occurred. The conclusion can be drawn that the observations of trap bycatch were highly representative of the areas in which spot prawn trapping traditionally occurs.

Observed vessels as representative of the entire fleet

The 17 trap vessels on which bycatch observations were obtained accounted for 81% of all spot prawn trap landings in during the September 2000-August 2001 period. Although 36 and 43 trap vessels, respectively, each landed spot prawns in 2000 and 2001, only 21 and 23 vessels, respectively, each landed at least 1,000 pounds of spot prawns in 2000 and 2001. Observations were obtained on 13 and 14 of those vessels, respectively (62 and 61%). The conclusion can be drawn that the observations of bycatch were fairly representative of the entire fleet.

Previous Studies

Northern California

In 1996-97 Dr. Robert Lea, the Department's marine fish taxonomist, identified 31 species of fish from 27 commercial spot prawn trap trips observed from Carmel Canyon, Monterey County. This was related to a research study of the spot prawn trap fishery by a Moss Landing Marine Laboratories student. No attempt was made to quantify all fish in the bycatch by weight or numbers. Fifteen non-rockfishes were identified; the most frequently observed species included threadfin sculpin, spotted cusk eel, dusky sculpin, blacktail snailfish, and sablefish. Sixteen rockfishes were identified; the most frequently observed species included rosethorn, blackgill, greenspotted, and redbanded. A total of four cowcod, one bocaccio, and two yelloweye rockfish were identified.

Southern California

In 1999 the Department conducted a study off Santa Catalina Island, with the primary goal of determining differences in catch composition between wire mesh and plastic, Fathom Plus spot prawn traps. All spot prawns and bycatch species were enumerated, but weights were not recorded. Total catch included 5,291 spot prawns, 219 fish, and numerous invertebrates. The numerical ratio of all fish to spot prawns was 0.04 to 1. Only 13 non-rockfishes were observed, including combfish sp, red brotula, Dover sole, and shortspine thornyheads. The numerical ratio of all rockfish to spot prawns was 0.04 to 1. Stripetail rockfish were by far the most numerically abundant species, accounting for at least 64% of all rockfishes (in some cases rockfish were not identified to species). Other frequently-observed rockfishes included greenspotted and greenblotched.

In 2000 the Department conducted another study, in the canyon areas of Santa Monica Bay, with a similar goal and methodology. The total catch included 94 spot prawns, 60 fish, and numerous invertebrates. The numerical ratio of all fish to spot prawns was 0.64 to 1. Only 9 non-rockfishes were observed, including shortspine combfish, one Dover sole, one lingcod, one Pacific sanddab, and one eelpout sp.. The numerical ratio of all rockfish to spot prawns was 0.54 to 1. Greenblotched rockfish

were by far the most numerically abundant species, accounting for 84% of all rockfishes. The other observed rockfishes included stripetail, splitnose, and cowcod (one occurrence).

Conclusions

Trawl fishery

1. Based on the location of ports of landing, bycatch ratio, by weight, of all finfishes to spot prawns averaged 7.5 to 1 in northern California and 17.7 to 1 in southern California. Bycatch ratio, by weight, of all rockfishes to spot prawns averaged 2.1 to 1 in northern California and 1.5 to 1 in southern California. The ratio of total bycatch, including invertebrates, to spot prawn catch was 8.8 to 1 in northern California and 20.6 to 1 in southern California.
2. Extreme variability was noted in the relative abundance of bycatch species.
3. The majority of observed bycatch species in trawl tows were of non-marketable sizes or the species themselves were not marketable. With a few exceptions (chilipepper and petrale sole in northern California, rockfishes in southern California), the percentage of the total estimated bycatch weight of each finfish species which was landed was very low.
4. The bycatch rates of overfished finfish species were relatively low with the exception of Pacific hake and possibly lingcod (although the latter has a high survival rate), but the implications nevertheless are potentially significant. For example, the estimated total bycatch of bocaccio was approximately 5 tons, which is close to the total amount considered by the Council as a recommended catch allocation for all California fisheries in 2003.
5. These results are from observations on vessels already complying with regulations requiring the use of a functional finfish excluder or a double-walled codend with mesh size at least 3 inches.
6. Data from the relatively few historical studies indicate that the results from this study are comparable in terms of relative amounts of bycatch. That is, the bycatch of non-target finfish species to spot prawn was greater than 4-to-1 by weight.

Trap fishery

1. Based on the location of ports of landing, bycatch ratio by weight of all finfishes to spot prawns averaged 0.15 to 1 in northern California and 0.22 to 1 in southern California. Bycatch ratio, by weight, of all rockfishes to spot prawns averaged 0.04 to 1 in northern California and 0.07 to 1 in southern California. The ratio of total bycatch, including invertebrates, to spot prawn catch was 1.0 to 1 in northern California and 2.0 to 1 in southern California.
2. Substantial variability was noted in the relative abundance of bycatch species, but in general the variability was lower than that for trawl bycatch species.
3. In northern California, the relative amount of bycatch for all fishes and rockfishes was 50 and 52 times greater, respectively, in the trawl fishery compared with the trap fishery. In southern California, the relative amount of bycatch for all fishes and rockfishes was 80 and 21 times greater, respectively, in the trawl fishery compared with the trap fishery.

4. The majority of observed bycatch species in traps were of non-marketable sizes or the species themselves were not marketable. Present regulations prohibit spot prawn trap fishermen from landing species caught in spot prawn traps when spot prawns are landed.

5. With the exception of rockfishes, the majority of observed individuals of bycatch species arrived at the surface alive and could be returned with a probable high degree of survival. Other exceptions were occasional fish, including lingcod and sablefish, which were caught in traps and preyed upon by amphipods before they could be released.

6. The bycatch rates of overfished species were very low with the possible exception of lingcod, and most lingcod could be returned with a probable high degree of survival, provided amphipods did not prey upon them.

Management Considerations

Due to the extremely high variability in bycatch ratios of finfish to spot prawns among areas, vessels, and gear types, there is no simple solution to determine acceptable methods to reduce bycatch in the spot prawn trawl fishery. It is clear from the results of these observations that, even though the levels of bycatch of overfished rockfish species in the spot prawn trawl fishery are relatively low compared with other finfish species in the bycatch, they are not insignificant. The potential management alternatives listed below are driven by two primary factors: 1) there is a need to reduce bycatch of those federally managed rockfishes which are considered to be overfished; and require rebuilding; and 2) the impacts of bycatch from the spot prawn trawl fishery are not being accounted for in the management of groundfish species

Option 1. (Trawl Permit Moratorium) Immediately establish a moratorium on the issuance of new spot prawn trawl vessel permits.

This would prevent an increase in trawl fishing effort from vessels which have not participated in the fishery before, while other management alternatives are considered. As of 2003 the state of Washington will prohibit the use of trawls to take spot prawns (they are converting to a trap-only fishery and have three trawl vessels fishing spot prawns). Oregon Department of Fish and Wildlife (ODFW) is planning to recommend a trap-only spot prawn fishery with a one-year conversion period to traps. ODFW issues six spot prawn trawl vessel permits each year. While four trawl vessels that have spot prawn trawl permits in Washington and/or Oregon fish presently or have fished previously in California, this would also prevent additional fishing effort from the two other vessels with Oregon trawl permits that have not fished in California.

Option 2a. (Observer Program) Require that all spot prawn trawl vessels cooperate with the federal observer program as a condition of their permit; and/or

Option 2b. (Observer Program) Implement a mandatory state observer program for all spot prawn trawl vessels and require cooperation as a condition of their permit.

An ongoing observer program would allow the Council and the Department to better quantify bycatch in this fishery. The observer program would allow real time management if overfished species were suddenly encountered in certain areas in large numbers. Analysis of observer data could lead to development of methods and/or regulations to reduce bycatch. Federal funds are now available for an observer program for groundfish trawlers and could be used to include spot prawn trawlers.

If federal funding cannot be obtained, the cost of an observer program would have to be borne by the trawlers or the Department. At present funding levels the Department does not have the resources to conduct such a program.

Option 3. (Restricted Access) Proceed with the development of a restricted access spot prawn trawl fishery program, including the provision of no transferability of restricted access trawl permits, and the establishment of a capacity goal for the trawl fishery (separate from the trap fishery, which has its own).

This will prevent an increase in fishing effort from new vessels and, presumably, prevent an increase in the existing level of bycatch. This could eliminate some vessels from the trawl fishery which do not meet whatever minimum landing requirements are adopted for qualifying in the restricted access program. This will require additional resources from the Department to develop and implement a restricted access program.

Option 4a. (Trawl Prohibition with Trap Conversion) Prohibit spot prawn trawling and convert all spot prawn restricted access trawl permits to restricted access trap permits.

This will significantly reduce the total amount of bycatch associated with the spot prawn fishery and will reduce negative impacts to spot prawn habitats from the use of roller gear. However, this could cause significant crowding in the existing trapping grounds and negatively impact the livelihoods of the existing spot prawn trap fishermen. It cannot be assumed that if trawling for spot prawns is eliminated, the trawling grounds would then become trapping grounds. Other trawlers in the groundfish fishery may continue to operate and thus cause potential conflicts if traps were set in these areas.

A potentially mitigating factor is the recent (2000) establishment of the Cowcod Conservation Areas. This large area in southern California, primarily in federal waters, is now closed to spot prawn and other types of trawling but is open for spot prawn trapping. This could provide some new trapping grounds, although the area is farther from port than most traditional trapping grounds.

A prohibition on spot prawn trawling could cause significant negative economic impacts to those trawl vessels not able to convert to trap fishing. The Department has some information related to the versatility of spot prawn trawl vessels. From 1997 to 2001, 45 vessels landed at least 1,000 pounds of spot prawns using trawl gear in at least one of those years. Based on landing receipts received by the Department, 16 of these vessels also had landings, not necessarily for spot prawns, using traps. Of these 16 vessels, 10 landed at least 1,000 pounds of spot prawns using the trap gear code during the 5-year period. Among the same 45 vessels, 16 had landings (species other than spot prawns) using the hook-and-line gear code, 5 had landings using the gill net gear code, and 2 had landings using the roundhaul gear code.

Summary of 45 spot prawn trawl vessels reporting other gear codes used on landing receipts

Trap (T)	Hook-and-line (HL)	T & HL	HL & Gillnet (GN)	HL & Roundhaul (RH)
10	7	3	2	1
T, HL, & GN		T, HL, GN, & RH		No other gear
2		1		16

In addition, 11 of the above 45 vessels currently possess federal limited entry groundfish permits.

A conversion of trawl permits to trap permits also would necessitate a revision of the spot prawn trap fishery regulations related to the capacity goal, which now stands at 17 Tier 1 restricted access permits.

Option 4b. (Trawl Prohibition) Prohibit spot prawn trawling.

This option is favored by some environmental organizations and would effectively eliminate bycatch of federally-managed groundfish as well as all other species. It would also severely impact the livelihoods of approximately 40 trawl vessel owners who have depended on this method of fishing for a significant portion of their income.

Option 5. (Bycatch Reduction and Requirement of Experimental Gear Permit) Convene a bycatch reduction committee, including several of the trawlers who demonstrated the lowest bycatch ratios from 2000-01 observations, to work on developing management recommendations to reduce bycatch in this fishery. Provide for Experimental Gear Permits to allow some spot prawn trawl vessels to continue to fish, but with rigid grid excluders. Require an industry-funded observer to be on-board during these deployments. If the vessel is double-rigged (i.e. tows two nets simultaneously), require one of the nets to have a rigid grid excluder. This would allow some fishing to continue inside 150 fathoms south of Point Reyes or 250 fathoms north of Point Reyes.

Option 6. (Buyout) Establish a fishery buyout program for spot prawn trawl vessels.

This could mitigate the substantial negative economic impact for current trawl vessel owners if other management measures were adopted to phase out the trawl fishery. This could serve as an incentive to leave the spot prawn trawl fishery and thus reduce total bycatch, provided there is not a compensatory increase in fishing effort by those vessels remaining in the fishery. Only vessels that qualify for permits under a restricted access program should be considered under this buyout option. However, it is not clear where sufficient funding for such a program would be obtained.

Option 7. (Closed Areas) Establish additional closed areas for spot prawn trawling where bycatch of overfished species is relatively high.

This could afford some protection to species such as cowcod and bocaccio if particular areas were identified with higher concentrations. For example, more than half of the estimated total weight in the sampled catch of 56 pounds of cowcod was taken in Fish and Game Block 671, southwest of Pt. Conception. However, a closure in this area could shift effort to other areas that were not sampled and that may have even higher concentrations of overfished species. This could also concentrate fishing effort into a smaller area and potentially cause relatively more impact in the smaller area.

Option 8 (Depth Restriction) Establish a minimum depth restriction of 150 fathoms south of Point Reyes or 250 fathoms north of Point Reyes for spot prawn trawling, except for vessels possessing an Experimental Gear Permit. Require a vessel monitoring system (VMS) for vessels without an Experimental Gear Permit to insure compliance with this regulation.

This would achieve consistency with a recent recommendation from the Council to prohibit trawling for groundfish species in depths less than 150 fm, but would allow for some experimental fishing designed to reduce finfish bycatch, and in particular bocaccio bycatch. This would likely reduce the bycatch of some of the rockfish species defined as "shelf" rockfish by the Council. Depth of tows may significantly impact bycatch rates for many species of concern including cowcod, canary, yelloweye, darkblotched and bocaccio. All but one of the observations of bocaccio, cowcod, canary, and yelloweye occurred in tows deployed in waters less than 150 fm in average depth. In the case of darkblotched rockfish, 20 of 21 observations occurred in depths less than 150 fm. Widow rockfish, however, occurred fairly uniformly at all tow depths

Because 91% of observed tows occurred in depths less than 150 fm, this would significantly impact those trawl vessels without Experimental Gear Permits and those vessels not able to work in the deeper part of the range of spot prawns.

Option 9. (Seasonal Closure) Increase closed season for spot prawn trawling from 3 months to 6 months.

This would provide more protection to the spot prawn resource in general and reduce overall bycatch unless a compensatory increase in fishing effort occurred in the shortened open season. This could cause a significant negative economic impact to trawlers and the markets that purchase their spot prawns.

Option 10. (Roller Gear Restrictions) Prohibit the use of large (greater than 8-inch diameter) roller gear.

This would effectively eliminate fishing in higher-relief rocky spot prawn habitat and reduce potential habitat damage in these areas. While there is no direct evidence of habitat damage from trawling for spot prawns, it is well known that trawlers return to the same areas year after year and thus some form of habitat alteration is likely. A maximum roller gear diameter would in effect establish "ad hoc" refuges unless trapping occurred in these areas in place of trawling. Trawlers may continue to fish these areas with smaller roller gear although at an increased risk of damaging their nets. There continues to be controversy about the relative amounts of bycatch associated with large and small roller gear. If nets with large roller gear have

relatively less bycatch than those with small roller gear, prohibiting its use could increase the relative amount of bycatch per tow in the trawl fishery.

Option 11. (Landing Requirements) Require all spot prawn trawl vessels to land all bycatch. Require the installation and operation of deck video cameras.

This would allow managers to assess the total amount of bycatch in this fishery and improve methods of allocating groundfish resources.

This would impose significant burdens on fishermen, processors, and biologists to retain, unload, weigh, and document the total bycatch. A change in regulations relative to what may be retained would be required. It would be difficult to enforce without 100% observer coverage and thus would not be a good substitute for an observer program. It would require additional trips to and from port by trawl vessels. This would likely cause significant additions to municipal landfills and result in significant wastage of marine resources.

The installation and operation of a video camera would allow biologists to document total bycatch after the fact but relatively soon after, depending on staff availability. This would impose significant burdens on fishermen and biologists to document the total bycatch. This would be problematic for verifying identification of some species, particularly rockfishes, which are difficult to distinguish even on sight.

Option 12. (Groundfish FMP Amendments) Include discard estimates of overfished species in PFMC management plans.

At present there are no estimates for mortality of federally-managed groundfish species from spot prawn trawl or trap fishing. This information would improve the ability of the Council to allocate and manage groundfish stocks, but would require a dedicated observer program. A summary of estimated mortality rates of overfished groundfish species is provided in Table 15, based on the ratio of pounds per fish species to pounds of spot prawns in observed trawl tows and trap strings.

Option 13. (No Additional Restrictions to the Trap Fishery)

Based on the results of the observer program, no additional restrictions are needed for the trap fishery. Other than occasional monitoring of the bycatch if funds and personnel are available, no further action is recommended at this time with regard to the spot prawn trap fishery bycatch issue. Levels of bycatch are significantly less than those of the trawl fishery.

Option 14. (Capacity Goal Re-evaluation) Re-evaluate the capacity goal for the spot prawn trap fishery.

This would be necessary if spot prawn trawling was phased out and it is determined that it is feasible to convert trawl permits to trap permits.

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Table 1. Summary of annual spot prawn trawl landings (in pounds) in California since 1980 (northern California consists of the ports of Monterey northward)

Year	Northern Calif.		Southern Calif.		Statewide		
	Pounds	Total boats	Pounds	Total boats	Total pounds	Unique boats*	Pounds per trip
1980	-	-	204,000	51	204,000	51	not avail.
1981	-	-	358,500	49	358,500	49	not avail.
1982	-	-	281,100	49	281,100	49	not avail.
1983	-	-	98,300	41	98,300	41	not avail.
1984	-	-	48,300	34	48,300	34	310
1985	900	1	45,600	26	46,500	27	327
1986	2,200	2	32,600	26	34,800	28	235
1987	-	-	51,300	27	51,300	27	295
1988	1,000	2	67,800	24	68,800	26	422
1989	-	-	56,000	22	56,000	22	364
1990	-	-	51,400	19	51,400	19	411
1991	-	-	50,000	23	50,000	23	355
1992	1,800	1	76,900	17	78,700	18	460
1993	11,000	8	102,300	23	113,300	29	603
1994	50,400	15	209,800	35	260,200	49	1,062
1995	14,200	9	287,700	43	301,900	51	1,385
1996	199,300	13	212,500	40	414,500	48	1,802
1997	250,800	21	315,100	32	565,900	45	2,338
1998	154,200	18	402,600	32	556,800	39	2,320
1999	126,300	28	285,400	37	411,700	45	1,752
2000	68,000	11	186,000	34	254,000	39	1,411
2001	156,900	30	45,500	26	202,400	44	1,163

*Some boats landed in northern and southern California in the same year.

Table 2. Summary of annual spot prawn trap landings (in pounds) in California since 1980 (northern California consists of the ports of Monterey northward)

Year	Northern Calif.		Southern Calif.		Statewide
Year	Landings	Total boats	Landings	Total boats	Total landings
1980	9,400	6	-	-	9,400
1981	11,700	6	900	2	12,600
1982	21,100	6	25	1	21,125
1983	10,800	6	-	-	10,800
1984	2,200	6	40	1	2,240
1985	8,600	4	8,800	5	17,400
1986	6,000	5	52,700	8	58,700
1987	11,200	5	25,900	23	37,100
1988	8,700	3	92,800	39	101,500
1989	6,400	5	104,300	35	110,700
1990	8,400	3	243,800	51	252,200
1991	12,600	8	247,200	66	259,800
1992	15,600	9	130,100	47	145,700
1993	21,200	9	200,300	48	221,500
1994	11,900	14	122,400	55	134,300
1995	10,500	9	82,600	37	93,100
1996	9,700	7	106,100	30	115,800
1997	42,300	9	130,100	43	172,400
1998	39,000	9	177,100	44	216,100
1999	27,100	8	174,200	36	194,200
2000	19,100	5	138,800	36	157,800
2001	43,600	8	165,900	35	209,500

* In some years some vessels landed in northern and southern California in the same year.

Table 3. Summary of spot prawn trawl regulations

Fishery is open access, but an annual \$30 golden, spot and ridgeback prawn trawl permit is required.

Trawling prohibited in waters less than 25 fathoms and within 3 nautical miles of the mainland shore and from all offshore islands.

Trawling prohibited inside a line from Malibu Point to Rocky Point in Santa Monica Bay.

Trawling prohibited in all waters from November 1 through January 31.

Trawling prohibited in the Cowcod Conservation Area, consisting of one large (exceeding 4,000 square miles) and a smaller area in southern California, primarily in federal waters.

Trawl net mesh with single-walled cod-end shall not be less than 1.5 inches in length.

Trawl net mesh with double-walled cod-end shall not be less than 3.0 inches in length.

All nets must be equipped with a functional finfish excluder with minimum surface area of 36 square inches unless a double-walled cod-end with a minimum mesh size of 3 inches is used.

On request, any authorized representative of the department shall be permitted to travel on the permittee's boat to observe golden, ridgeback, or spot prawn trawling operations.

Not more than 1,000 pounds of any fish caught incidentally with spot prawns may be possessed on any boat operating under a prawn trawl permit.

Within this 1,000 pound limit, not more than 300 pounds of any species of federally-managed groundfish caught incidentally with spot prawns may be possessed on any boat operating under a prawn trawl permit. This includes approximately 80 species of federally managed groundfish, and is a PFMC-imposed regulation subject to change. Cowcod may not be landed.

Open access groundfish season closures and cumulative trip limits apply to prawn trawl bycatch. Pounds of landed groundfish cannot exceed pounds of landed prawns, except for spiny dogfish.

Table 4. Summary of spot prawn trap regulations

Fishery is restricted access, with an annual \$35 general trap permit and a \$250 restricted access spot prawn trap vessel permit required.

A two-tiered, vessel-based permit structure is in effect. Tier 1 permits will be fully transferable after April 1, 2005. The maximum number of traps may be used. There is no individual annual quota on landings. Tier 2 permits are not transferable. No more than 150 traps may be used. There is an individual annual quota of 2,500 pounds of spot prawns. The capacity goal of the fishery is 17 Tier 1 permits and zero Tier 2 permits.

Trapping is prohibited in all waters south of Point Arguello from November 1 through January 31.

Trapping is prohibited in all waters north of Point Arguello from May 1 through July 31.

No more than 500 traps may be used from any vessel, except within 3 miles of the mainland shore north of Point Arguello no more than 300 traps may be used.

Traps must have a minimum mesh size of 7/8 inches and must have a destruction device (if traps are lost they will not continue to fish).

No other species may be landed incidentally with spot prawns taken by trap.

Table 5. Summary of observer trips on spot prawn trawl vessels 2000-01

Name of vessel	Port	Month/year	No. of tows	Weight ratio rockfish to spot prawns	Weight ratio all fish to spot prawns
Northern Calif.					
Vessel A	MB	Sep/Oct 00	12	0.71	8.60
Vessel A	MB	Oct 00	7	0.61	12.25
Vessel B	MB	Oct 00	11	4.25	7.91
Vessel C	MB	Mar 01	3	0.36	2.53
Vessel D	MT	Oct 00	5	4.98	20.95
Vessel E	MT	Mar 01	6	1.53	5.59
Vessel E	MT	Jun 01	5	1.08	7.13
Vessel F	SF	Mar 01	12	0.85	4.18
Vessel G	FB	Feb 01	10	3.75	9.42
Southern Calif.					
Vessel H	SB	Sep 00	3	0.60	5.07
Vessel I	SB	Aug 01	8	0.97	10.44
Vessel H	SB	Sep 01	4	5.43	23.84

Table 6. Summary of all rockfishes and lingcod, by weight, in observed spot prawn trawl tows from northern California, based on port of landing, 2000-2001, with calculated expansions to entire fleet for a one-year period. (Total estimated pounds with 95% bounds are expanded in Column 7 for boats that were sampled, based on ratio of their total spot prawn landings to landings from observed tows during the 1-year sampling period. Total estimated pounds are further expanded for all vessels in fishery based on ratio of total spot prawn landings to total landings of observed vessels)

Common name	Estimated pounds in sampled catch	Pounds per 1000 lbs prawns	Mean pounds per tow	Standard deviation	Standard error of mean	Estimated total bycatch sampled boats	Lower 95% bound sampled boats	Upper 95% bound sampled boats	Estimated total catch from all boats
Rockfish, shortbelly	1610	423	18.7	93.6	10.1	32257	1610	66817	65106
Rockfish, splitnose	1474	387	17.1	45.1	4.9	29522	12869	46174	59586
Rockfish, sharpchin	1293	340	15.0	36.2	3.9	25910	12548	39272	52296
Rockfish, stripetail	1123	295	13.1	29.6	3.2	22503	11568	33438	45420
Rockfish, chilipepper	1007	265	11.7	24.0	2.6	20169	11301	29038	40709
Lingcod	817	215	9.5	18.4	2.0	16361	9560	23162	33022
Rockfish, unspecified	431	113	5.0	14.7	1.6	8641	3196	14086	17441
Rockfish, greenstriped	408	107	4.7	9.9	1.1	8176	4533	11820	16503
Rockfish, darkblotched	314	83	3.7	15.1	1.6	6297	738	11856	12710
Rockfish, bocaccio	221	58	2.6	7.5	0.8	4435	1667	7203	8951
Rockfish, greenspotted	204	54	2.4	8.7	0.9	4083	855	7311	8241
Rockfish, bank	165	43	1.9	17.3	1.9	3305	165	9677	6671
Rockfish, widow	125	33	1.5	5.8	0.6	2500	362	4638	5046
Rockfish, halfbanded	90	24	1.0	5.1	0.6	1796	90	3696	3626
Rockfish, cowcod	57	15	0.7	3.0	0.3	1142	57	2261	2305
Rockfish, redstripe	50	13	0.6	5.4	0.6	1010	50	3017	2038
Rockfish, rosethorn	43	11	0.5	1.8	0.2	869	221	1518	1755
Rockfish, greenblotched	30	8	0.3	1.4	0.2	599	78	1121	1210
Rockfish, redbanded	29	8	0.3	1.8	0.2	574	29	1239	1159
Rockfish, aurora	22	6	0.3	1.4	0.1	445	22	945	899
Rockfish, pink	14	4	0.2	0.9	0.1	272	14	613	550
Rockfish, rosy	12	3	0.1	0.8	0.1	244	12	556	493
Rockfish, pinkrose	8	2	0.1	0.9	0.1	168	8	503	340
Rockfish, vermilion	8	2	0.1	0.8	0.1	150	8	449	303
Rockfish, flag	4	1	<0.1	0.4	<0.1	80	4	239	162
Rockfish, yelloweye	2	1	<0.1	0.2	<0.1	40	2	120	81
Rockfish, blackgill	1	<1	<0.1	0.1	<0.1	28	1	61	57
Rockfish, canary	1	<1	<0.1	0.1	<0.1	20	1	60	40
Rockfish, Mexican	1	<1	<0.1	0.1	<0.1	14	1	42	28
Rockfish, tiger	<1	<1	<0.1	<0.1	<0.1	8	<1	24	16
Grand Total	9566	2515	111.2	155.1	16.7	191621	134346	248897	386764
Number of tows sampled		71							
Sampled prawns landed by port		3804							
Total prawns landed by sampled boats		76200							
Total prawns landed by port		153800							

Table 7. Summary of other fishes, by weight, in observed spot prawn trawl tows from northern California, based on port of landing, 2000-2001, with calculated expansions to entire fleet for a one-year period. (Total estimated pounds with 95% bounds are expanded in Column 7 for boats that were sampled, based on ratio of their total spot prawn landings to landings from observed tows during the 1-year sampling period. Total estimated pounds are further expanded for all vessels in fishery based on ratio of total spot prawn landings to total landings of observed vessels)

Common name of bycatch species	Estimated pounds in sampled catch	Pounds per 1000 labs prawns	Mean pounds per tow	Standard deviation	Standard error of mean	Estimated total bycatch sampled boats	Lower 95% bound sampled boats	Upper 95% bound sampled boats	Estimated total catch from all boats
Hake, Pacific	6624	1741	93.3	141.8	16.8	132687	84977	180398	267813
Sole, Dover	3106	817	43.7	58.0	6.9	62218	42686	81750	125579
Sablefish	2507	659	35.3	130.7	15.5	50214	6220	94208	101351
Sole, English	1727	454	24.3	35.9	4.3	34589	22497	46682	69814
Sole, Slender	1340	352	18.9	29.6	3.5	26845	16884	36807	54184
Sole, Rex	1135	298	16.0	19.8	2.4	22742	16075	29408	45901
Ratfish	899	236	12.7	34.5	4.1	18001	6394	29607	36332
Sanddab, Pacific	412	108	5.8	13.7	1.6	8248	3652	12845	16649
Midshipman, Plainfin	370	97	5.2	12.8	1.5	7404	3102	11706	14944
Eelpout, Bigfin	277	73	3.9	7.8	0.9	5548	2916	8180	11197
Sculpin sp.	265	70	3.7	29.7	3.5	5298	265	15280	10694
Sole, Petrale	137	36	1.9	7.8	0.9	2747	137	5361	5545
Skate, Longnose	112	29	1.6	4.3	0.5	2247	810	3683	4535
Skate, Sandpaper	101	26	1.4	4.3	0.5	2015	566	3463	4067
Skate, Big	91	24	1.3	5.4	0.6	1828	91	3646	3689
Poacher, Blackedge	80	21	1.1	2.3	0.3	1609	834	2383	3247
Flounder, Arrowtooth	78	21	1.1	3.7	0.4	1562	324	2801	3154
Thornyhead, Shortspine	67	18	0.9	5.3	0.6	1347	67	3130	2718
Argentina, Pacific	65	17	0.9	2.4	0.3	1308	498	2119	2641
Cusk-eel, Spotted	59	16	0.8	2.1	0.3	1183	468	1899	2388
Combfish sp.	57	15	0.8	2.4	0.3	1142	318	1966	2305
Snailfish, Blacktail	45	12	0.6	1.6	0.2	895	367	1422	1806
Sculpin, Threadfin	37	10	0.5	1.5	0.2	739	229	1249	1492
Shark, Filetail Cat	35	9	0.5	3.1	0.4	700	35	1748	1412
Dogfish, Spiny	33	9	0.5	2.1	0.2	661	33	1361	1334
Shark, Swell	20	5	0.3	2.4	0.3	401	20	1199	809
Combfish, Shortspine	16	4	0.2	0.8	0.1	319	43	594	643
Shark, Brown cat	13	3	0.2	1.3	0.2	250	13	676	505
Rattail	10	3	0.1	1.2	0.1	200	10	600	404
Poacher sp.	9	2	0.1	0.7	0.1	180	9	400	364
Turbot, Curfin	9	2	0.1	1.1	0.1	180	9	540	364
Ray, Pacific electric	6	2	0.1	0.5	0.1	120	6	298	243
Poacher, Bluespotted	5	1	0.1	0.4	0.0	108	5	246	218
Brotula, Red	5	1	0.1	0.6	0.1	100	5	300	202
Thornyhead sp.	5	1	0.1	0.6	0.1	100	5	300	202
Turbot, Hornyhead	5	1	0.1	0.4	0.1	100	5	243	202
Sculpin, Staghorn	4	1	0.1	0.2	<0.1	76	4	157	154
Sole, Sand	4	1	<0.1	0.4	<0.1	70	4	210	142
Combfish, Longspine	3	1	<0.1	0.4	<0.1	60	3	180	121
Poacher, Smootheye	1	<1	<0.1	0.1	<0.1	16	1	48	32
Skate sp.	<1	<1	<0.1	<0.1	<0.1	<1	<1	<1	<1
Grand Total	19772	5198	278.5	238.9	28.4	396059	315642	476475	799394
Number of tows sampled		71							
Sampled prawns landed by port		3804							
Total prawns landed by sampled boats		76200							
Total prawns landed by port		153800							

Table 8. Summary of actual landed catch (pounds) from trawl gear and estimated total discards for finfish species associated with spot prawn landings in northern and southern California during the period October 2000-September 2001, based on port of landing. (Estimated total discards is obtained by subtracting the actual landed catch from the estimated total catch from all boats in Tables 6-7 and 9-10)

Rockfishes and lingcod

Species	Northern California		Southern California	
	Actual landed catch	Estimated discards	Actual landed catch	Estimated discards
Lingcod	262	32,760	20	None*
All rockfishes	(8,774)	(344,970)	(395)	(70,520)
Aurora	34	860	-	-
Bank	300	6,370	-	40
Blackgill	933	None*	-	40
Bocaccio	492	8,460	98	1,120
Canary	34	10	-	-
Chilipepper	5,771	34,940	-	7,910
Cowcod	33	2,270	-	60
Darkblotched	49	12,660	-	250
Greenspotted	198	8,040	-	-
Redbanded	17	1,140	-	40
Splitnose (rosefish)	182	59,400	-	300
Widow	296	4,750	-	-
Yelloweye	21	60	-	-
Other	414	Unknown	277	Unknown

Other fishes

Species	Northern California		Southern California	
	Actual landed catch	Estimated discards	Actual landed catch	Estimated discards
All Flatfishes	(13,098)	(303,290)	(3,106)	(463,090)
Dover sole	9,557	116,020	69	26,680
English sole	748	* 69,070	95	12,590
Petrале sole	2,530	3,010	1,086	None*
Rex sole	853	45,050	121	20,380
Rock sole	136	None*	-	-
Sanddabs	17	16,630	242	357,110
Sole unspecified	-	-	1,493	Unknown

Starry flounder	110	None*	-	-
Sablefish	2,521	98,830	187	14,640
Shark sp.	54	4,000	24	4,050
Skate sp.	1,138	11,150	-	1,550
Thornyheads	463	6,520	66	None*

*None: indicates that this species was not encountered in observed tows.

Table 9. Summary of all rockfishes and lingcod, by weight, in observed spot prawn trawl tows from southern California, based on port of landing, 2000-2001, with calculated expansions to entire fleet for a one-year period. (Total estimated pounds with 95% bounds are expanded in Column 7 for boats that were sampled, based on ratio of their total spot prawn landings to landings from observed tows during the 1-year sampling period. Total estimated pounds are further expanded for all vessels in fishery based on ratio of total spot prawn landings to total landings of observed vessels)

Common name	Estimated pounds in sampled catch	Pounds per 1000 lbs prawns	Mean pounds per tow	Standard deviation	Standard error of mean	Estimated total bycatch sampled boats	Lower 95% bound sampled boats	Upper 95% bound sampled boats	Estimated total catch from all boats
Rockfish, shortbelly	304	688	20.3	41.9	10.8	13414	304	28665	31506
Rockfish, striptail	115	261	7.7	7.8	2.0	5089	2255	7923	11953
Rockfish, halfbanded	85	193	5.7	11.5	3.0	3768	85	7957	8849
Rockfish, chilipepper	76	173	5.1	7.5	1.9	3366	641	6091	7906
Rockfish, unspecified	45	101	3.0	3.6	0.9	1963	662	3265	4611
Rockfish, greenstriped	15	34	1.0	1.7	0.4	662	42	1282	1554
Rockfish, pink	12	27	0.8	2.1	0.5	534	12	1303	1254
Rockfish, bocaccio	12	27	0.8	2.1	0.5	521	12	1287	1223
Rockfish, greenblotched	11	25	0.7	1.4	0.3	481	11	973	1129
Rockfish, splitnose	3	6	0.2	0.4	0.1	126	3	276	296
Rockfish, darkblotched	2	5	0.2	0.5	0.1	106	2	295	249
Rockfish, Sharpchin	2	4	0.1	0.4	0.1	71	2	221	166
Rockfish, Mexican	1	2	<0.1	0.2	<0.1	31	1	97	73
Rockfish, cowcod	1	1	<0.1	0.2	<0.1	26	1	83	62
Rockfish, blackgill	<1	1	<0.1	0.1	<0.1	18	<1	55	41
Rockfish, redbanded	<1	1	<0.1	0.1	<0.1	18	<1	55	41
Grand Total	684	1548	45.6	41.0	10.6	30192	15267	45118	70913

Number of tows sampled	15
Sampled prawns landed by port	442
Total prawns landed by sampled boats	19500
Total prawns landed by location	45800

Table 10. Summary of other fishes, by weight, in observed spot prawn trawl tows from southern California, based on port of landing, 2000-2001, with calculated expansions to entire fleet for a one-year period. (Total estimated pounds with 95% bounds are expanded in Column 7 for boats that were sampled, based on ratio of their total spot prawn landings to landings from observed tows during the 1-year sampling period. Total estimated pounds are further expanded for all vessels in fishery based on ratio of total spot prawn landings to total landings of observed vessels)

Common name of bycatch species	Estimated pounds in sampled catch	Pounds per 1000 labs prawns	Mean pounds per tow	Standard deviation	Standard error of mean	Estimated total bycatch sampled boats	Lower 95% bound sampled boats	Upper 95% bound sampled boats	Estimated total catch from all boats
Sanddab, Pacific	3449	7802	229.9	828.8	214.0	152148	3449	453998	357353
Hake, Pacific	2020	4569	134.6	148.0	38.2	89096	35180	143011	209260
Sole, Slender	467	1056	31.1	24.3	6.3	20590	11732	29449	48361
Sole, Dover	258	584	17.2	13.2	3.4	11391	6593	16189	26753
Sole, Rex	198	448	13.2	12.6	3.2	8727	4154	13300	20497
Midshipman, Plainfin	146	330	9.7	33.4	8.6	6425	146	18571	15091
Sablefish	143	324	9.5	34.7	9.0	6314	143	18967	14831
Sole, English	122	277	8.2	10.4	2.7	5402	1619	9184	12687
Eelpout, Bigfin	80	180	5.3	7.9	2.0	3518	634	6403	8264
Combfish, Shortspine	50	113	3.3	3.4	0.9	2200	962	3438	5168
Argentine, Pacific	35	79	2.3	2.6	0.7	1544	609	2478	3625
Poacher, Sturgeon	29	66	1.9	3.0	0.8	1286	204	2368	3020
Ratfish	26	59	1.7	4.0	1.0	1143	26	2582	2684
Eelpout, sp.	24	53	1.6	3.5	0.9	1040	24	2310	2442
Shark, Filetail Cat	17	38	1.1	2.9	0.8	742	17	1806	1742
Dogfish, Spiny	15	34	1.0	3.9	1.0	662	15	2072	1554
Skate, Sandpaper	13	29	0.9	3.4	0.9	574	13	1796	1347
Surfperch, Pink	10	23	0.7	1.4	0.4	455	10	966	1069
Cusk-eel, Spotted	8	19	0.6	1.3	0.3	364	8	822	855
Sole, Petrale	5	12	0.4	1.4	0.4	234	5	734	550
Poacher, sp.	5	11	0.3	0.9	0.2	224	5	570	526
Shark, Brown cat	5	10	0.3	0.9	0.2	199	5	534	466
Shark, Sixgill	3	7	0.2	0.8	0.2	132	3	414	311
Poacher, Blackedge	2	5	0.2	0.6	0.2	99	2	311	233
Skate, California	2	5	0.1	0.5	0.1	88	2	276	207
Scabbardfish, Pacific	1	3	0.1	0.3	0.1	55	1	173	130
Snailfish, Blacktail	<1	1	<0.01	0.1	<0.01	11	<1	33	25
Grand Total	7132	16137	475.5	791.9	204.5	314662	26247	603076	739052

Number of tows sampled	15
Sampled prawns landed by port	442
Total prawns landed by sampled boats	19500
Total prawns landed by port	45800

Table 11. Occurrence of overfished rockfish species in observed tows (total number and weight)

Port of Landing	Tow number	Number of fish	Weight	Tow latitude	Tow longitude	CDFG Block number	Depth (fm)
Cowcod, Northern California							
MT	37	1	2.1	37 13'	122 46'	480	89
MB	55	1	2.0	34 23'	120 19'	656	126
MB	59	1	3.0	34 40'	120 54'	638	153
MB	62	3	3.0	34 12'	120 27'	671	113
MB	65	9	22.7	34 12'	120 27'	671	116
MB	66	1	7.0	34 12'	120 27'	671	126
MB	68	1	1.5	35 32'	121 14'	602	115
MB	82	1	15.0	34 28'	120 41'	659	122
Total		18	56.3				
Cowcod, Southern California							
VT	84	1	0.7	34 07'	119 23'	684	124
Bocaccio, Northern California							
MT	28	2	7.5	36 37'	122 01'	527	120
MT	30	10	10.0	36 16'	122 03'	540	140
MT	37	22	33.0	37 13'	122 46'	480	89
MB	39	15	7.5	34 22'	120 31'	658	133
MB	41	7	4.1	34 22'	120 31'	658	130
MB	42	15	9.0	34 22'	120 31'	658	125
MB	47	2	1.5	34 27'	120 41'	659	122
MB	51	8	39.5	34 28'	120 43'	659	145
MB	54	8	4.0	34 22'	120 25'	657	112
MB	62	24	12.0	34 12'	120 27'	671	113
MB	63	7	4.2	34 12'	120 27'	671	125
MB	64	63	35.0	34 12'	120 26'	671	106
MB	65	41	28.5	34 12'	120 27'	671	116
MB	66	12	8.0	34 12'	120 26'	671	126
Total		236	203.8				
Bocaccio, Southern California							
VT	78	4	6.8	34 23'	120 04'	655	140
VT	84	9	10.8	34 06'	119 23'	685	124
Total		13	17.6				
Canary rockfish, Northern California							
FB	7	1	1.0	39 47'	124 02'	250	92
Yelloweye rockfish, Northern California							
FB	2	1	2.0	39 44'	123 59'	249	83
Widow rockfish, Northern California							
MB	57	20	20.0	34 43'	120 54'	638	138
MB	58	20	15.0	34 40'	120 54'	638	145
MB	59	60	45.0	34 43'	120 54'	638	153
MB	60	6	2.4	34 40'	120 55'	638	144
MB	61	12	16.0	34 40'	120 53'	638	147

Table 12. Summary of all fishes, by weight, in observed spot prawn trap strings from northern California, based on port of landing, 2000-2001, with calculated expansions to entire fleet for a one-year period. (Total estimated pounds with 95% bounds are expanded in Column 7 for boats that were sampled, based on ratio of their total spot prawn landings to landings from observed trap strings during the 1-year sampling period. Total estimated pounds are further expanded for all vessels in fishery based on ratio of total spot prawn landings to total landings of observed vessels)

Common name of bycatch species	Estimated pounds in sampled catch	Pounds per 1000 lbs prawns	Mean pounds per trap string	Standard deviation	Standard error of mean	Estimated total bycatch sampled boats	Lower 95% bound sampled boats	Upper 95% bound sampled boats	Estimated total catch from all boats
Sablefish	86.3	79.3	1.14	2.61	0.30	1507	717	2298	1861
Rosethorn rockfish	11.9	10.9	0.16	0.38	0.04	208	91	324	257
Rockfish, greenblotched group	10.6	9.7	0.14	0.34	0.04	185	83	286	228
Spotted cusk eel	10.1	9.3	0.13	0.27	0.03	177	94	260	219
Filetail cat shark	5.9	5.4	0.08	0.31	0.04	102	7	197	126
Lingcod	4.8	4.4	0.06	0.42	0.05	84	5	210	104
Blacktail snailfish	4.0	3.6	0.05	0.27	0.03	69	4	152	85
Threadfin sculpin	3.8	3.5	0.05	0.13	0.02	66	25	107	81
Stripetail rockfish	3.8	3.4	0.05	0.24	0.03	65	4	137	81
Pinkrose rockfish	3.6	3.3	0.05	0.18	0.02	63	10	117	78
Red brotula	3.6	3.3	0.05	0.26	0.03	62	4	140	77
Swordspine rockfish	2.6	2.3	0.03	0.23	0.03	45	3	115	55
Redbanded rockfish	2.1	2.0	0.03	0.09	0.01	37	9	66	46
Starry rockfish	1.2	1.1	0.02	0.12	0.01	21	1	56	26
Shortspine thornyhead	1.1	1.0	0.01	0.07	0.01	18	1	40	23
Greenstriped rockfish	0.9	0.8	0.01	0.07	0.01	16	1	38	19
Rosy rockfish	0.7	0.7	0.01	0.04	<0.01	12	1	24	15
Yelloweye rockfish	0.7	0.6	0.01	0.06	0.01	12	1	30	15
Bank rockfish	0.5	0.5	0.01	0.06	0.01	9	1	26	11
Pacific hagfish	0.5	0.5	0.01	0.04	0.00	9	1	21	11
Plainfin midshipman	0.5	0.5	0.01	0.06	0.01	9	1	26	11
Splitnose rockfish	0.4	0.4	0.01	0.04	<0.01	7	<1	18	9
Widow rockfish	0.3	0.3	<0.01	0.04	<0.01	6	<1	17	7
Cowcod	0.2	0.2	<0.01	0.03	<0.01	4	<1	11	5
Blackgill rockfish	0.2	0.2	<0.01	0.01	<0.01	3	<1	7	4
Darkblotched rockfish	0.1	0.1	<0.01	0.01	<0.01	2	<1	5	2
Dusky sculpin	0.1	0.1	<0.01	0.01	<0.01	2	<1	5	2
Halfbanded rockfish	0.1	0.1	<0.01	0.01	<0.01	2	<1	5	2
Slender sole	0.1	0.1	<0.01	0.01	<0.01	2	<1	5	2
Cabezon	0.1	0.1	<0.01	0.01	<0.01	1	<1	4	2
Grand Total	160.6	147.6	2.11	2.80	0.32	2805	1957	3652	3463

Number of trap strings sampled	88
Sampled prawns landed by port	1088
Total prawns landed by sampled boats	19000
Total prawns landed by port	23460

MB	62	6	2.4	34 12'	120 27'	671	113
MB	63	7	1.4	34 13'	120 27'	671	125
MB	64	21	7.0	34 12'	120 27'	671	106
MB	65	8	3.2	34 13'	120 27'	671	116
MB	66	4	1.6	34 12'	120 27'	671	126
MB	67	10	6.0	34 12'	120 26'	671	127
MB	68	10	3.2	35 32'	121 14'	602	115
MB	69	8	1.6	35 32'	121 14'	602	117
Total		192	124.8				
Darkblotched rockfish, Northern California							
FB	1	24	5.2	39 43'	123 59'	249	85
FB	3	7	1.4	39 45'	123 59'	249	86
FB	5	52	7.2	39 44'	123 59'	249	85
FB	6	5	0.5	39 43'	123 59'	249	84
FB	7	544	110.5	39 47'	124 02'	250	92
FB	8	120	28.0	39 48'	124 03'	250	99
FB	9	8	1.2	39 44'	123 59'	249	83
FB	10	273	45.5	39 43'	123 59'	249	85
SF	11	4	0.4	37 16'	122 52'	481	148
SF	15	130	58.5	37 21'	122 54'	481	139
SF	19	155	42.5	37 02'	122 38'	504	125
SF	20	10	2.0	37 02'	122 38'	504	129
SF	21	2	0.2	37 06'	122 42'	503	129
MT	24	7	0.7	37 06'	122 42'	504	130
MT	27	15	1.5	36 53'	122 13'	510	135
MT	34	36	4.5	36 56'	122 17'	510	77
MT	35	8	1.2	36 59'	122 23'	511	80
MT	37	5	0.6	37 13'	122 46'	480	89
MB	69	4	0.4	35 32'	121 14'	602	117
Total		1,450	312.0				
Darkblotched rockfish, Southern California							
VT	78	4	0.4	34 23'	120 05'	655	140
VT	79	10	2.0	34 23'	120 09'	655	150
Total		14	2.4				

Port Legend: FB- Fort Bragg; MB- Morro Bay; MT- Monterey; SF- San Francisco; VT- Ventura

Table 14. Occurrence of overfished rockfish species in observed trap strings (total number and weight)

Port of Landing	String number	Number of fish	Weight	String latitude	String longitude	CDFG Block number	Depth (fm)
Cowcod, Northern California							
MB	70	1	0.2	36 12'	121 41'	538	80
Cowcod, Southern California							
CI	102	1	0.25	34 04'	119 18'	683	144
CI	103	1	0.2	34 04'	119 19'	683	123
CI	140	1	0.1	33 59'	119 53'	729	131
NB	151	1	0.25	33 35'	117 53'	738	120
NB	157	1	0.3	33 32'	117 55'	757	115
NB	161	1	0.3	33 35'	117 50'	738	110
OC	168	3	2.0	33 22'	117 40'	757	114
DP	184	1	1.0	33 17'	118 16'	806	80
DP	185	3	1.2	33 18'	118 19'	806	90
DP	186	1	0.5	33 17'	118 16'	806	85
OC	236	3	0.7	32 45'	118 29'	867	125
OC	241	3	0.4	32 47'	118 31'	868	125
OC	243	3	0.9	32 53'	118 34'	850	125
Total		23	8.1				
Bocaccio, Southern California							
CI	92	1	0.4	33 55'	119 48'	709	145
CI	101	1	0.25	34 06'	119 19'	683	127
CI	104	1	1.3	34 04'	119 18'	683	120
CI	110	1	0.25	33 57'	119 38'	708	146
CI	114	1	0.1	33 58'	119 28'	707	180
CI	142	1	0.6	33 48'	119 54'	729	103
NP	146	1	0.5	33 31'	117 49'	738	120
NB	147	2	1.0	33 31'	117 49'	738	120
NB	149	1	0.1	33 31'	117 49'	738	120
NB	150	1	0.5	33 31'	117 49'	738	120
DP	187	3	4.5	33 17'	118 16'	806	90
SD	261	3	3.1	33 02'	118 40'	829	123
Total		17	12.6				
Yelloweye rockfish, Northern California							
MT	3	1	0.1	36 32'	121 58'	526	140
MT	4	1	0.1	36 32'	121 58'	526	140
MB	78	1	0.5	36 12'	121 44'	538	80
Total		3	0.7				

Port Legend: CI- Channel Islands Harbor; DP- Dana Point; MB- Morro Bay; MT- Monterey; NB- Newport Beach; OC- Oceanside; SD- San Diego

Table 13. Summary of all fishes, by weight, in observed spot prawn trap strings from southern California, based on port of landing, 2000-2001, with calculated expansions to entire fleet for a one-year period. (Total estimated pounds with 95% bounds are expanded in column 7 for boats that were sampled, based on ratio of their total spot prawn landings to landings from observed trap strings during the 1-year sampling period. Total estimated pounds are further expanded for all vessels in fishery based on ratio of total spot prawn landings to total landings of observed vessels)

Common name of bycatch species	Estimated pounds in sampled catch	Pounds per 1000 lbs prawns	Mean pounds per tow	Standard deviation	Standard error of mean	Estimated total bycatch sampled boats	Lower 95% bound sampled boats	Upper 95% bound sampled boats	Estimated total catch from all boats
Lingcod	109	37	0.68	2.03	0.16	4038	2169	5907	4982
Rockfish. Greenblotched grouper	105	36	0.66	1.20	0.10	3886	2775	4997	4795
Threadfin sculpin	90	31	0.56	1.65	0.13	3328	1807	4850	4107
Sablefish	74	25	0.46	2.59	0.20	2747	357	5137	3390
Swell shark	44	15	0.27	1.71	0.14	1609	44	3189	1985
Spotted cusk eel	43	15	0.27	0.49	0.04	1591	1135	2047	1963
Shortspine combfish	28	10	0.18	0.44	0.03	1039	637	1440	1282
Greenstriped rockfish	19	6	0.12	0.42	0.03	689	302	1076	850
Stripetail rockfish	14	5	0.09	0.28	0.02	532	271	794	657
Shortspine thornyhead	13	5	0.08	0.54	0.04	496	13	995	612
Pinkrose rockfish	13	4	0.08	0.28	0.02	486	229	743	600
Bocaccio	13	4	0.08	0.45	0.04	465	46	885	574
Red brotula	9	3	0.06	0.24	0.02	347	125	568	428
Cowcod	8	3	0.05	0.23	0.02	300	90	510	370
Unidentified Fish	7	2	0.04	0.51	0.04	253	7	723	312
Ratfish	6	2	0.04	0.34	0.03	233	6	547	287
Speckled rockfish	6	2	0.04	0.33	0.03	229	6	533	283
Splitnose rockfish	6	2	0.03	0.19	0.02	204	29	379	252
Flag rockfish	5	2	0.03	0.29	0.02	203	5	468	250
Chilipepper	5	2	0.03	0.20	0.02	190	5	379	234
Halfbanded rockfish	3	1	0.02	0.13	0.01	100	3	216	124
Blacktail snailfish	3	1	0.02	0.14	0.01	99	3	225	123
Unidentified rockfish	2	1	0.01	0.06	0.01	55	2	115	68
Longspine thornyhead	1	<1	0.01	0.07	0.01	45	1	109	56
Blackgill rockfish	1	<1	0.01	0.04	<0.01	45	9	81	55
Unidentified Flatfish	1	<1	0.01	0.09	0.01	43	1	127	53
Dover sole	1	<1	0.01	0.06	<0.01	37	1	88	46
Pacific hagfish	1	<1	0.01	0.06	<0.01	37	1	88	46
Longspine combfish	1	<1	0.01	0.04	<0.01	34	1	74	42
Shortbelly rockfish	1	<1	0.01	0.05	<0.01	34	1	80	41
Spotfin sculpin	1	<1	<0.01	0.05	<0.01	22	1	66	27
English sole	1	<1	<0.01	0.04	<0.01	18	1	55	23
Squarespot rockfish	<1	<1	<0.01	0.03	<0.01	18	<1	48	22
Aurora rockfish	<1	<1	<0.01	0.02	<0.01	13	<1	33	16
Sharpchin rockfish	<1	<1	<0.01	0.02	<0.01	11	<1	33	14
Starry rockfish	<1	<1	<0.01	0.02	<0.01	9	<1	27	11
Basketweave cusk eel	<1	<1	<0.01	0.02	<0.01	7	<1	22	9
Rosethorn rockfish	<1	<1	<0.01	0.02	<0.01	7	<1	22	9
Swordspine rockfish	<1	<1	<0.01	0.02	<0.01	7	<1	22	9
Roady rockfish	<1	<1	<0.01	0.01	<0.01	4	<1	10	5
Redbanded rockfish	<1	<1	<0.01	0.01	<0.01	3	<1	10	4
Grand Total	636	216	3.98	5.12	0.40	23516	8791	28241	29016

Number of trap strings sampled	174
Sampled prawns landed by port	2947
Total prawns landed by sampled boats	108900
Total prawns landed by port	134370

Table 15. Estimated mortality rates of overfished groundfish species in the California spot prawn fishery by gear type and area of landing¹. Values are pounds of fish per pound of landed spot prawn².

	Trawl		Trap	
	Northern	Southern	Northern	Southern
Bocaccio	0.06	0.03	0.00	negligible ³
Canary rockfish	negligible	0.00	0.00	0.00
Cowcod	0.01	negligible	negligible	negligible
Darkblotched rockfish	0.08	0.01	negligible	0.00
Widow rockfish	0.03	0.00	negligible	0.00
Yelloweye rockfish	negligible	0.00	negligible	0.00
Lingcod ⁴	0.11	0.00	negligible	0.07
Pacific hake (whiting)	1.74	4.57	0.00	0.00

¹ Northern: ports north of Point Conception; Southern: ports south of Point Conception

² Includes discards and landed catch

³ less than 0.01

⁴ Assumes 50% catch and release survival rate

Appendix 1. Expansions of observed bycatch data from spot prawn trawl vessels based on location of observed tows.

This methodology is based on whether the observed tows were north or south of the line of latitude at Point Conception. Two of the vessels fished in part south of Point Conception but landed their catch north of Point Conception. Sixty-one and sixty percent, respectively, of the observed tows for these vessels were south of Point Conception. These percentages of the total landings of these vessels for the one-year period were subtracted from landings from the northern area and added to landings from the southern area. Estimated total spot prawn trawl landings based on area of capture during this period were 140,800 pounds for all ports north of Pt. Conception and 58,800 pounds for all ports south of Pt. Conception. This may underestimate the landings captured in southern California because other vessels fishing out of Morro Bay which were not observed may have fished south of Point Conception.

Among the 71 observed tows on vessels based in northern California ports, 17 were conducted south of Point Conception. Thus this analysis (based on location of tow) for northern California had a sample size of 54 tows (71 minus 17). The top five species observed in the bycatch, in decreasing frequency of occurrence, were the same as in the first analysis: Pacific hake, Dover sole, sablefish, English sole, and splitnose rockfish, comprising 53.7% of all fishes by weight. Twenty-four species of rockfishes were observed, comprising 30.1% by weight of all fishes. Ratio of total fish bycatch to total spot prawn catch from all tows combined was 6.4 to 1. Ratio of total rockfish bycatch to total spot prawn catch was 1.9 to 1. It is estimated that the observed tows represented 2.2% of all trawl spot prawn landings north of Point Conception during the 12-month sampling period.

Appendix 1.1. Summary of all rockfishes and lingcod, by weight, in observed spot prawn trawl tows from northern California, based on location of tow, 2000-2001, with calculated expansions to entire fleet for a 1-year period. (Total estimated pounds with 95% bounds are expanded in Column 7 for boats that were sampled, based on ratio of their total spot prawn landings to landings from observed tows during the 1-year sampling period. Total estimated pounds are further expanded for all vessels in fishery based on ratio of total spot prawn landings to total landings of observed vessels)

Common name	Estimated pounds in sampled catch	Pounds per 1000 lbs prawns	Mean pounds per tow	Standard deviation	Standard error of mean	Estimated total bycatch sampled boats	Lower 95% bound sampled boats	Upper 95% bound sampled boats	Estimated total catch from all boats
Rockfish, splitnose	1461.9	467.96	27.07	54.67	7.44	35658	16011	55306	65888
Rockfish, shortbelly	1059.4	339.12	19.62	115.45	15.71	25841	1059	67330	47748
Rockfish, stripetail	982.5	314.51	18.19	36.16	4.92	23966	10970	36961	44283
Rockfish, Sharpchin	736.9	235.87	13.65	32.10	4.37	17973	6437	29510	33211
Lingcod	664.3	212.63	12.30	21.16	2.88	16202	8596	23808	29938
Rockfish, chilipepper	382.2	122.34	7.08	16.75	2.28	9322	3304	15340	17225
Rockfish, greenstriped	328.1	105.02	6.08	11.08	1.51	8002	4022	11983	14787
Rockfish, darkblotched	312.0	99.86	5.78	18.73	2.55	7609	877	14342	14060
Rockfish, bank	165.0	52.82	3.06	21.77	2.96	4025	165	11848	7437
Rockfish, widow	103.2	33.03	1.91	7.17	0.98	2517	103	5095	4651
Rockfish, bocaccio	97.2	31.11	1.80	7.09	0.96	2371	97	4919	4381
Rockfish, greenspotted	75.5	24.18	1.40	3.24	0.44	1842	677	3007	3404
Rockfish, unspecified	67.8	21.72	1.26	3.78	0.51	1655	296	3014	3058
Rockfish, redstripe	50.4	16.13	0.93	6.86	0.93	1229	50	3694	2272
Rockfish, rosethorn	41.6	13.32	0.77	2.17	0.30	1015	234	1796	1875
Rockfish, redbanded	28.3	9.05	0.52	2.26	0.31	690	28	1501	1274
Rockfish, aurora	22.2	7.12	0.41	1.69	0.23	542	22	1151	1002
Rockfish, cowcod	21.7	6.95	0.40	2.09	0.28	529	22	1282	978
Rockfish, greenblotched group	17.5	5.61	0.32	1.62	0.22	427	18	1008	790
Rockfish, rosy	10.7	3.43	0.20	1.04	0.14	261	11	636	482
Rockfish, pinkrose	8.4	2.69	0.16	1.14	0.16	205	8	616	379
Rockfish, halfbanded	2.2	0.70	0.04	0.18	0.02	53	2	116	98
Rockfish, yelloweye	2.0	0.64	0.04	0.27	0.04	49	2	147	90
Rockfish, blackgill	1.0	0.32	0.02	0.10	0.01	24	1	59	45
Rockfish, canary	1.0	0.32	0.02	0.14	0.02	24	1	73	45
Rockfish, tiger	0.4	0.13	0.01	0.05	0.01	10	0	29	18
Grand Total	6643.3	2126.55	123.02	170.17	23.16	162043	100889	223197	299418

Number of tows sampled	54
Sampled prawns landed by location	3124
Total prawns landed by sampled boats	76200
Total prawns landed by location	140800

Appendix 1.3. Summary of all rockfishes and lingcod, by weight, in observed spot prawn trawl tows from southern California, based on location of tow, 2000-2001, with calculated expansions to entire fleet for a 1-year period. (Total estimated pounds with 95% bounds are expanded in Column 7 for boats that were sampled, based on ratio of their total spot prawn landings to landings from observed tows during the 1-year sampling period. Total estimated pounds are further expanded for all vessels in fishery based on ratio of total spot prawns landings to total landings of observed vessels)

Common name	Estimated pounds in sampled catch	Pounds per 1000 lbs prawns	Mean pounds per tow	Standard deviation	Standard error of mean	Estimated total bycatch sampled boats	Lower 95% bound sampled boats	Upper 95% bound sampled boats	Estimated total catch from all boats
Rockfish, chilipepper	624.7	539.93	19.52	31.65	5.59	10529	4383	16674	31748
Rockfish, Sharpchin	556.6	481.07	17.39	42.65	7.54	9381	1098	17663	28287
Rockfish, shortbelly	550.9	476.15	17.22	34.95	6.18	9285	2497	16072	27997
Rockfish, unspecified	363.5	314.21	11.36	22.48	3.97	6127	1761	10493	18475
Lingcod	152.5	131.81	4.77	11.28	1.99	2570	380	4761	7750
Rockfish, stripetail	140.9	121.74	4.40	6.71	1.19	2374	1071	3677	7158
Rockfish, greenspotted	128.3	110.89	4.01	13.68	2.42	2162	128	4819	6520
Rockfish, bocaccio	124.2	107.35	3.88	8.08	1.43	2093	524	3662	6312
Rockfish, halfbanded	87.5	75.63	2.73	8.23	1.46	1475	88	3074	4447
Rockfish, greenstriped	80.1	69.23	2.50	6.98	1.23	1350	80	2706	4071
Rockfish, cowcod	35.3	30.51	1.10	4.17	0.74	595	35	1405	1794
Rockfish, widow	21.6	18.67	0.68	1.71	0.30	364	31	697	1098
Rockfish, pink	13.6	11.75	0.42	1.49	0.26	229	14	518	691
Rockfish, greenblotched group	12.4	10.72	0.39	1.00	0.18	209	15	403	630
Rockfish, splitnose	11.9	10.25	0.37	1.60	0.28	200	12	511	603
Rockfish, vermilion	7.5	6.48	0.23	1.33	0.23	126	8	384	381
Rockfish, flag	4.0	3.46	0.13	0.71	0.13	67	4	205	203
Rockfish, darkblotched	2.4	2.07	0.08	0.36	0.06	40	2	110	122
Rockfish, rosethorn	1.8	1.56	0.06	0.22	0.04	30	2	74	91
Rockfish, rosy	1.5	1.30	0.05	0.27	0.05	25	2	77	76
Rockfish, Mexican	0.7	0.61	0.02	0.12	0.02	12	1	36	36
Rockfish, blackgill	0.4	0.35	0.01	0.07	0.01	7	0	20	20
Rockfish, redbanded	0.4	0.35	0.01	0.07	0.01	7	0	20	20
Grand Total	2922.7	2526.06	91.33	125.68	22.22	49258	24851	73665	148532

Number of tows sampled	32
Sampled prawns landed by location	1157
Total prawns landed by sampled boats	19500
Total prawns landed by location	58800

Appendix 1.2. Summary of other fishes, by weight, in observed spot prawn trawl tows from northern California, based on location of tow, 2000-2001, with calculated expansions to entire fleet for a 1-year period.. (Total estimated pounds with 95% bounds are expanded in Column 7 for boats that were sampled, based on ratio of their total spot prawn landings to landings from observed tows during the 1-year sampling period. Total estimated pounds are further expanded for all vessels in fishery based on ratio of total spot prawn landings to total landings of observed vessels)

Common name of bycatch species	Estimated pounds in sampled catch	Pounds per 1000 labs prawns	Mean pounds per tow	Standard deviation	Standard error of mean	Estimated total bycatch sampled boats	Lower 95% bound sampled boats	Upper 95% bound sampled boats	Estimated total catch from all boats
Hake, Pacific	2817	902	52	63	9	68722	46213	91231	126983
Sole, Dover	2728	873	51	62	8	66541	44363	88719	122952
Sablefish	2027	649	38	144	20	49448	2027	101091	91369
Sole, English	1612	516	30	39	5	39307	25240	53375	72631
Sole, Rex	988	316	18	22	3	24106	16242	31971	44543
Ratfish	716	229	13	39	5	17467	3587	31347	32275
Sole, Slender	588	188	11	20	3	14334	7163	21505	26486
Sanddab, Pacific	352	113	7	15	2	8593	3129	14056	15877
Sculpin sp.	262	84	5	34	5	6378	262	18598	11786
Eelpout, Bigfin	208	67	4	9	1	5072	2005	8139	9372
Sole, Petrale	137	44	3	9	1	3345	169	6521	6181
Skate, Longnose	112	36	2	5	1	2736	1012	4460	5055
Midshipman, Plainfin	103	33	2	8	1	2515	103	5490	4647
Skate, Sandpaper	90	29	2	5	1	2197	502	3892	4060
Skate, Big	86	28	2	6	1	2104	86	4310	3887
Flounder, Arrowtooth	78	25	1	4	1	1903	404	3401	3515
Shark, Filetail Cat	35	11	1	4	0	852	35	2133	1574
Dogfish, Spiny	33	11	1	2	0	805	33	1658	1487
Argentine, Pacific	32	10	1	2	0	774	32	1555	1430
Cusk-eel, Spotted	32	10	1	2	0	770	106	1433	1423
Thornyhead, Shortspine	27	9	1	3	0	664	27	1669	1227
Snailfish, Blacktail	25	8	0	1	0	602	162	1041	1111
Poacher, Blackedge	25	8	0	1	0	598	184	1011	1104
Shark, Brown cat	13	4	0	1	0	305	13	826	563
Rattail	10	3	0	1	0	244	10	733	451
Sculpin, Threadfin	10	3	0	1	0	241	10	502	446
Turbot, Curlfin	9	3	0	1	0	220	9	660	406
Ray, Pacific electric	6	2	0	1	0	146	6	363	270
Poacher, Bluespotted	5	2	0	0	0	132	5	300	244
Combfish, Shortspine	5	2	0	0	0	129	5	293	239
Brotula, Red	5	2	0	1	0	122	5	366	225
Combfish sp.	5	2	0	0	0	122	5	297	225
Thornyhead sp.	5	2	0	1	0	122	5	366	225
Poacher sp..	4	1	0	0	0	98	4	215	180
Sculpin, Staghorn	4	1	0	0	0	93	4	192	171
Sole, Sand	4	1	0	0	0	85	4	257	158
Poacher, Smootheye	1	0	0	0	0	20	1	59	36
Skate sp.	0	0	0	0	0	0	0	0	0
Grand Total	13197	4225	244	226	31	321911	240868	402954	594817

Number of tows sampled	54
Sampled prawns landed by location	3124
Total prawns landed by sampled boats	76200
Total prawns landed by location	140800

Appendix 1.4 Summary of other fishes, by weight, in observed spot prawn trawl tows from southern California, based on location of tow, 2000-2001, with calculated expansions to entire fleet for a 1-year period. (Total estimated pounds with 95% bounds are expanded in Column 7 for boats that were sampled, based on ratio of their total spot prawn landings to landings from observed tows during the 1-year sampling period. Total estimated pounds are further expanded for all vessels in fishery based on ratio of total spot prawn landings to total landings of observed vessels)

Common name of bycatch species	Estimated pounds in sampled catch	Pounds per 1000 labs prawns	Mean pounds per tow	Standard deviation	Standard error of mean	Estimated total bycatch sampled boats	Lower 95% bound sampled boats	Upper 95% bound sampled boats	Estimated total catch from all boats
Hake, Pacific	5826	5035	182.1	195.7	34.6	98191	60177	136205	296084
Sanddab, Pacific	3508	3032	109.6	568.7	100.5	59127	3508	169571	178290
Sole, Slender	1219	1054	38.1	33.8	6.0	20549	13979	27118	61962
Sole, Dover	636	550	19.9	29.1	5.1	10722	5077	16367	32332
Sablefish	623	538	19.5	62.2	11.0	10494	623	22581	31642
Midshipman, Plainfin	412	356	12.9	26.2	4.6	6946	1867	12026	20946
Sole, Rex	345	298	10.8	10.2	1.8	5811	3824	7799	17524
Sole, English	238	205	7.4	11.1	2.0	4006	1855	6157	12080
Ratfish	208	180	6.5	12.7	2.2	3512	1055	5970	10591
Eelpout, Bigfin	149	129	4.6	6.5	1.1	2507	1244	3770	7560
Argentine, Pacific	69	59	2.1	2.7	0.5	1156	634	1678	3486
Combfish, Shortspine	60	52	1.9	2.9	0.5	1019	465	1573	3073
Poacher, Blackedge	58	50	1.8	3.0	0.5	978	395	1562	2950
Combfish sp.	52	45	1.6	3.4	0.6	876	207	1546	2643
Thornyhead, Shortspine	40	35	1.3	7.1	1.3	674	40	2047	2033
Cusk-eel, Spotted	36	31	1.1	2.2	0.4	603	171	1034	1817
Poacher, Sturgeon	29	25	0.9	2.2	0.4	491	59	924	1481
Sculpin, Threadfin	27	23	0.8	2.0	0.4	455	61	849	1372
Eelpout sp.	24	20	0.7	2.5	0.4	397	24	878	1197
Skate, Sandpaper	24	20	0.7	2.9	0.5	396	24	961	1194
Snailfish, Blacktail	20	17	0.6	1.8	0.3	341	20	684	1029
Shark, Swell	20	17	0.6	3.5	0.6	337	20	1024	1016
Shark, Filetail Cat	17	15	0.5	2.0	0.4	283	17	680	854
Dogfish, Spiny	15	13	0.5	2.7	0.5	253	15	768	762
Surfperch, Pink	10	9	0.3	1.0	0.2	174	10	369	524
Poacher sp.	10	9	0.3	1.1	0.2	170	10	380	512
Sole, Petrale	5	5	0.2	0.9	0.2	89	5	272	270
Skate, Big	5	4	0.2	0.9	0.2	84	5	256	254
Turbot, Hornyhead	5	4	0.2	0.6	0.1	84	5	206	254
Shark, Brown cat	5	4	0.1	0.6	0.1	76	5	200	229
Combfish, Longspine	3	3	0.1	0.5	0.1	51	3	154	152
Sculpin sp.	3	3	0.1	0.5	0.1	51	3	154	152
Shark, Sixgill	3	3	0.1	0.5	0.1	51	3	154	152
Skate, California	2	2	0.1	0.4	0.1	34	2	102	102
Scabbardfish, Pacific	1	1	0.0	0.2	0.0	21	1	64	64
Grand Total	13707	11847	428.3	564.6	99.8	231010	121364	340655	696584

Number of tows sampled	32
Sampled prawns landed by location	1157
Total prawns landed by sampled boats	19500
Total prawns landed by location	58800

Figure 1. Length frequency histograms for aurora, bocaccio, and chilipepper rockfishes from observed spot prawn trawl tows from northern California vessels, 2000 - 01.

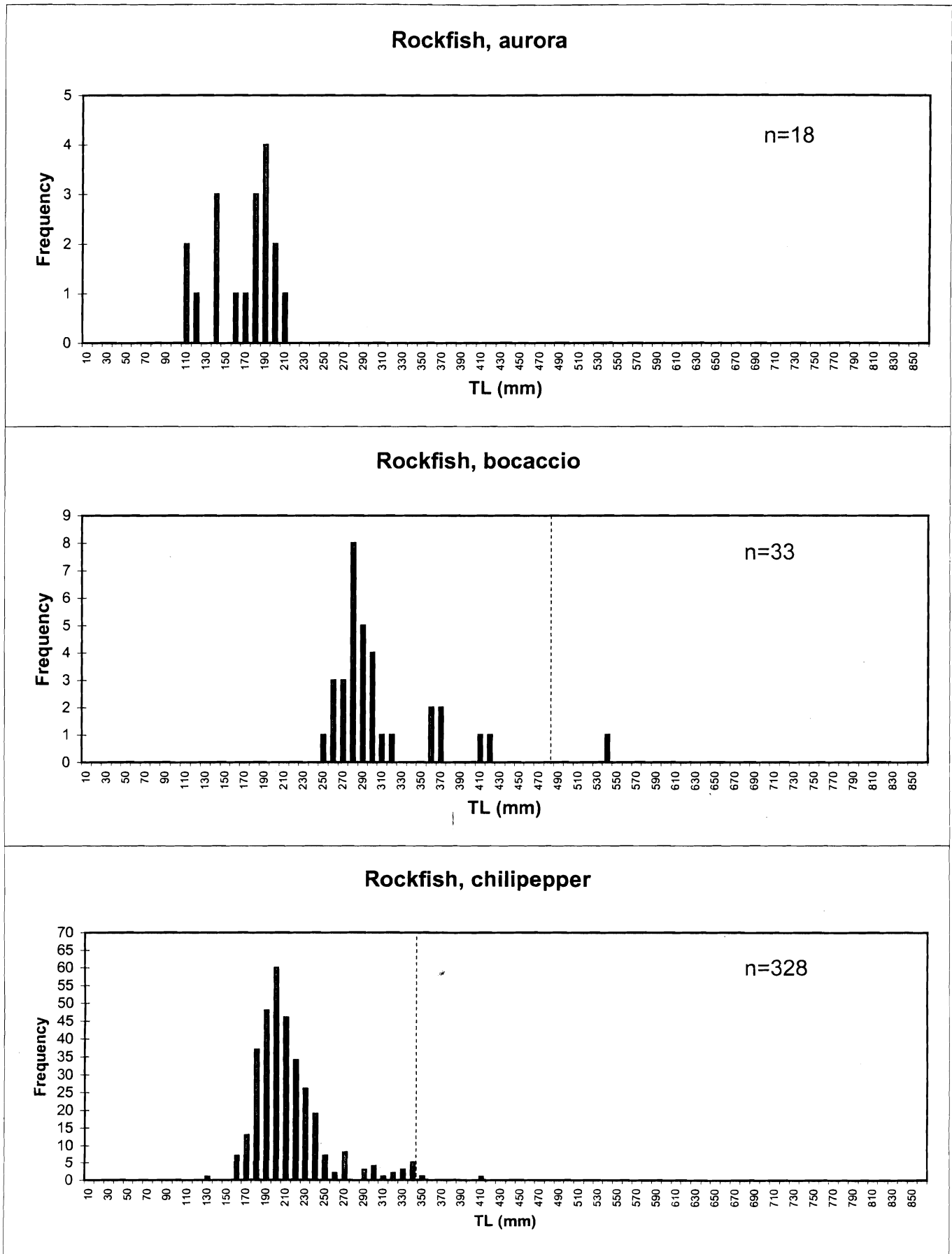


Figure 2. Length frequency histograms for cowcod, darkblotched, and greenspotted rockfishes from observed spot prawn trawl tows from northern California vessels, 2000 - 01.

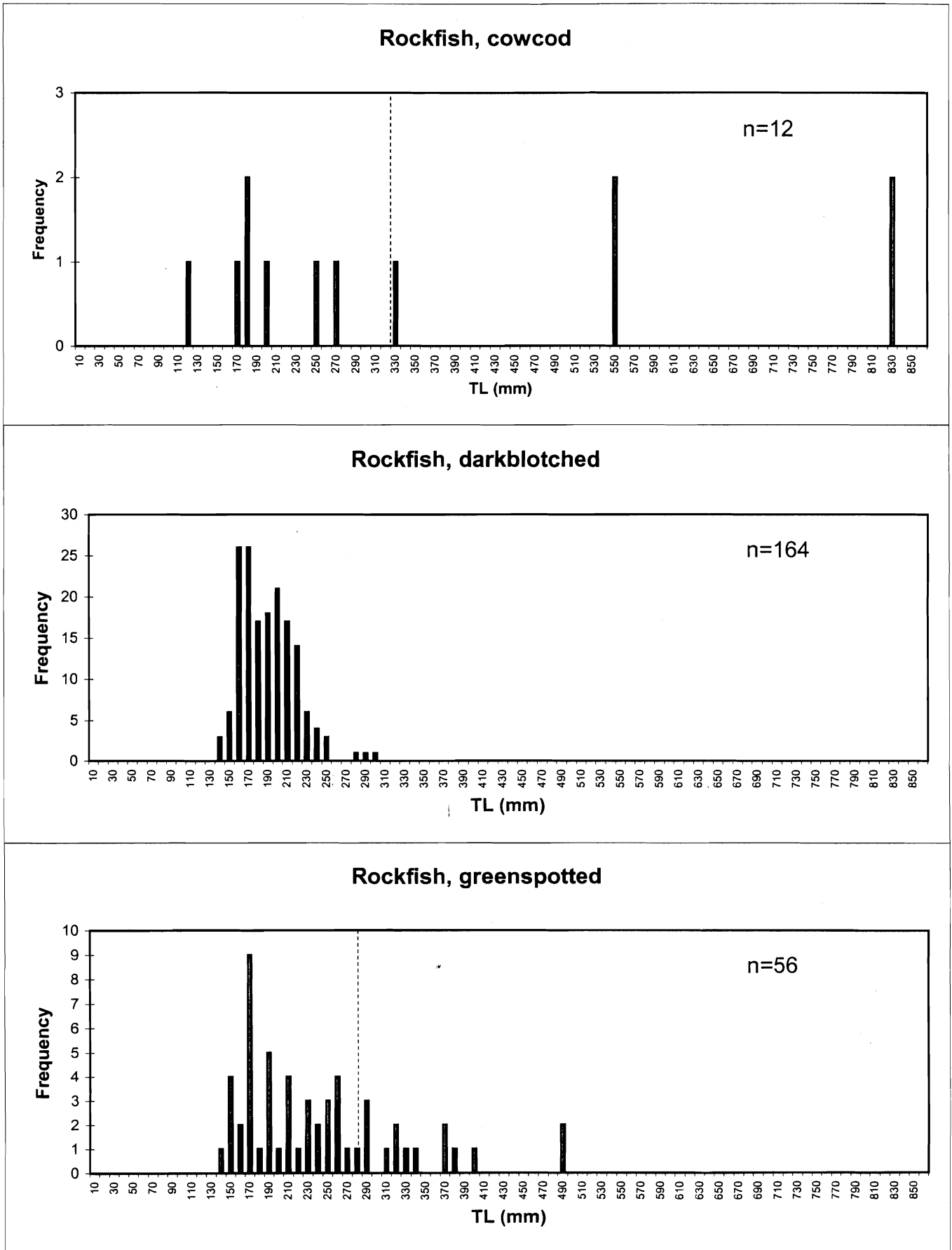


Figure 3. Length frequency histograms for greenstriped, redbanded, and redstripe rockfishes from observed spot prawn trawl tows from northern California vessels, 2000 - 01.

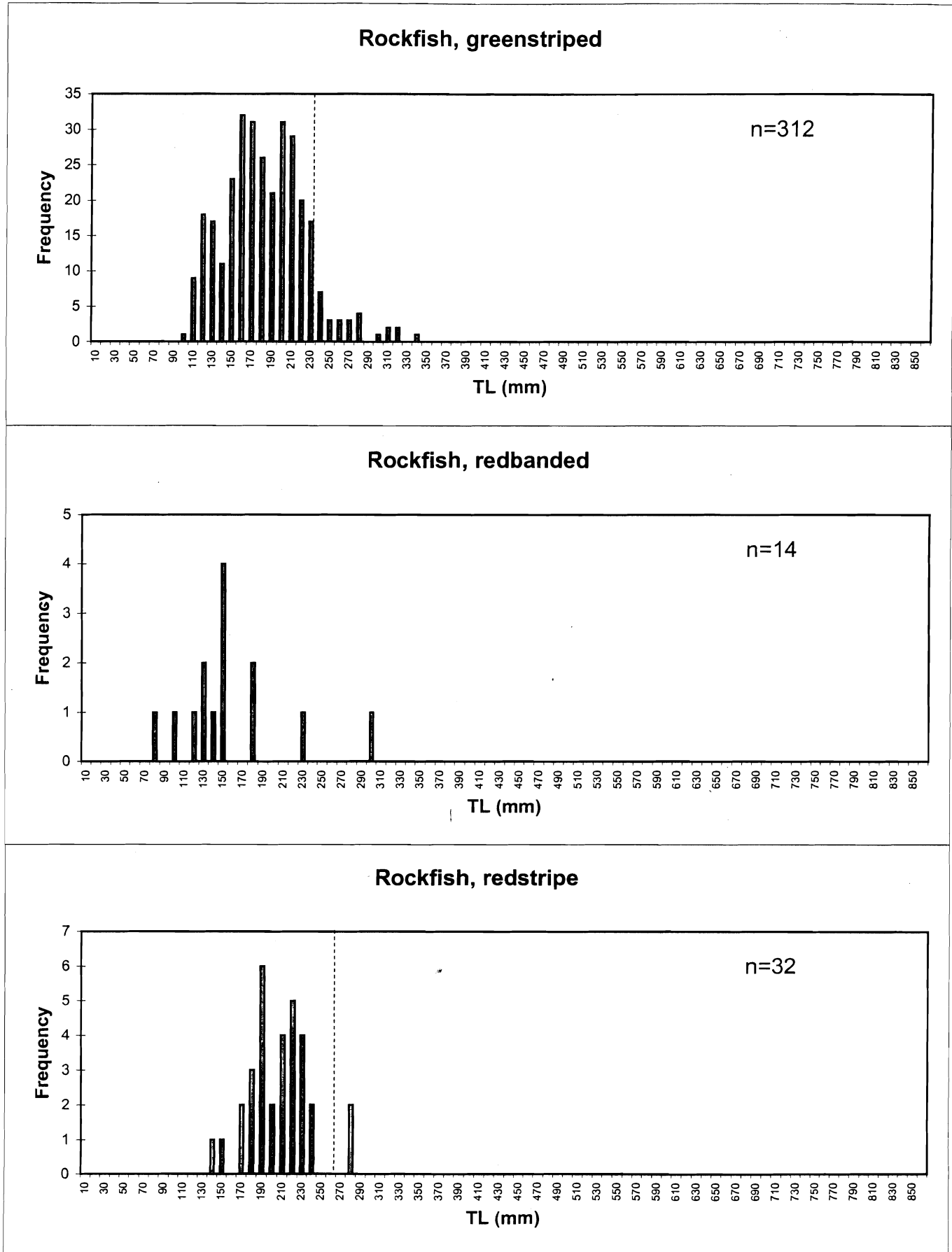


Figure 4. Length frequency histograms for bank, rosethorn, and sharpchin rockfishes from observed spot prawn trawl tows from northern California vessels, 2000 - 01.

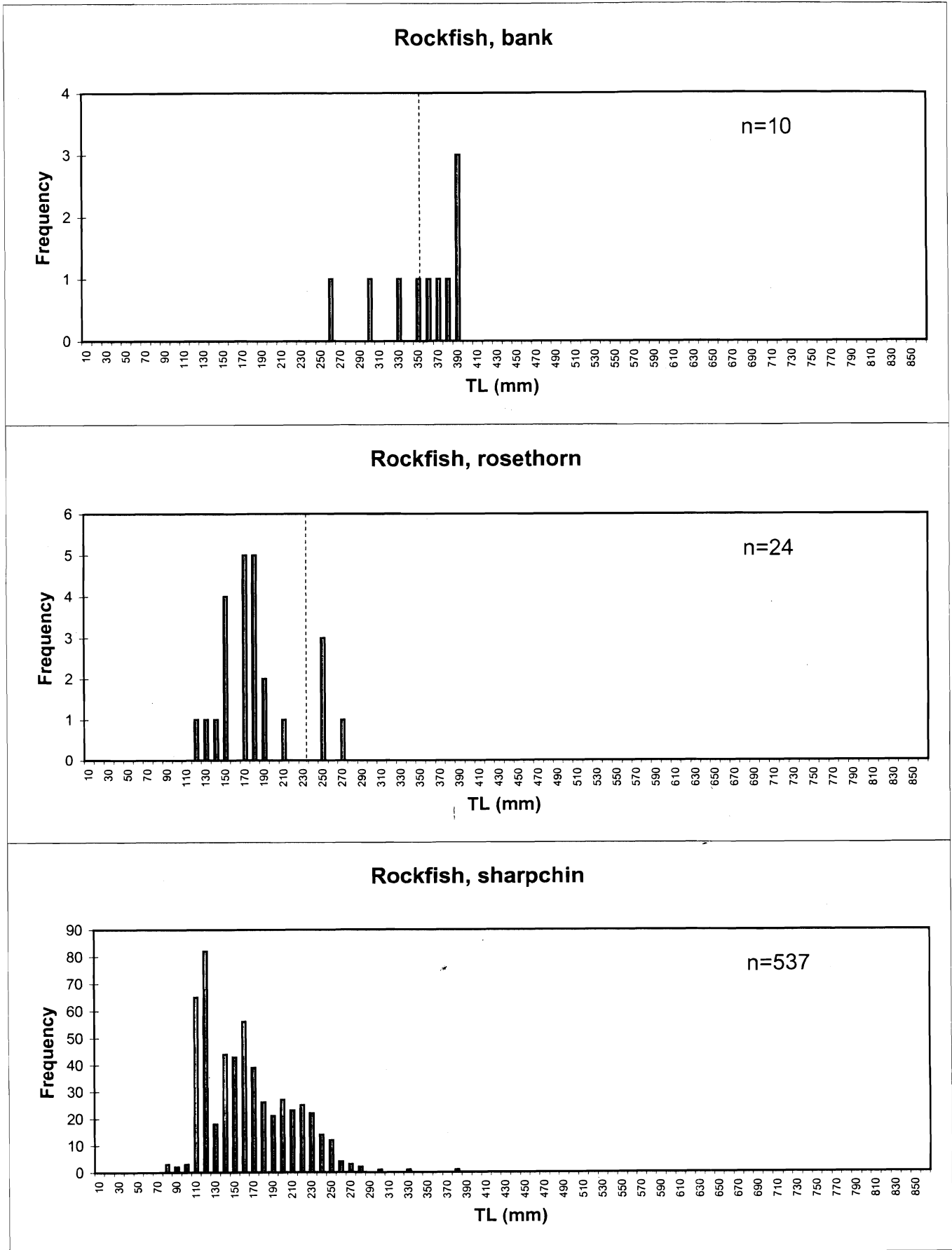


Figure 5. Length frequency histograms for shortbelly, splitnose, and striptail rockfishes from observed spot prawn trawl tows from northern California vessels, 2000 - 01.

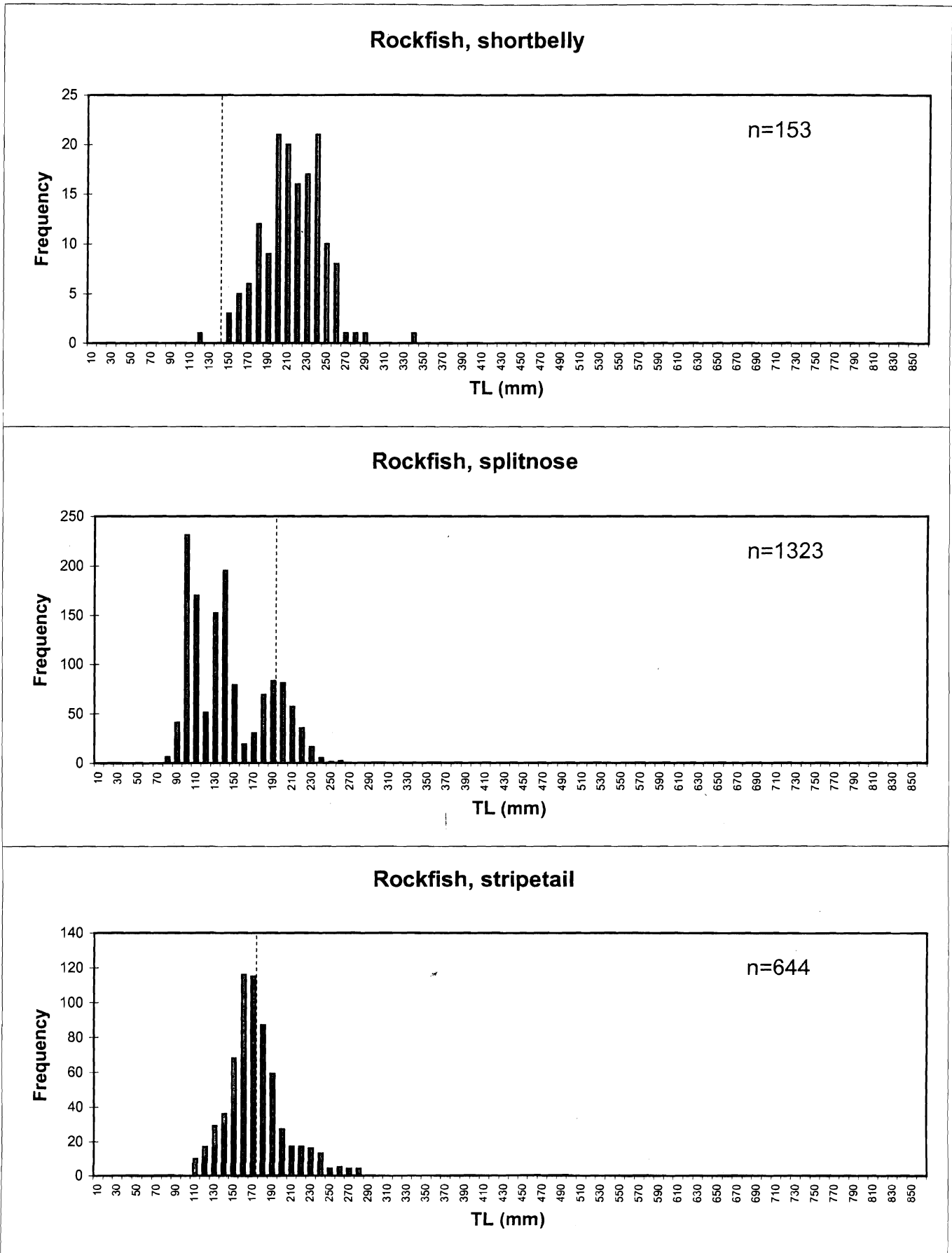


Figure 6. Length frequency histograms for widow and unspecified rockfishes from observed spot prawn trawl tows from northern California vessels, 2000 - 01.

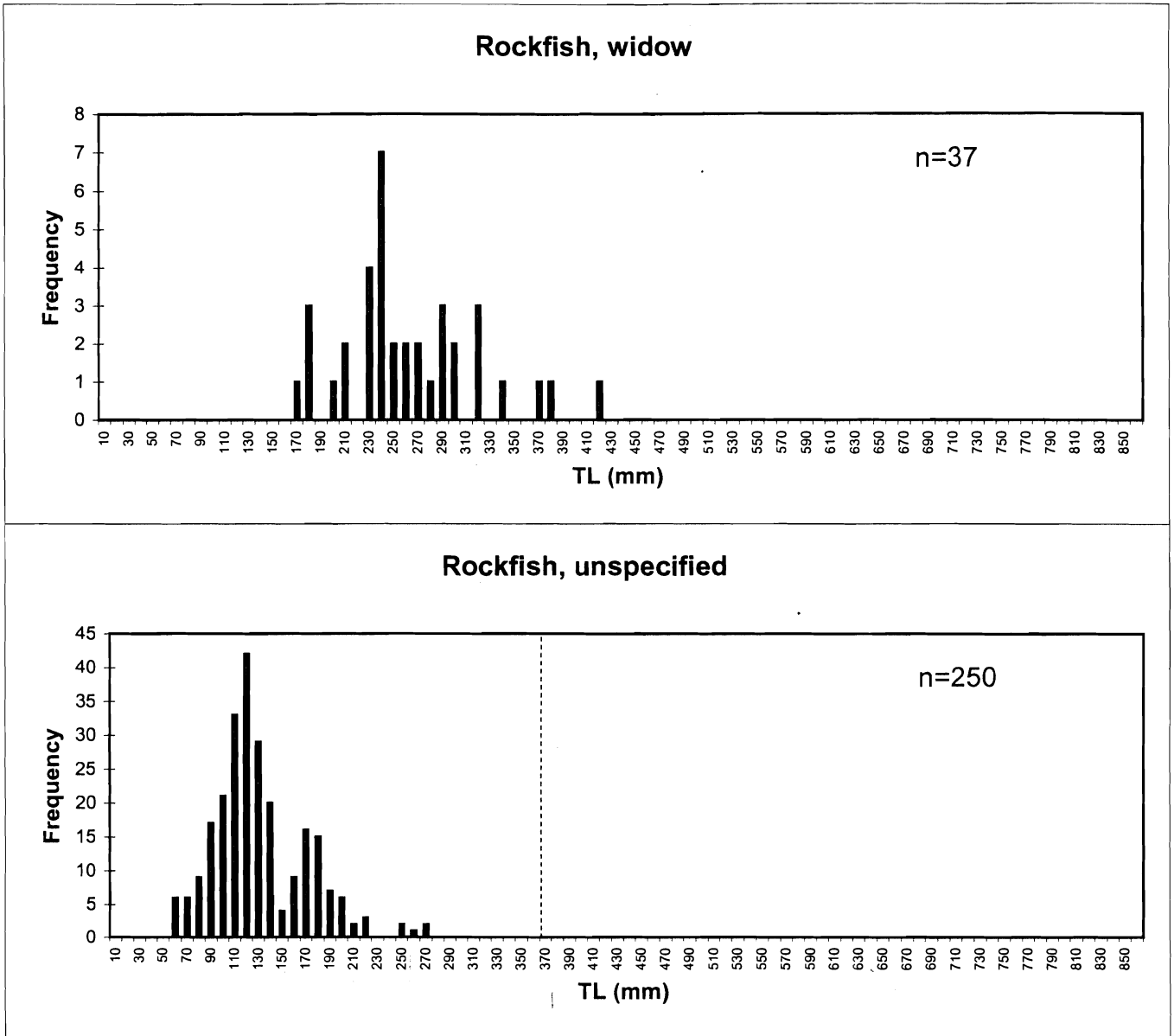


Figure 7. Length frequency histograms for Pacific argentine, spotted cusk-eel and bigfin eelpout from observed spot prawn trawl tows from northern California vessels, 2000 - 01.

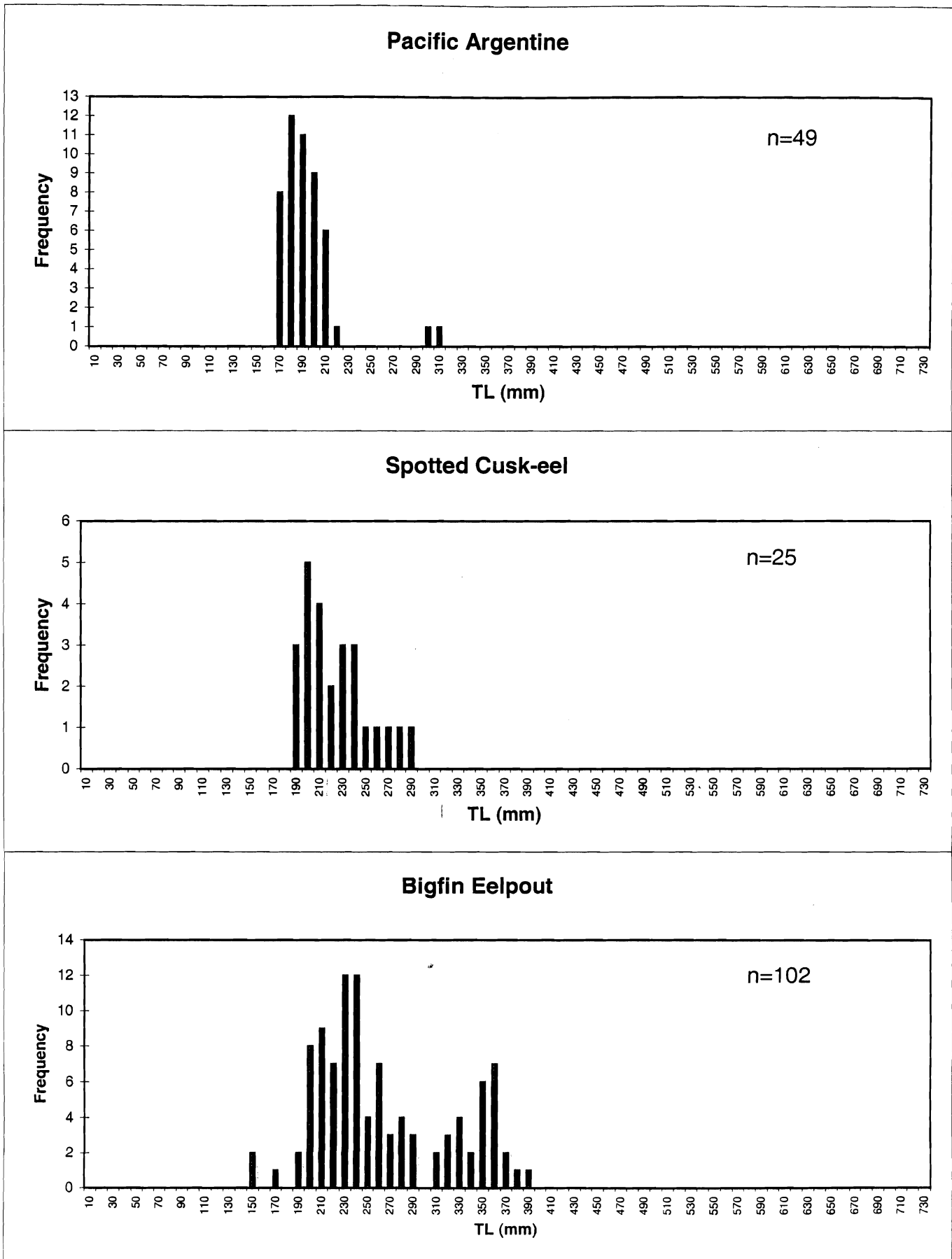


Figure 8. Length frequency histograms for arrowtooth flounder, Pacific hake and lingcod from observed spot prawn trawl tows from northern California vessels, 2000 - 01.

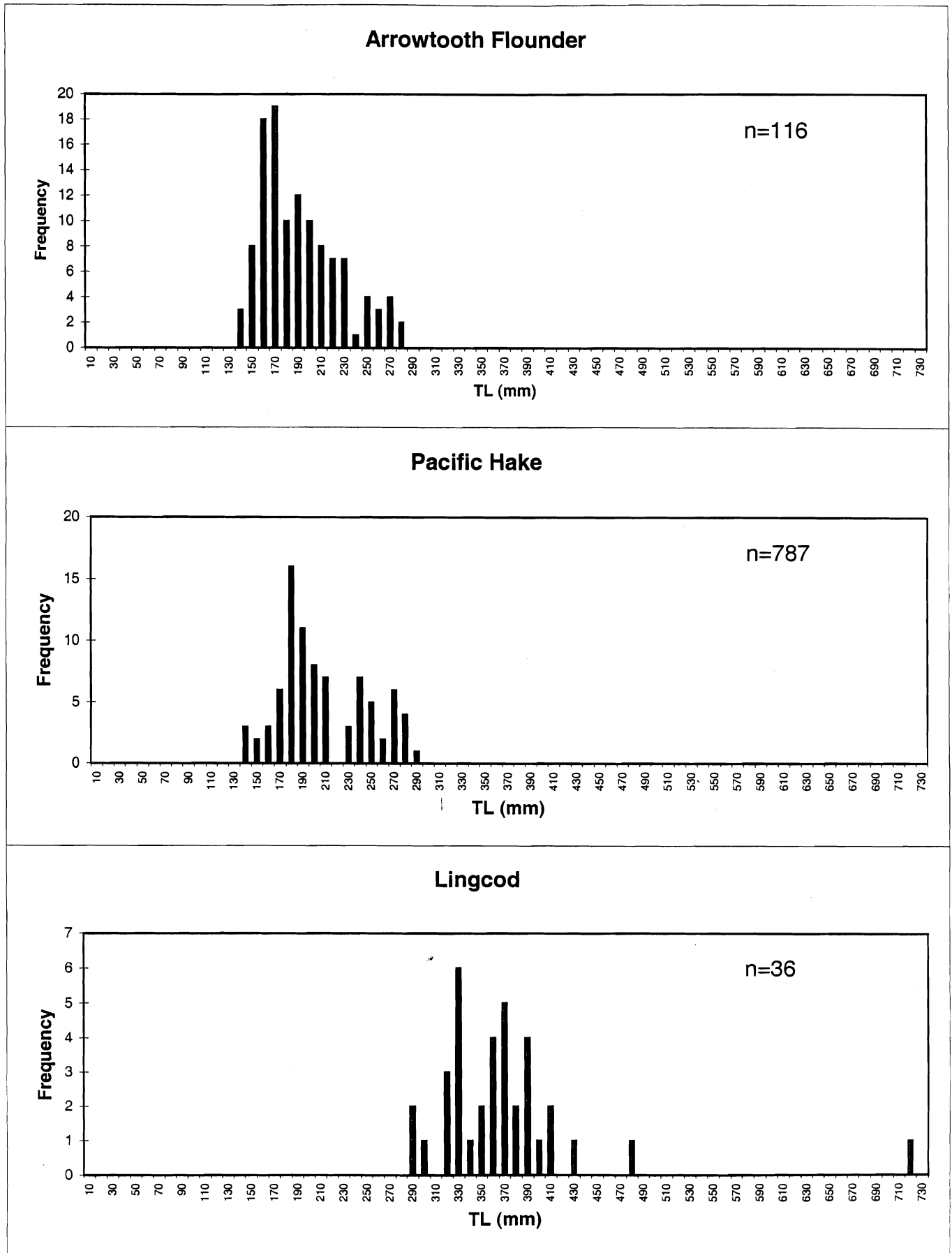


Figure 9. Length frequency histograms for plainfin midshipman, blackedge poacher, and spotted ratfish from observed spot prawn trawl tows from northern California vessels, 2000 - 01.

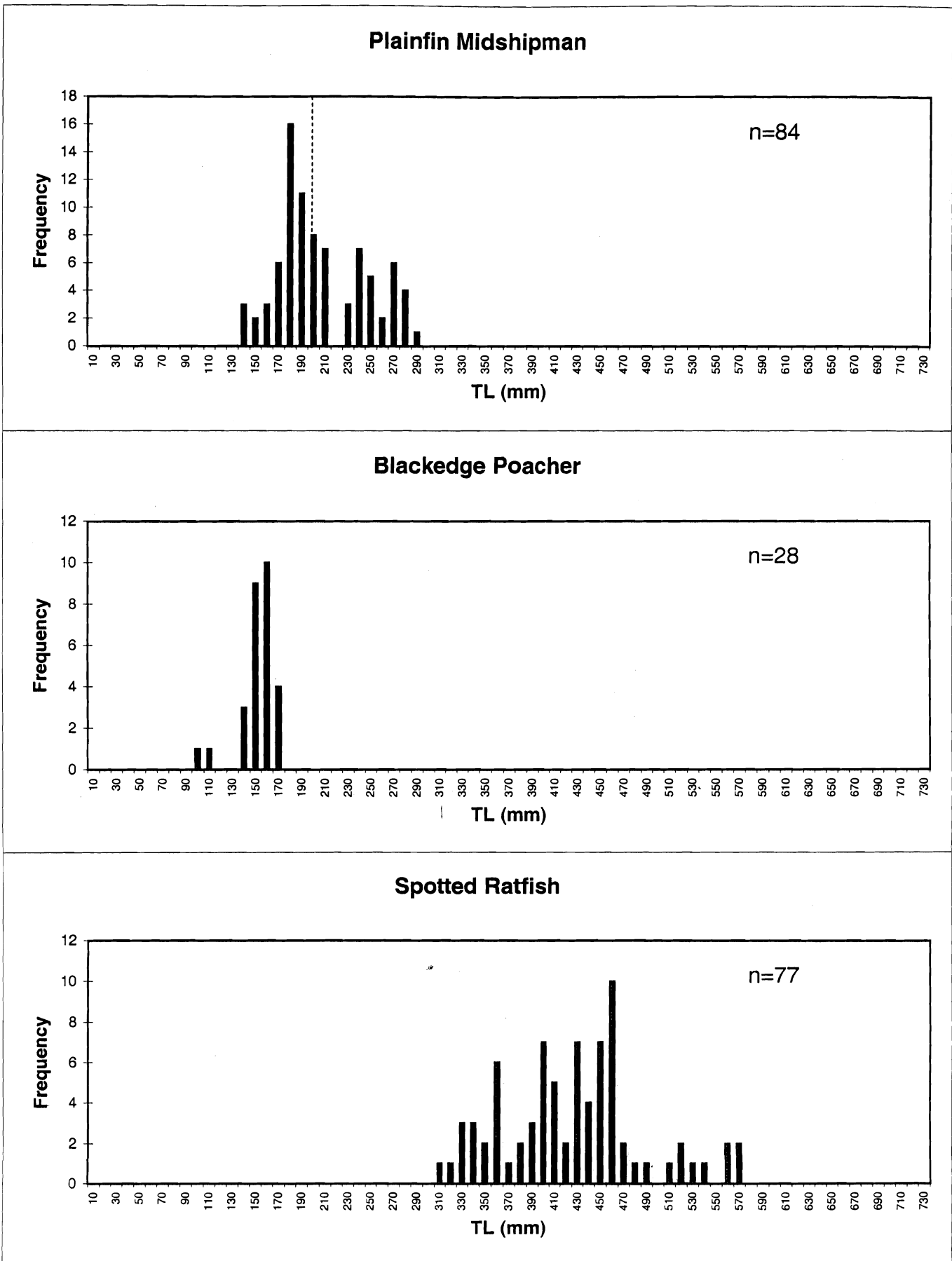


Figure 10. Length frequency histograms for sablefish, Pacific sanddab and threadfin sculpin from observed spot prawn trawl tows from northern California vessels, 2000 - 01.

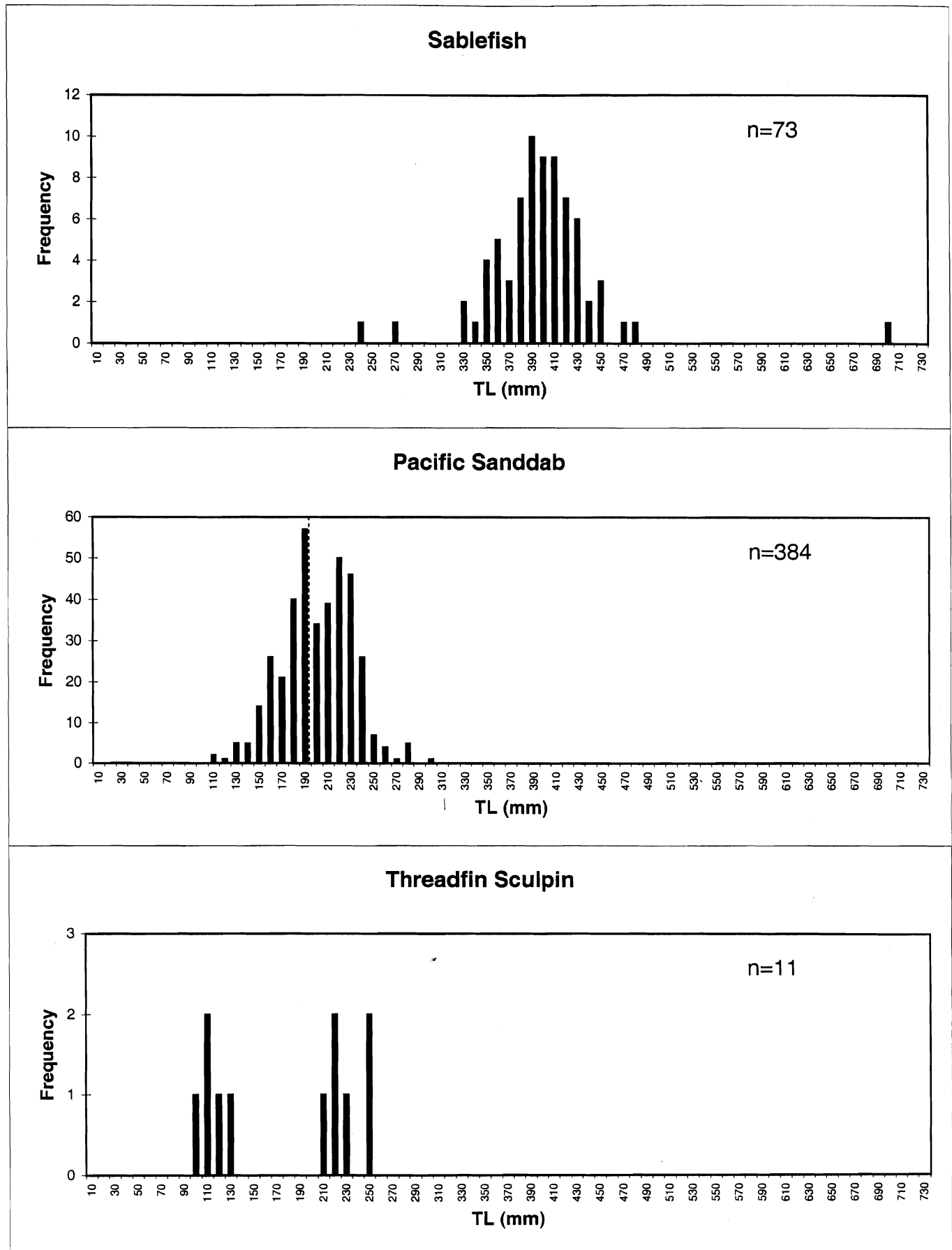


Figure 11. Length frequency histograms for big skate, longnose skate and sandpaper skate from observed spot prawn trawl tows from northern California vessels, 2000 - 01.

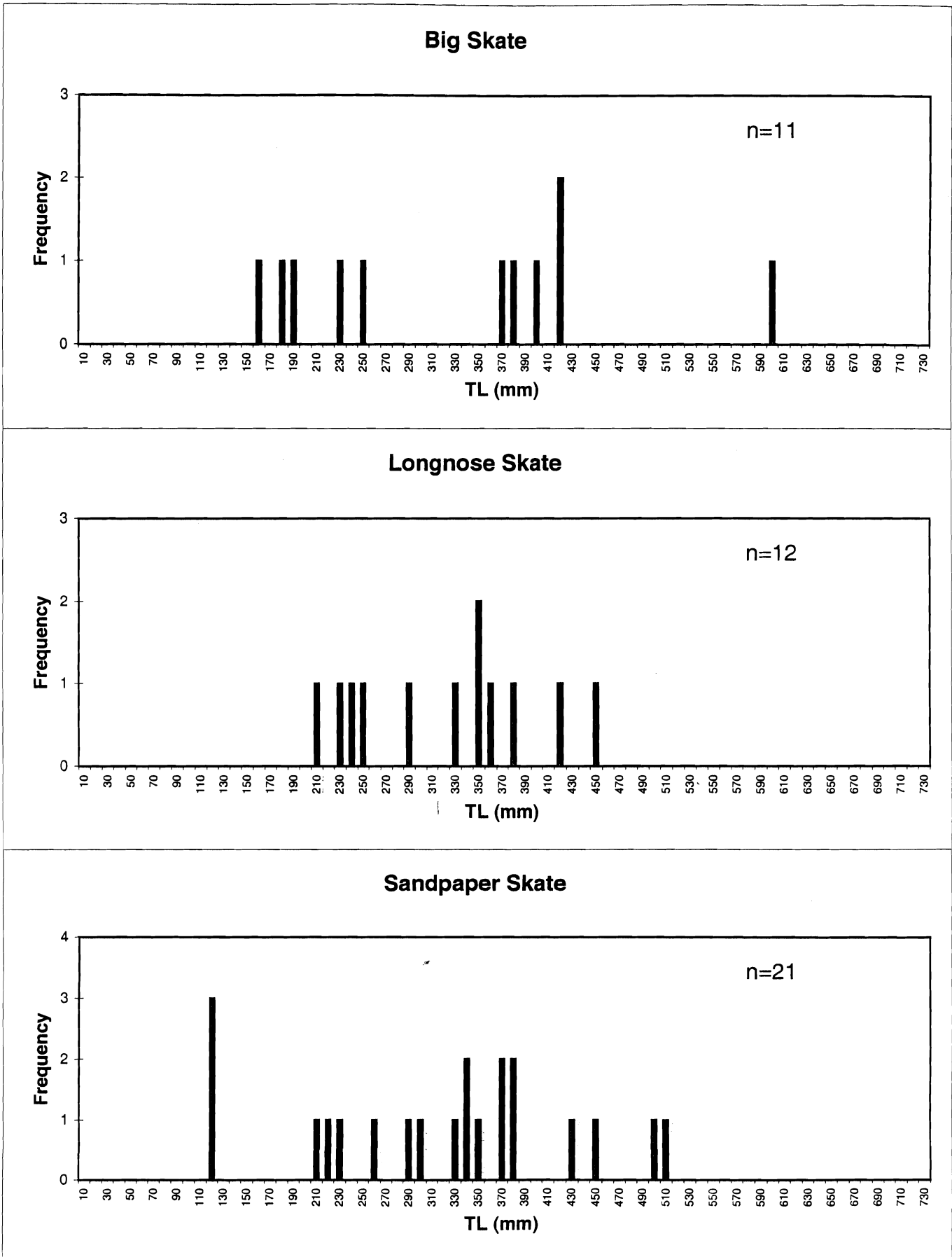


Figure 12. Length frequency histograms for blacktail snailfish, Dover sole and English sole from observed spot prawn trawl tows from northern California vessels, 2000 - 01.

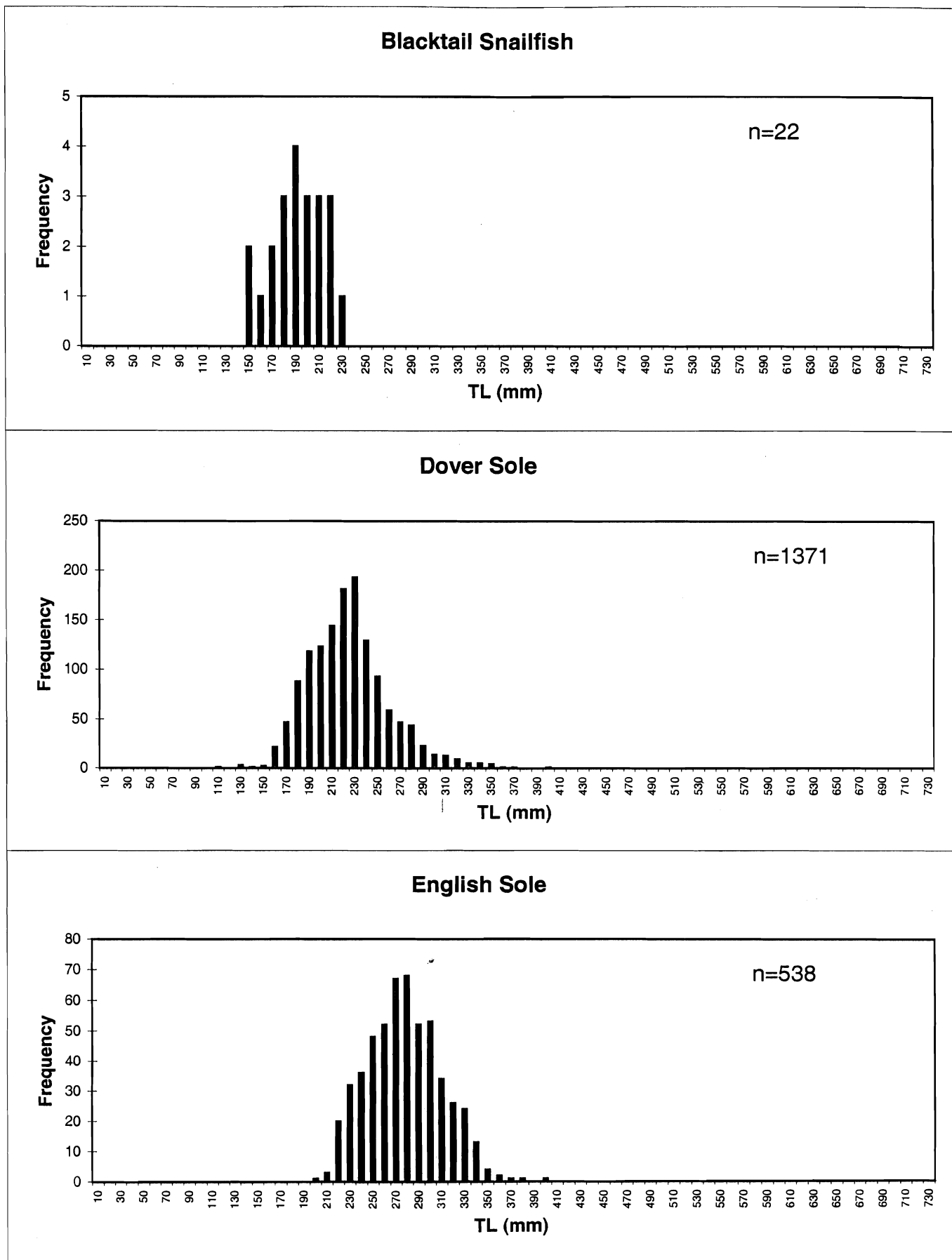


Figure 13. Length frequency histograms for petrale sole, rex sole and slender sole from observed spot prawn trawl tows from northern California vessels, 2000 - 01.

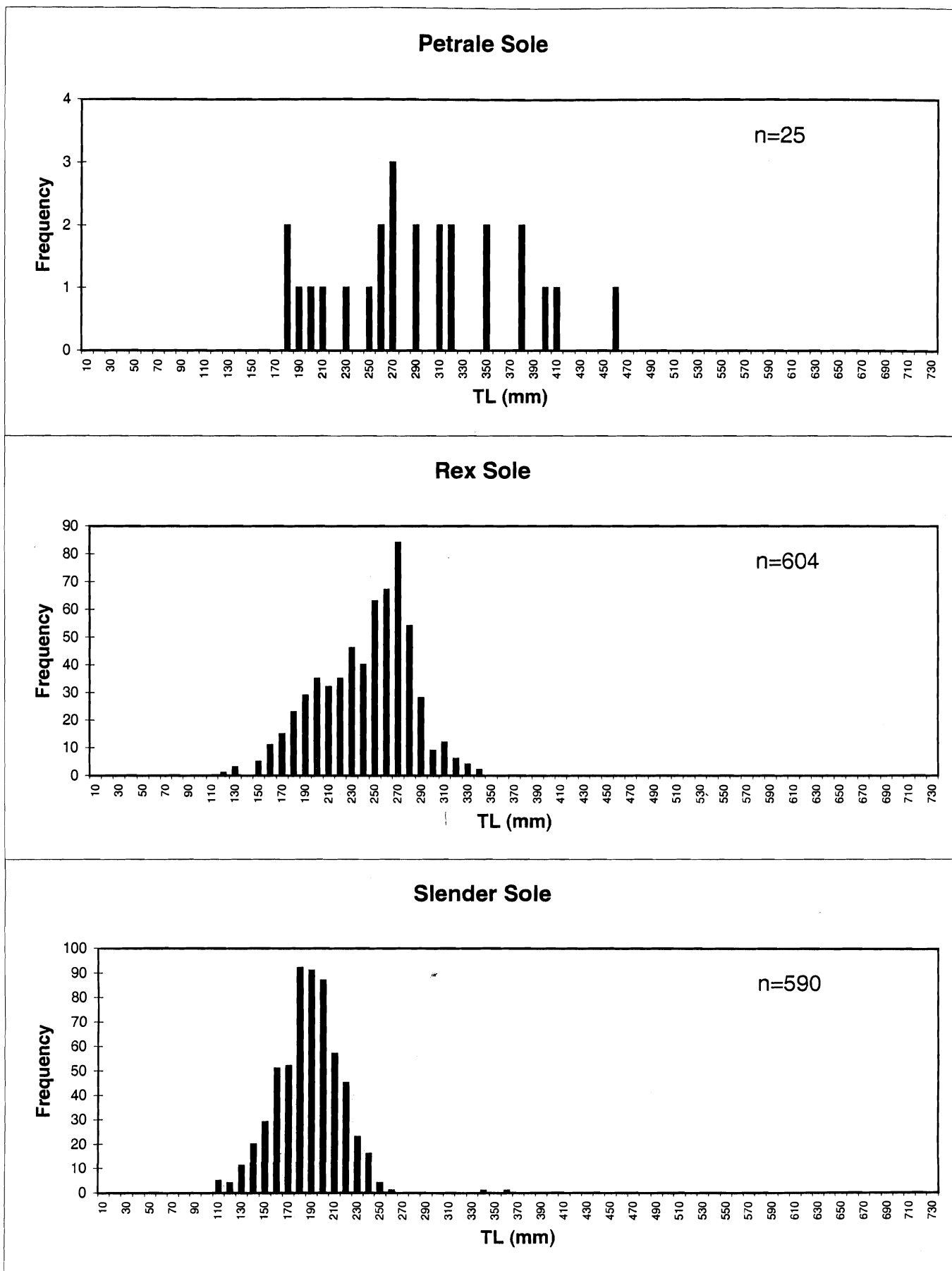


Figure 14. Length frequency histogram for shortspine thornyhead from observed spot prawn trawl tows from northern California vessels, 2000 - 01.

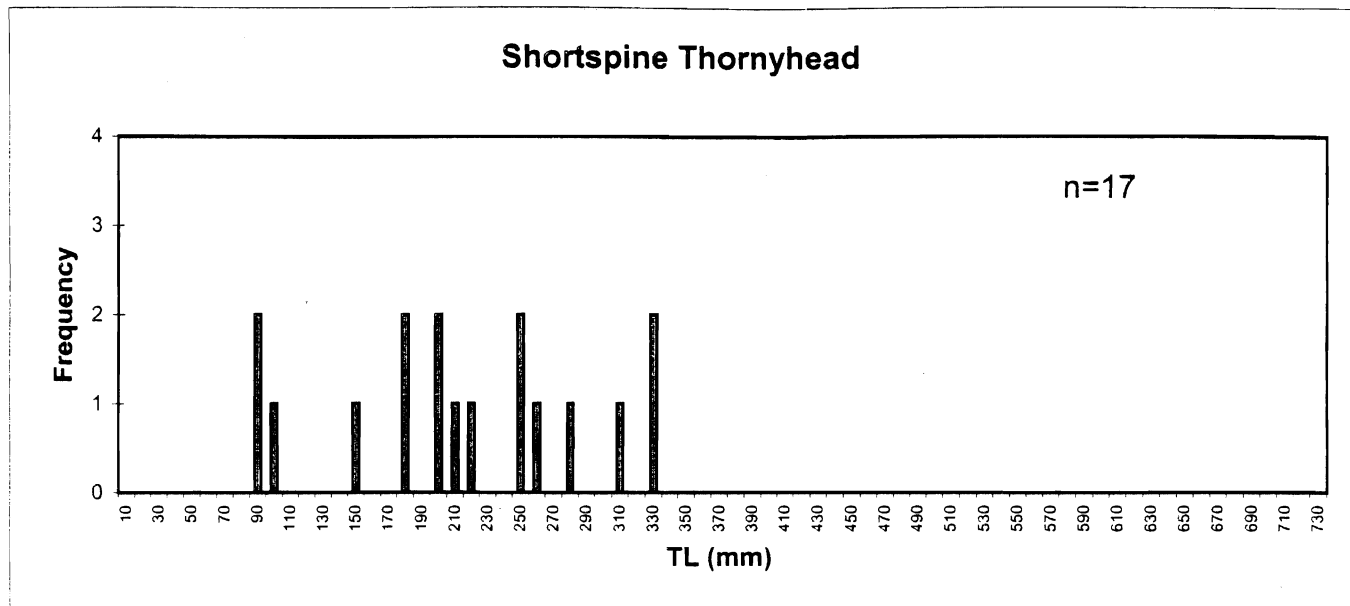


Figure 15. Length frequency histograms for chilipepper, halfbanded, and shortbelly rockfishes from observed spot prawn trawl tows from southern California vessels, 2000 - 01.

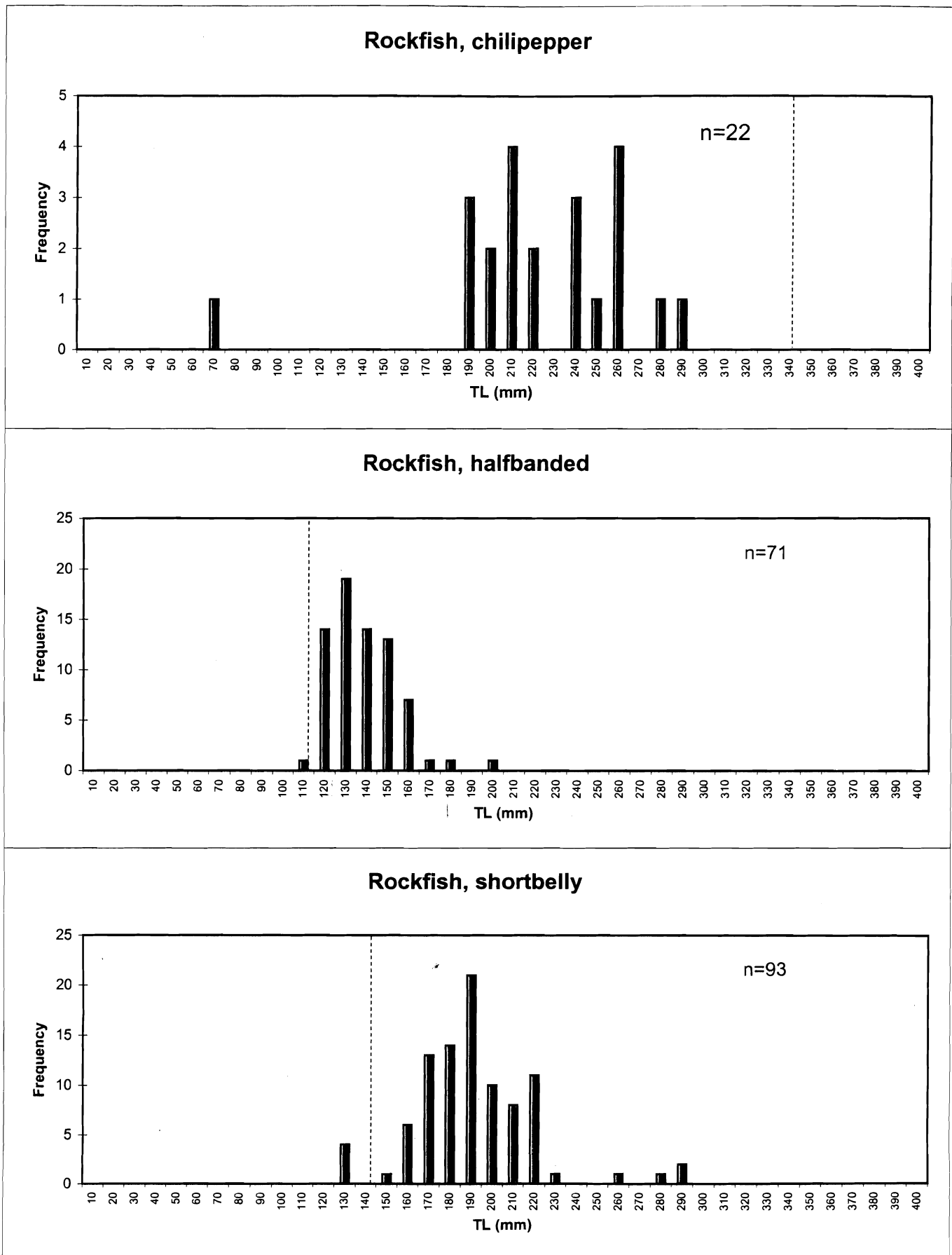


Figure 16. Length frequency histograms for striptetail and unspecified rockfishes from observed spot prawn trawl tows from southern California vessels, 2000 - 01.

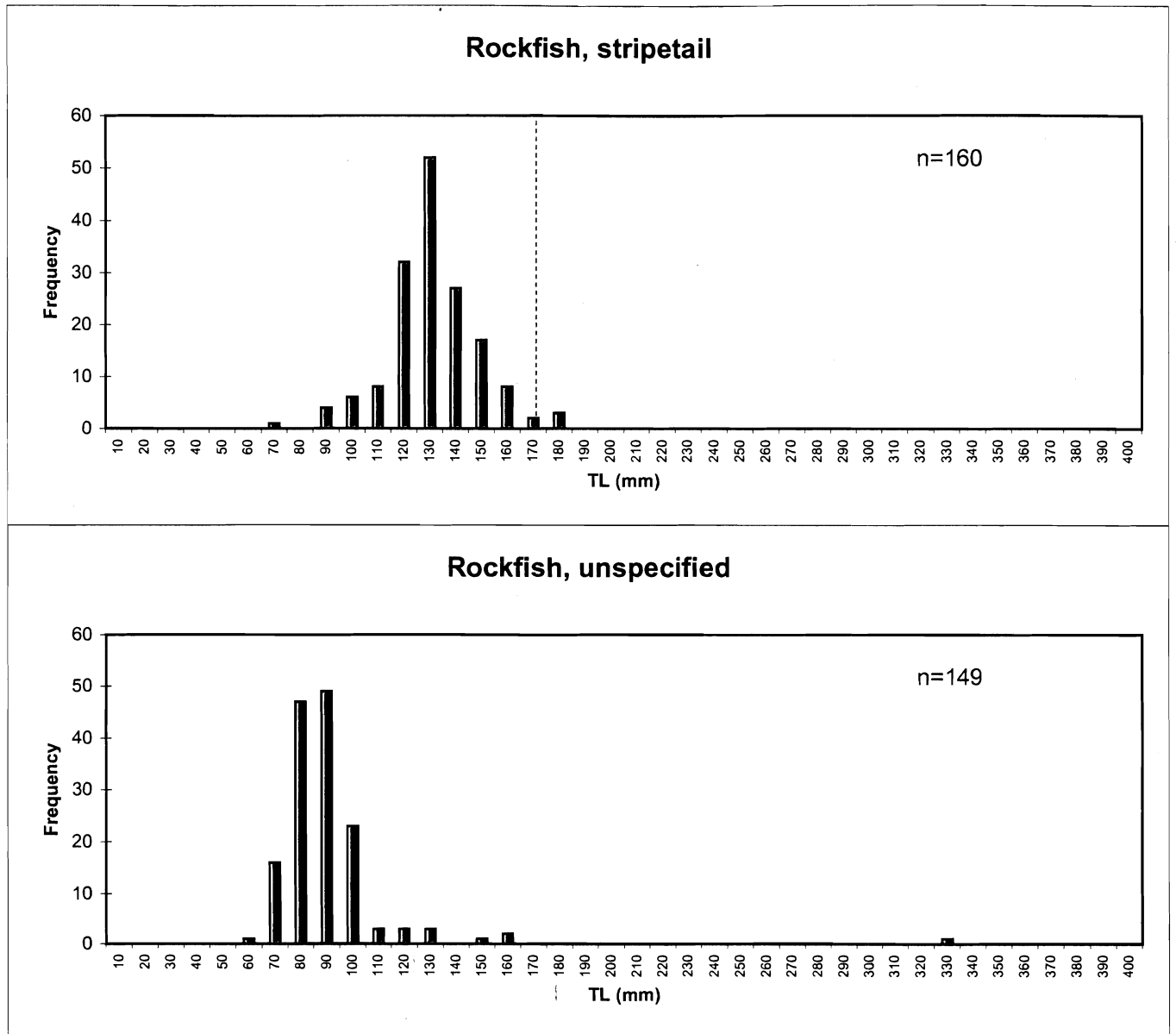


Figure 17. Length frequency histograms for Pacific argentine, shortspine combfish, and eelpout sp. from observed spot prawn trawl tows from southern California vessels, 2000 - 01.

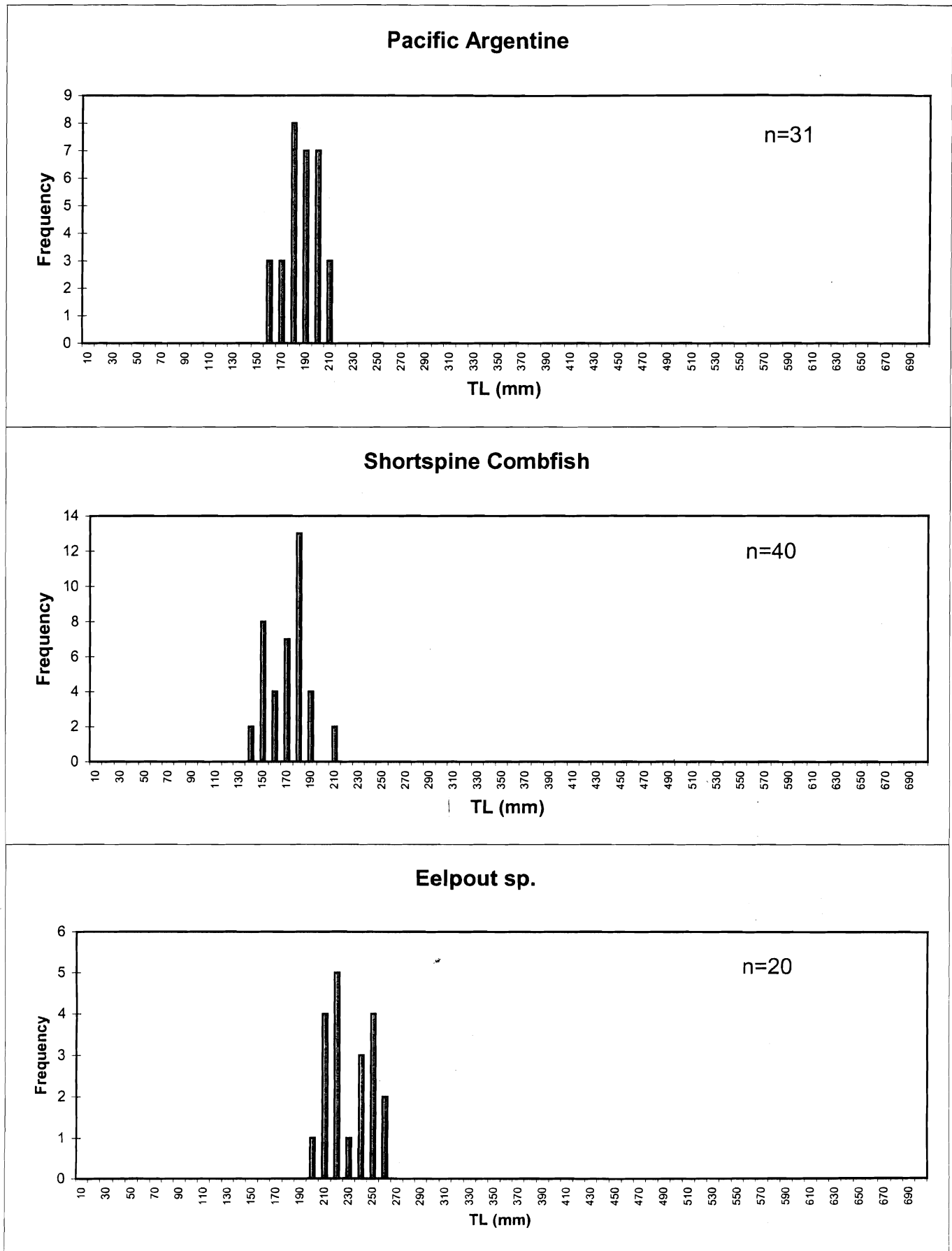


Figure 18. Length frequency histograms for bigfin eelpout, Pacific hake and plainfin midshipman from observed spot prawn trawl tows from southern California vessels, 2000 - 01.

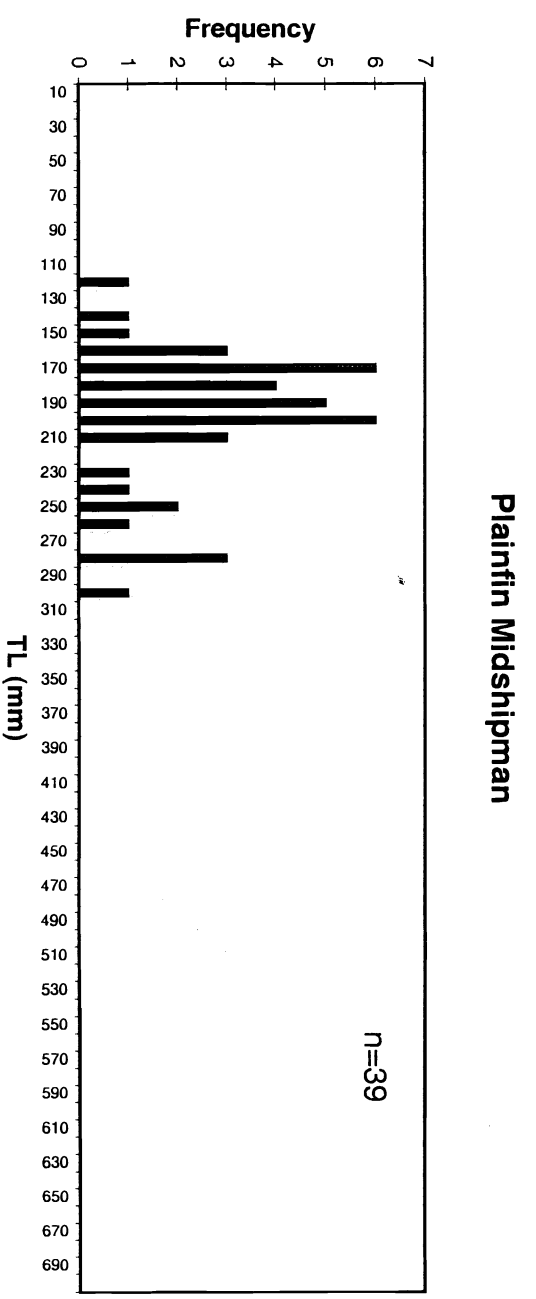
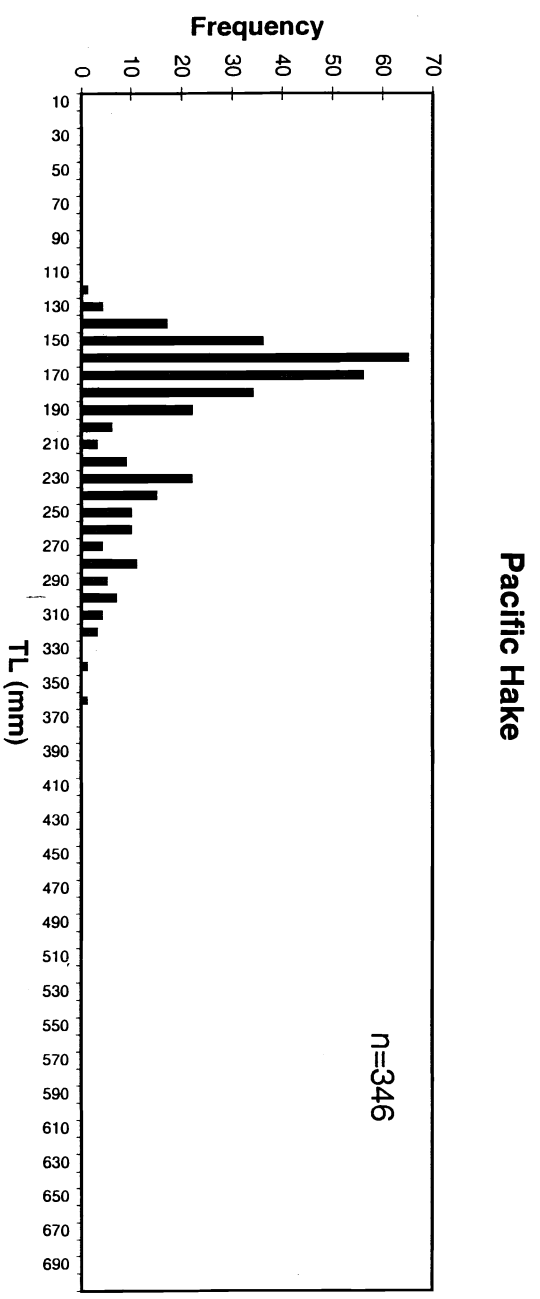
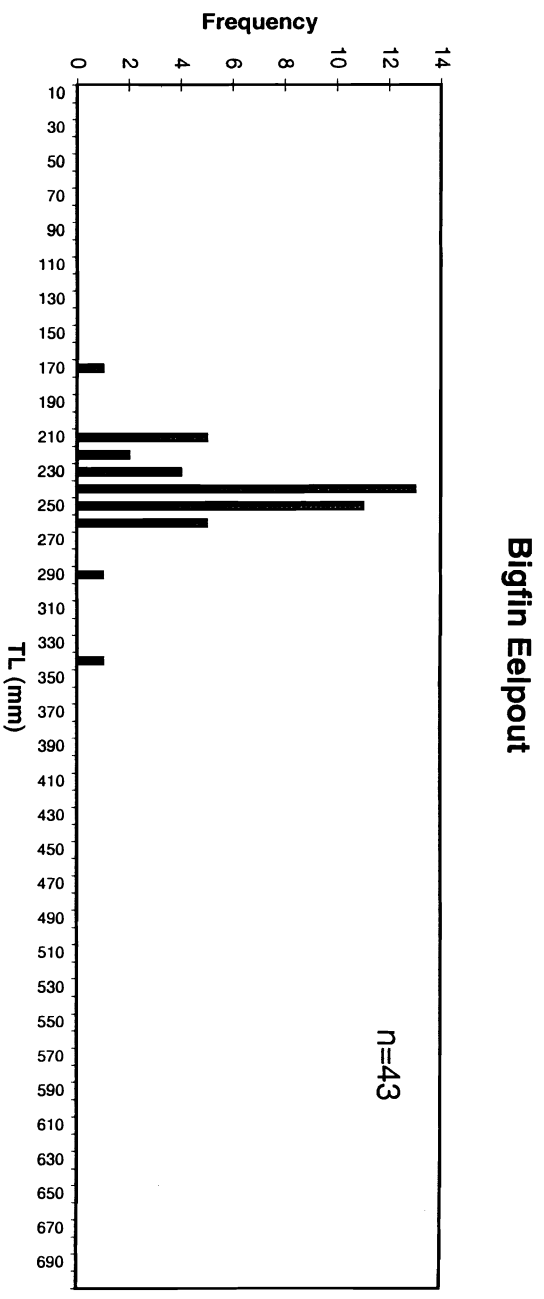


Figure 19. Length frequency histograms for poacher sp. sablefish and pink surfperch from observed spot prawn trawl tows from southern California vessels, 2000 - 01.

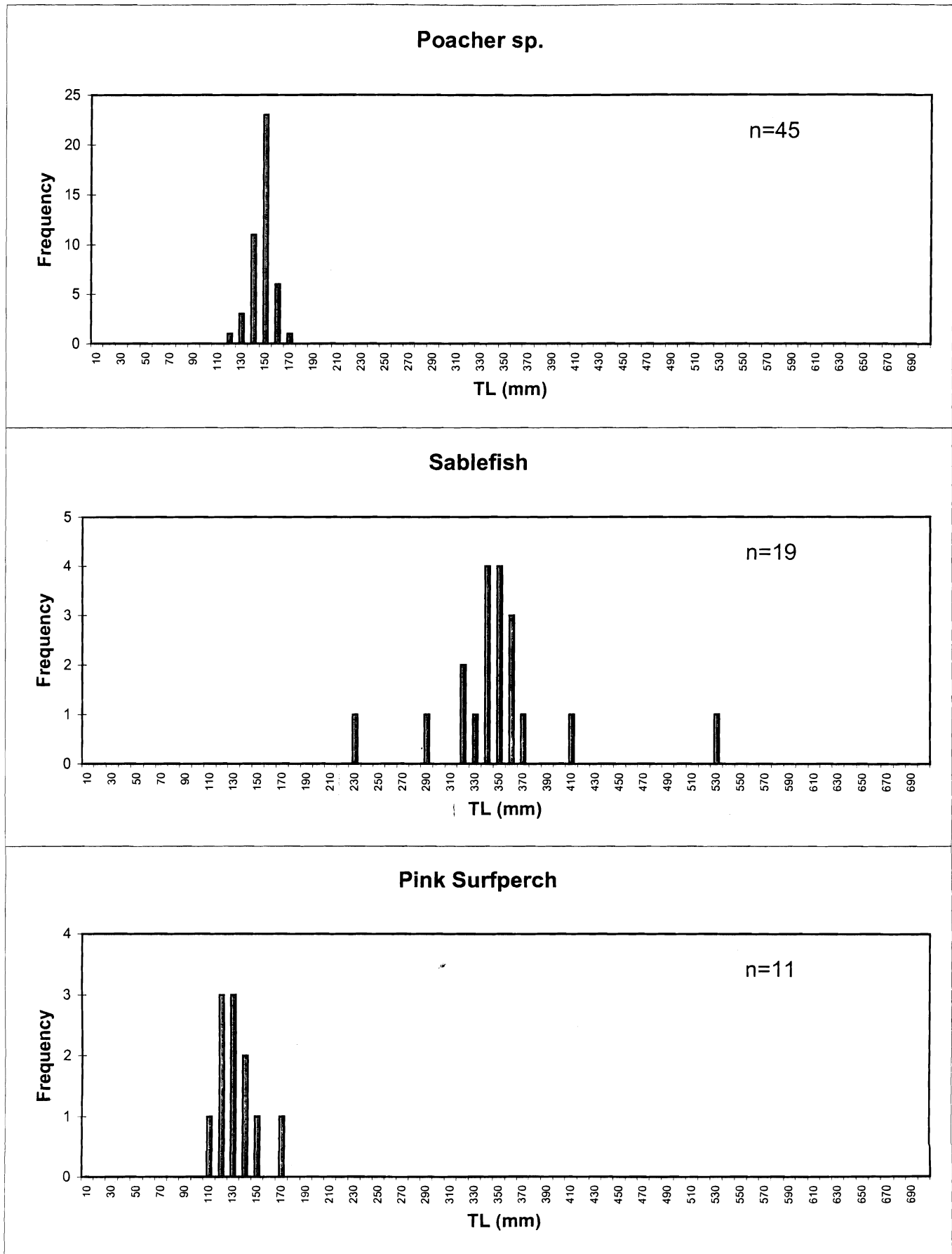


Figure 20. Length frequency histograms for Pacific sanddab, Dover sole and English sole from observed spot prawn trawl tows from southern California vessels, 2000 - 01.

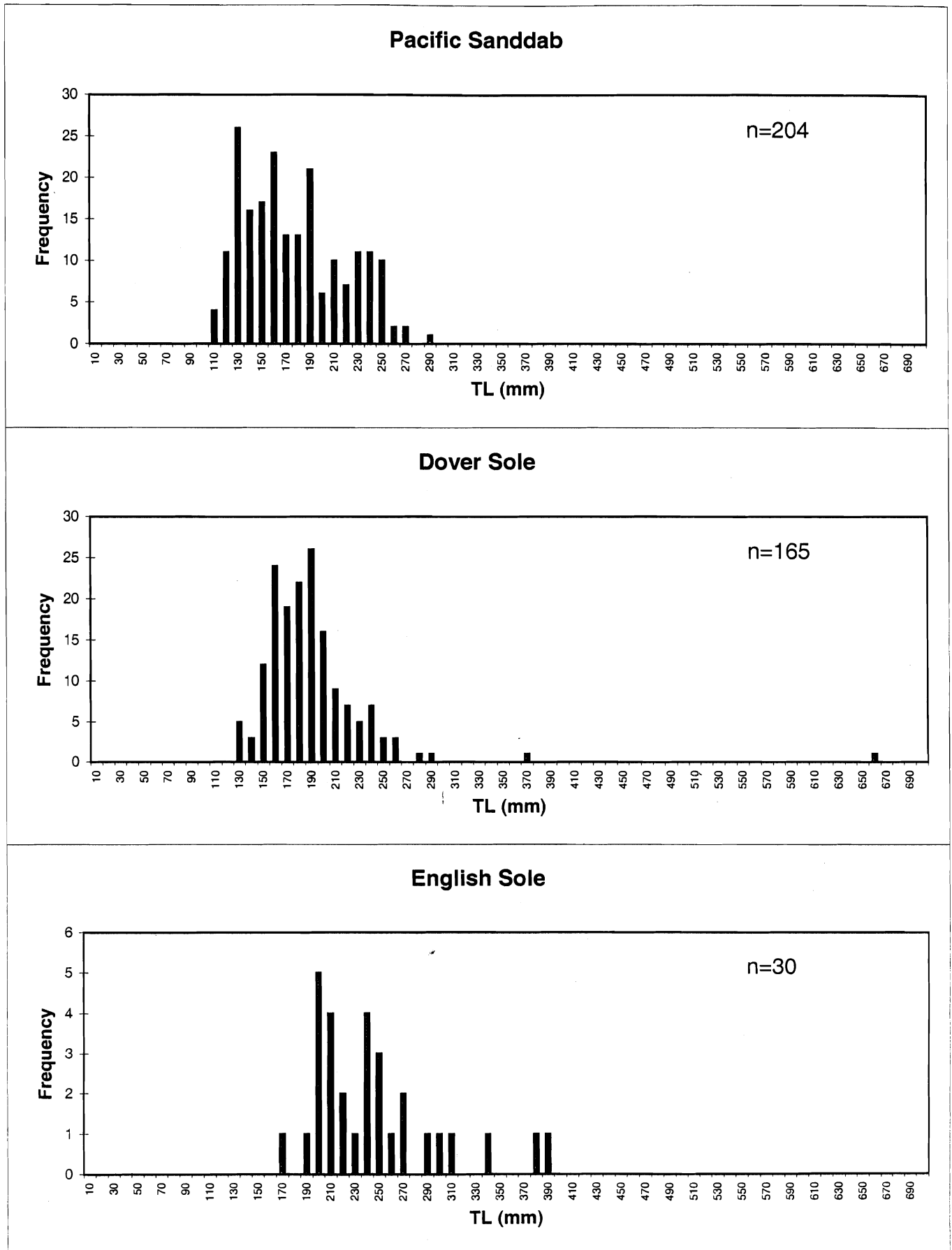


Figure 21. Length frequency histograms for rex sole and slender sole from observed spot prawn trawl tows from southern California vessels, 2000 - 01.

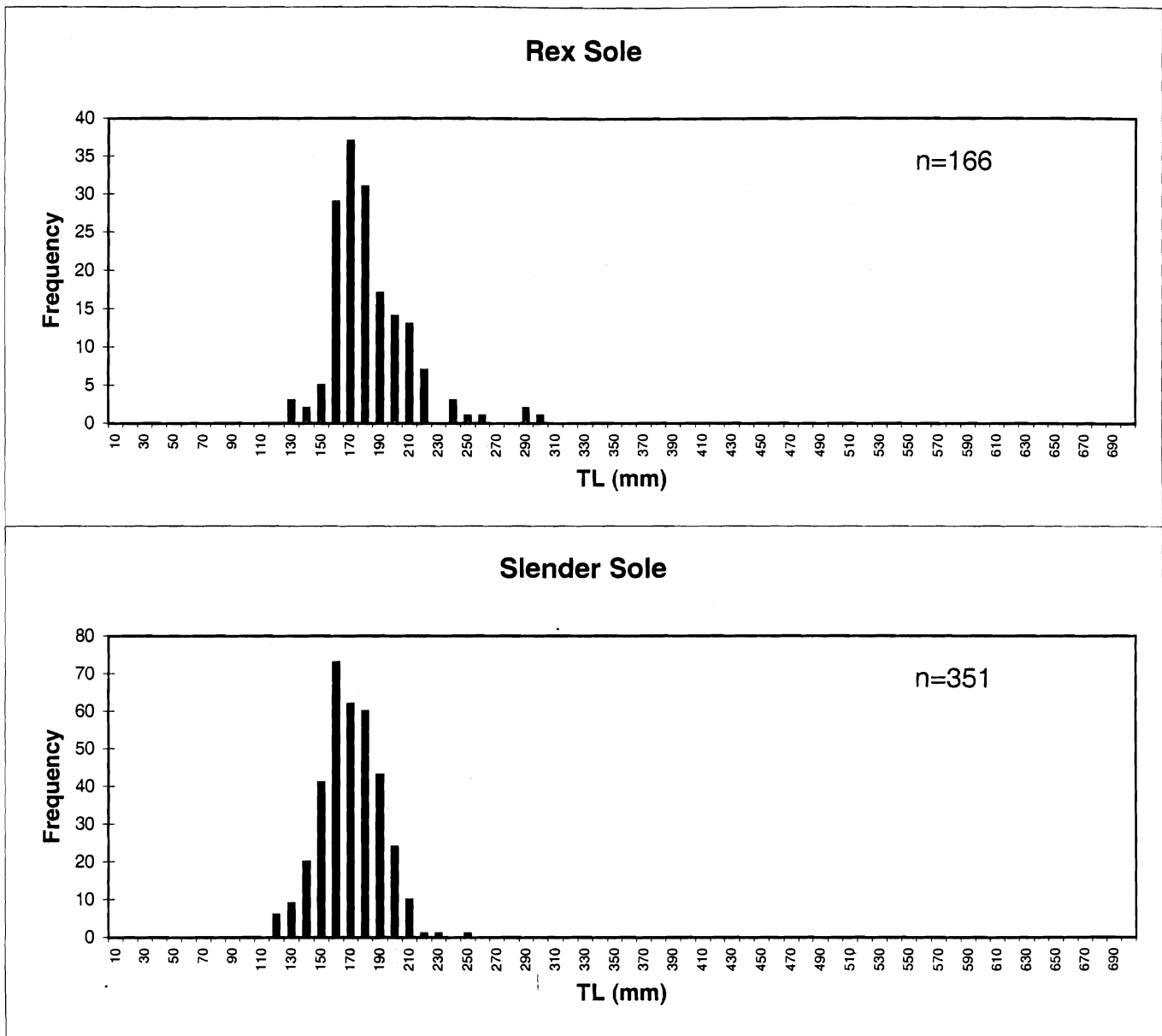


Figure 22. Length frequency histograms for blacktail snailfish, sablefish and spotted cusk-eel from observed spot prawn traps from northern California vessels, 2000–01.

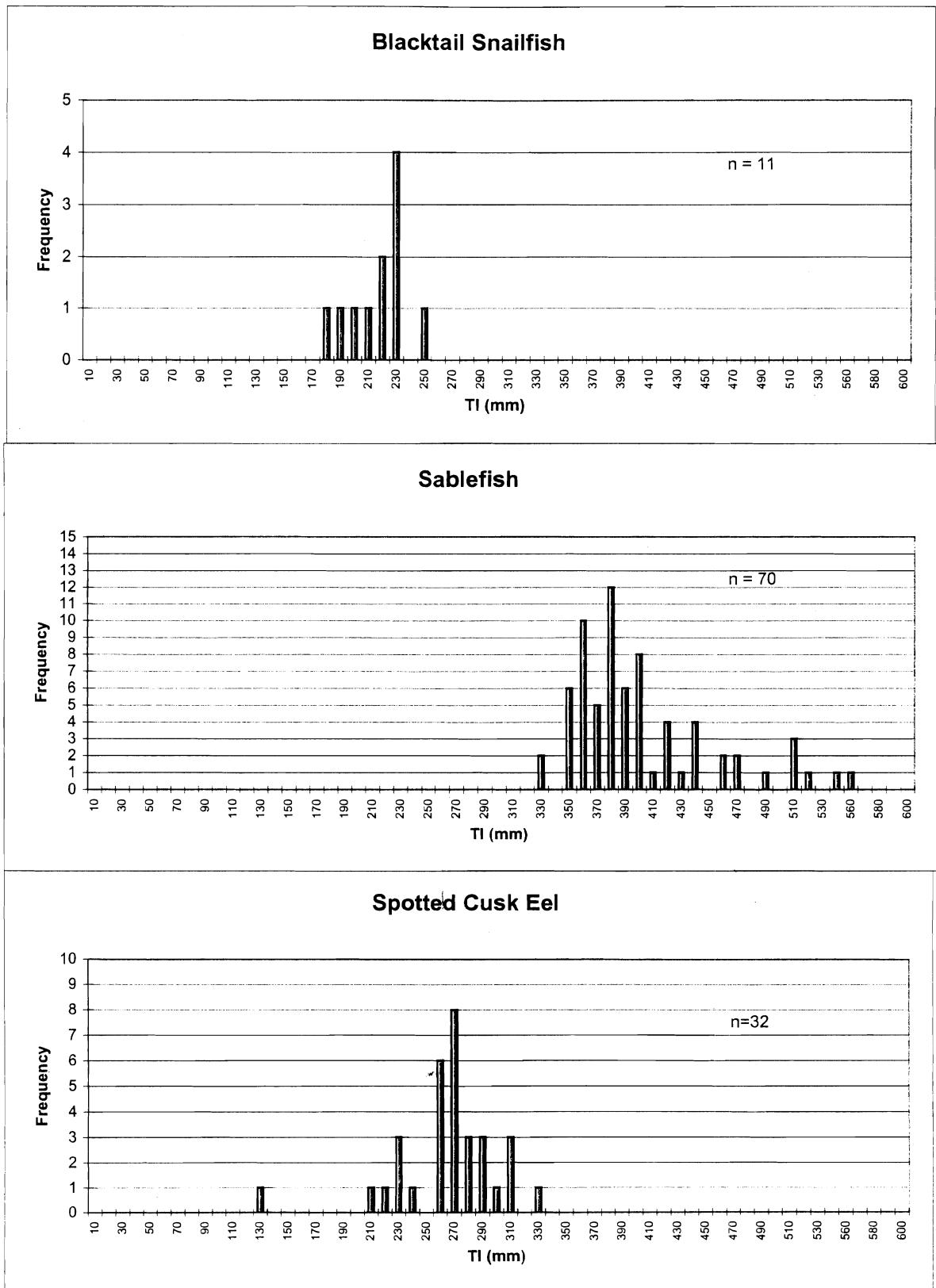


Figure 23. Length frequency histograms for threadfin sculpin, redbanded and rosethorn rockfishes from observed spot prawn traps from northern California vessels, 2000–01.

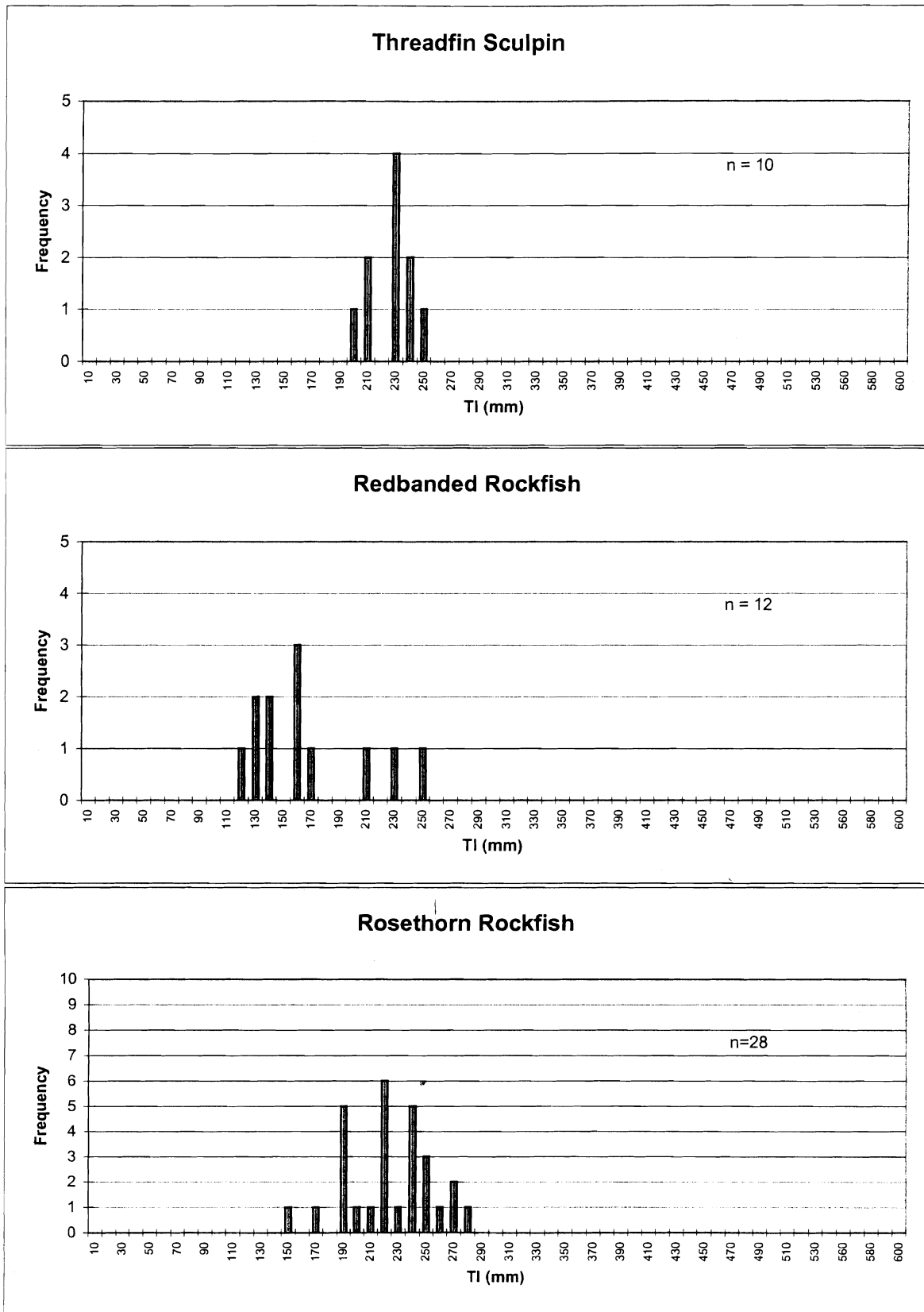


Figure 24. Length frequency histograms for greenblotched / greenspotted, pinkrose and stripetail rockfishes, from observed spot prawn traps from northern California vessels, 2000–01.

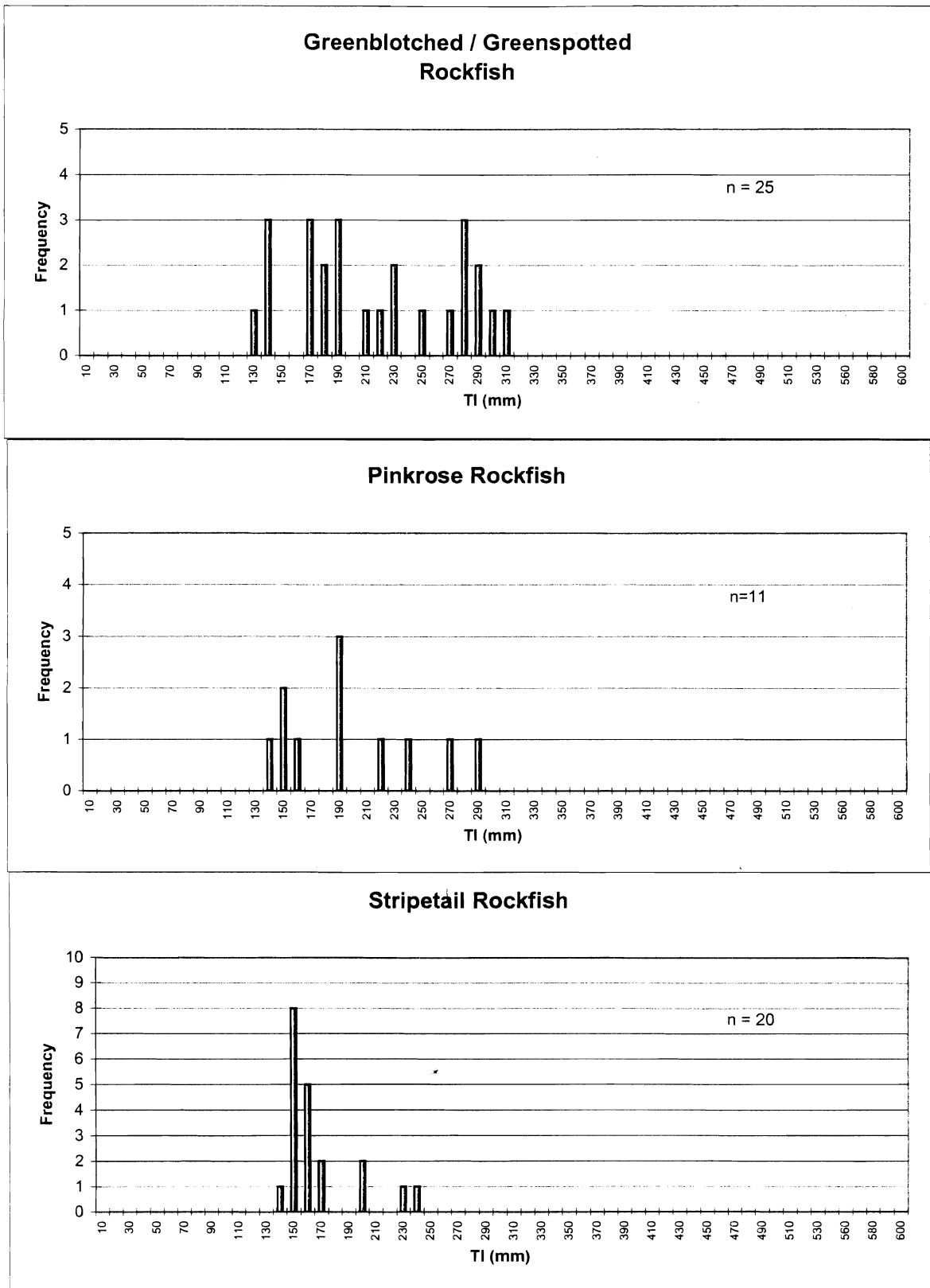


Figure 25. Length frequency histograms for lingcod, red brotula and sablefish from observed spot prawn traps from southern California vessels, 2000–01.

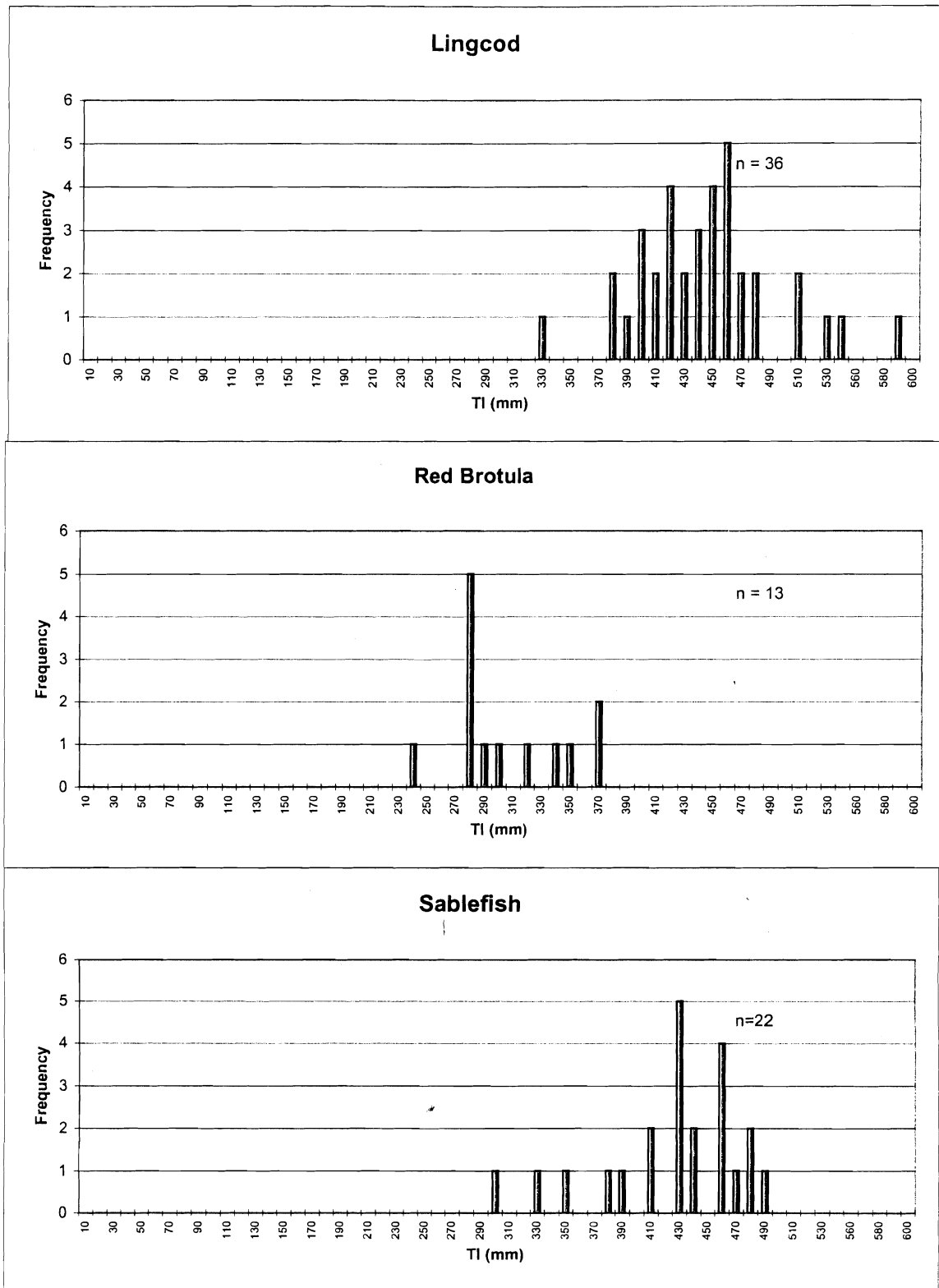


Figure 26. Length frequency histograms for shortspine combfish, shortspine thornyhead and spotted cusk-eel from observed spot prawn traps from southern California vessels, 2000–01.

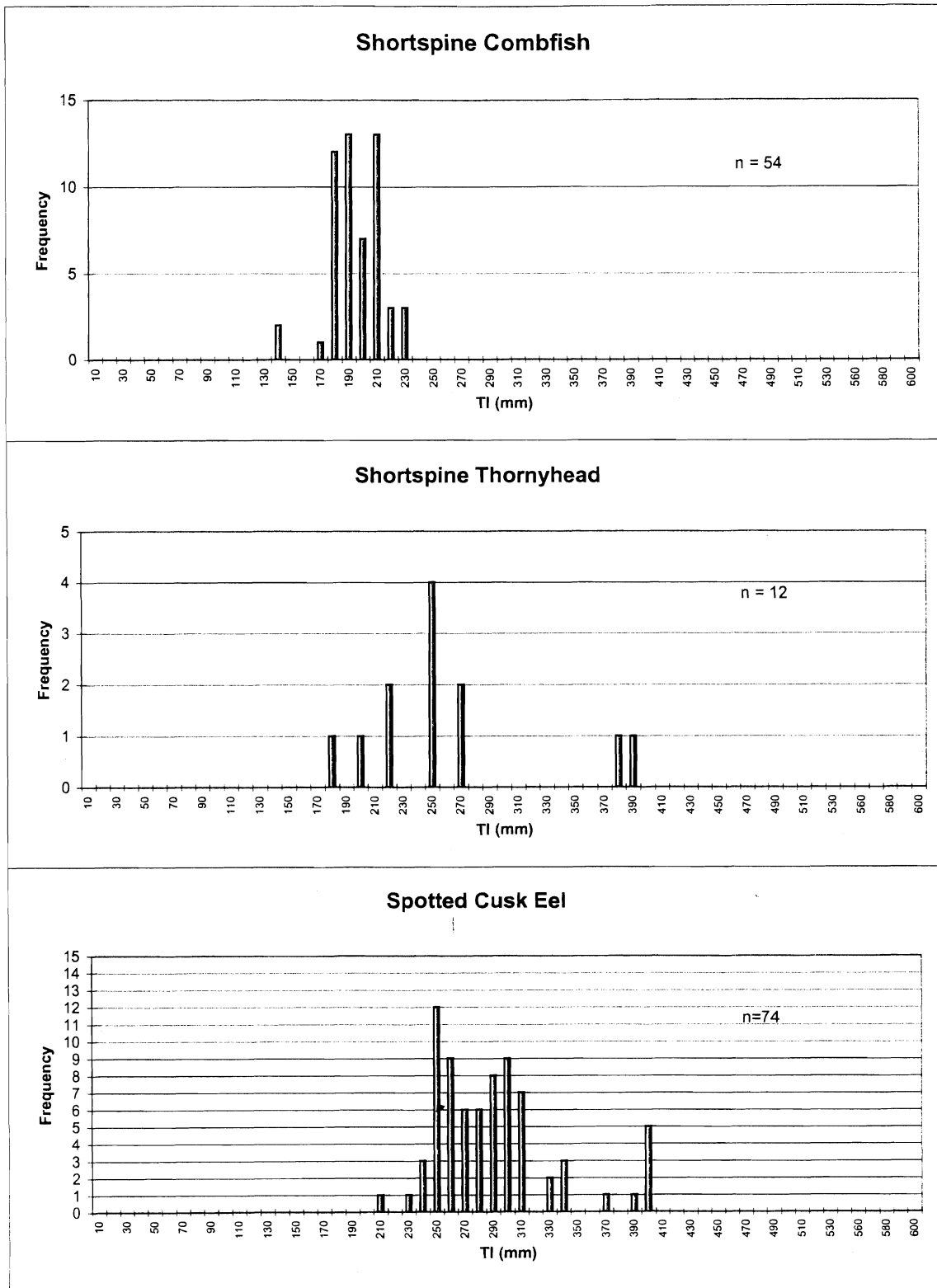


Figure 27. Length frequency histogram for threadfin sculpin from observed spot prawn traps from southern California vessels, 2000–01.

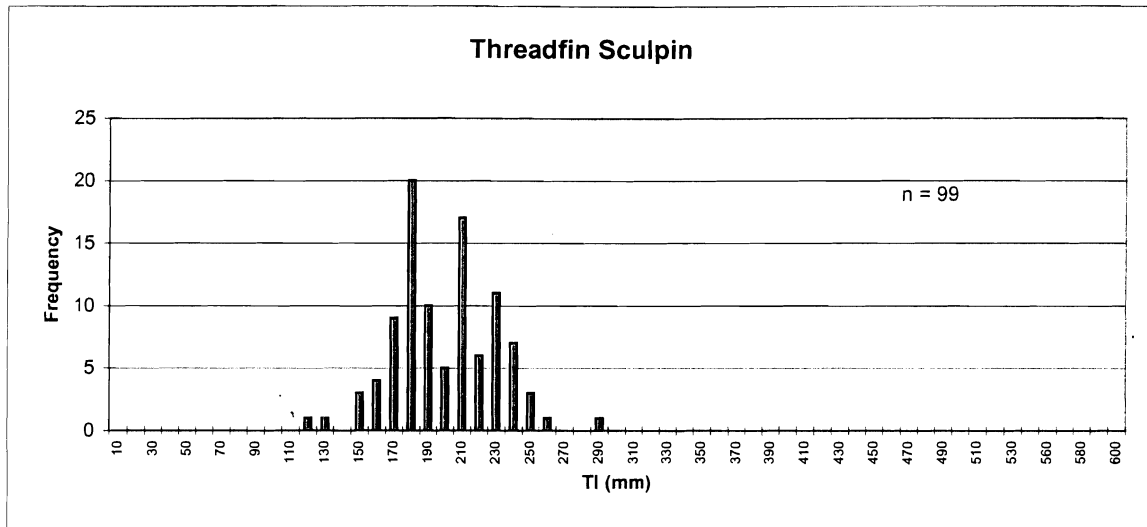


Figure 28. Length frequency histograms for bocaccio, chilipepper and cowcod from observed spot prawn traps from southern California vessels, 2000–01.

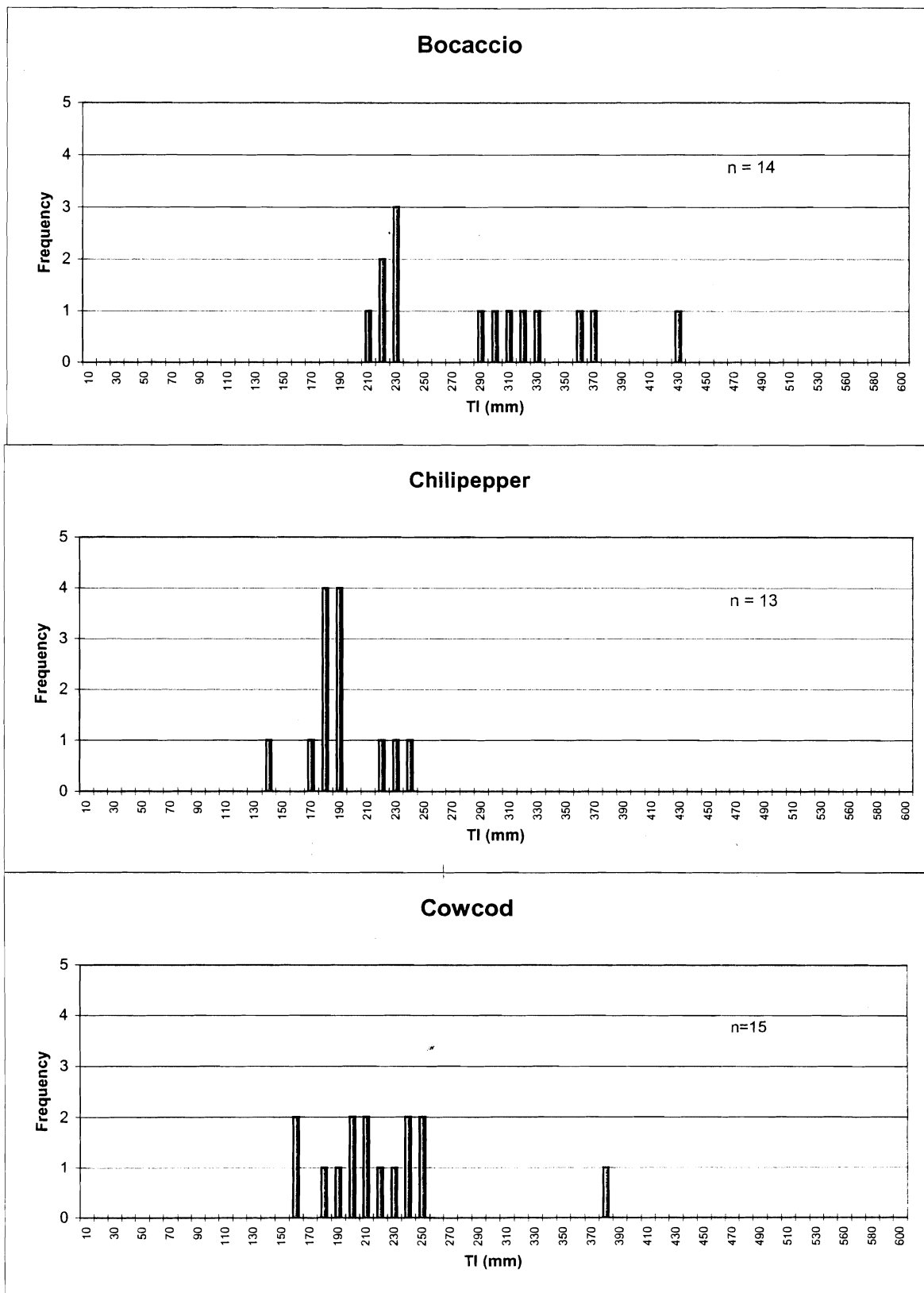


Figure 29. Length frequency histograms for greenblotched / greenspotted / pink, greenstriped and halfbanded rockfishes from observed spot prawn traps from southern California vessels, 2000–01.

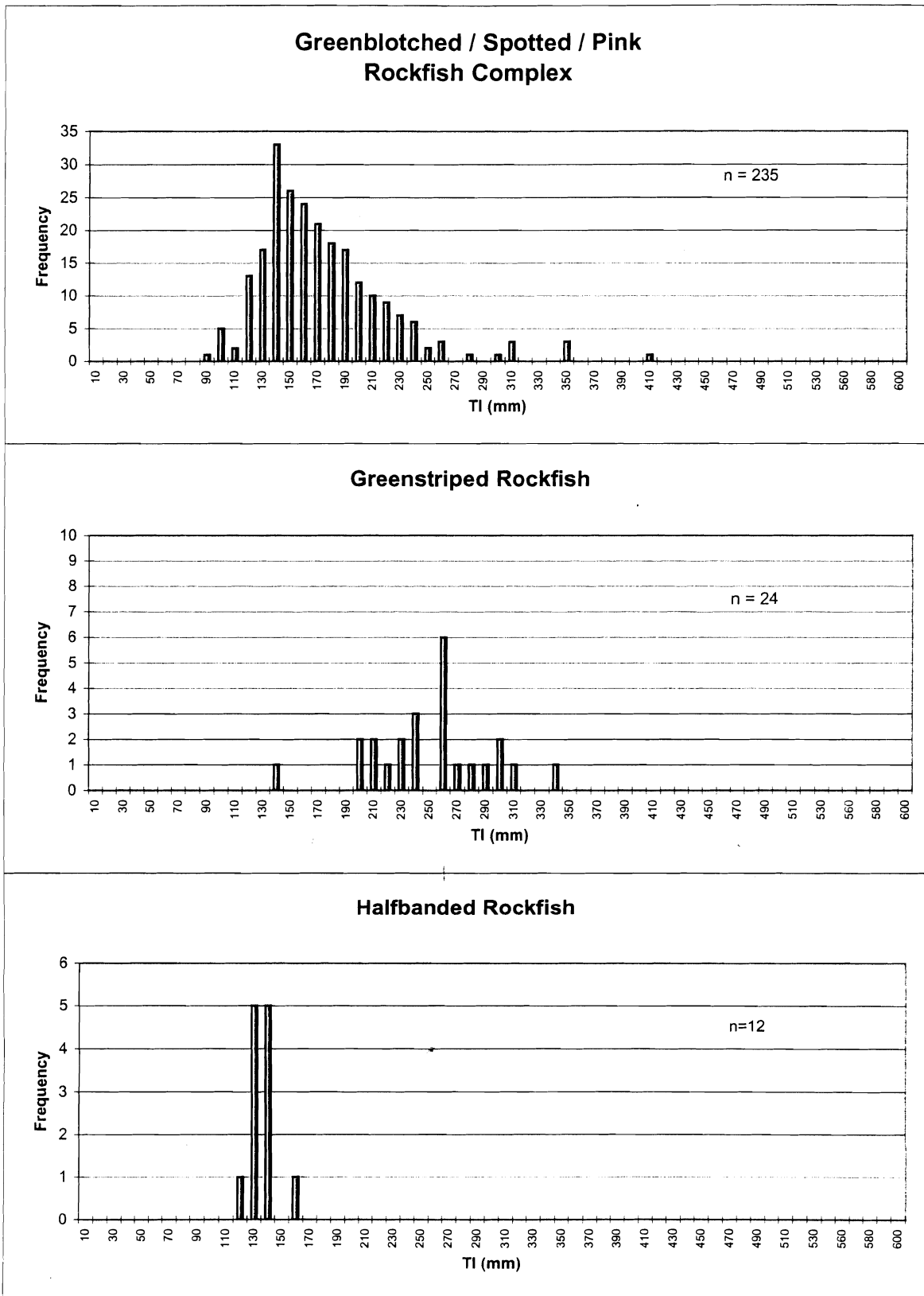


Figure 30. Length frequency histograms for pinkrose, splitnose and stripetail rockfishes from observed spot prawn traps from southern California vessels, 2000-01.

