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# STATUS OF MAJOR SOUTHERN CALIFORNIA MARINE SPORT FISH SPECIES WITH MANAGEMENT RECOMMENDATIONS, BASED ON ANALYSES OF CATCH AND SIZE COMPOSITION DATA COLLECTED ON BOARD COMMERCIAL PASSENGER FISHING VESSELS FROM 1985 THROUGH 1987

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MARINE RESOURCES DIVISION

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## ABSTRACT

This report on the status of major southern California marine sport fish species, together with management recommendations, is based on analyses of catch and size composition data, which were collected on board Commercial Passenger Fishing Vessels (CPFV) from 1985 through 1987. The project was designed to determine the status of those fishes that support the CPFV industry, and to make management recommendations when deemed necessary.

We collected and analyzed data based on random, stratified, on-board sampling of weekday (excluding holidays), open CPFV's on a year-round basis. We sampled 1/2-day, 3/4-day, and full-day type trips at a level of 5%. The survey area extended from below the United States-Mexican border to Point Arguello. Catch estimates were extrapolated to include weekday as well as weekend and holiday, open and chartered CPFV's.

We sampled 736 CPFV trips in 1985, 650 in 1986, and 631 in 1987. We encountered 180 species of fishes, including 49 species of rockfishes. We performed detailed analyses on 14 non-rockfish species and 12 rockfish species, as well as all fishes as a group and all rockfishes as a group.

We found a moderate increase in total catch of combined fish species between this study and one in the mid-1970's, due primarily to sizeable increases in catches of Pacific mackerel, kelp bass, barred sand bass, and barracuda. However, we also found that there has been more than a 50% decline in the CPFV rockfish catches, due primarily to substantial decreases in catches of bocaccio, chilipepper, and olive rockfish. We have recommended that the current 15-rockfish bag limit regulation be reduced to a 10-rockfish bag limit, and that additional and equitable conservation measures also be implemented on the commercial rockfish fishery.

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# INTRODUCTION

This report on the status of major southern California marine sport fish species, together with management recommendations, is based on analyses of catch and size composition data, which were collected by California Department of Fish and Game (DFG) personnel on board Commercial Passenger Fishing Vessels (CPFV) from 1985 through 1987. The project collected data through the early part of 1990, then was forced to discontinue because of the loss of its Federal Aid in Sport Fish Restoration funds. It is anticipated that 1988 and 1989 data will be analyzed at a later date.

The project was designed to determine the status of those fishes that support the CPFV industry, to monitor the fishery, and to make management recommendations when deemed necessary.

In southern California, there are over one million marine recreational anglers who account for approximately 2/3 of California's total marine sport fish catch (Steve Crooke, California Department of Fish and Game, Marine Resources Division, pers. comm.). A sizeable commercial fishery also exists in this area. Fishing pressure, as well as coastal habitat degradation caused by increasing urbanization, necessitates the acquisition of a sound database, in order to properly evaluate the status of the major sport fish species.

This study gathered fishery data, much of which are unavailable from CPFV fishing logs [required by State law since 1935 to be submitted by CPFV owner/operator on forms provided by DFG (Fish and Game Code 1935, Sec. 432.5)], and from the Federal Marine Recreational Fisheries Statistics Survey (MRFSS).

A similar DFG CPFV study was conducted between 1975 and 1978. Although 14 quarterly reports were published during the earlier study (Black and Schultze 1977; Crooke 1978a, 1978b, 1978c, 1979a, 1979b, 1979c; Crooke and Schultze 1977; Maxwell and Schultze 1976a, 1976b, 1976c, 1977a, 1977b, and 1977c), the results of the study were not published in a final report. However, a draft manuscript of the study results was produced by R. A. Collins and S. J. Crooke (California Department of Fish and Game, Marine Resources Division), entitled "An evaluation of the commercial passenger fishing vessel record system and the results of sampling the southern California catch for species and size composition, 1975-1978." The draft manuscript is unavailable. In it they concluded that "The logbook record system, while satisfactory for its original purpose, does not meet today's needs, and, in fact, provides inaccurate and misleading information which can lead to the mismanagement of marine resources." This was based on their discovery that compliance with the log record system by the CPFV industry, as well as the accuracy of log records, were inadequate. They further stated that the problems with the logbook system were such that new importance is given to the independent estimates of catches made possible by on-board sampling. Additionally, they opined that even if compliance and accuracy of the log records were significantly improved, the system would still not provide adequate information for fishery management. The reason for this is that the log record system does not provide information on size composition, which is a vital tool in fishery management. Also, it does not provide catch information by discrete fishing site, nor does it provide information on the catch of fishes released.

Our CPFV study provides a better method of collecting information for resource management. Work on the study design began in July 1983, and field sampling began in July 1984. CPFV fishing site catch estimates, which had not been available until this study, were the subject of another report published in 1988 (Ally et al.).

Collins and Crooke's methodology and data analyses differed somewhat from those of this study. However, where possible, we made comparisons. Collins and Crooke are cited throughout this report as "Collins and Crooke unpublished manuscript."

## METHODS AND MATERIALS

For a clear understanding of the subject matter in this report, the following terms are defined:

1. CPFV: Commercial Passenger Fishing Vessel, AKA Partyboat.
2. Landing: Depending on context, this term refers to either a CPFV docking facility from which vessels operate, or to the catch of fishes kept.
3. Complex: One or more landings whose CPFV's fish the same general area.
4. Open CPFV: A fishing vessel that is open to any customer.
5. Chartered CPFV: A fishing vessel that is leased by a group, and open only to members of the group.
6. 1/2-day boat: A CPFV trip type of 4 to 6 hours duration.
7. 3/4-day boat: A CPFV trip type that varies in duration according to location. San Diego County: 8 to 12 hours; Orange and Los Angeles counties: more than 6 hours and up to 12 hours; Ventura and Santa Barbara counties: 8 to 10 hours.

8. **Full-day boat (all-day boat):** A CPFV trip type that varies in duration according to location. San Diego, Orange, and Los Angeles counties: more than 12 hours and up to 24 hours; Ventura and Santa Barbara counties: more than 10 hours and up to 24 hours.

9. **Multi-day trip:** A CPFV trip of more than 24 hours duration.

10. **Six-pack:** A chartered CPFV carrying six or fewer paying passengers.

11. **Trips taken:** Unless otherwise specified, all CPFV trips that the landings actually ran, except multi-day trips and six-packs.

12. **Trips sampled (or surveyed):** Those CPFV trips randomly selected from the pool of weekday (excluding holidays), open trips taken, and sampled by our personnel.

13. **Catch:** A general term denoting the capture of fishes.

14. **Released fish:** Fish returned to sea after capture, usually alive.

15. **Total catch:** Fishes kept plus fishes released.

16. **Fishing effort:** The total available fishing time, expressed in minutes, on CPFV trips. We assumed that all anglers fished the full time available.

17. **Legal fish (legal size fish):** Fish whose sizes are equal to or greater than the minimum size limit regulation set for their species. They are legal to keep.

18. **Short fish (sublegal or undersized fish):** Fish whose sizes are less than the minimum size limit regulation set for their

species. They are not legal to keep. Currently, there is a species (Pacific bonito) whose minimum size limit regulation is modified by a bag limit regulation (discussed in that species' section).

19. **Habitat types:** Categories of fishes' living environments, which we named (i) nearshore-surface-coastal, (ii) nearshore-surface-island, (iii) nearshore-bottom-coastal, (iv) nearshore-bottom-island, (v) nearshore-mix-coastal, (vi) nearshore-mix-island, (vii) offshore-surface, (viii) offshore-bottom, and (ix) outer bank. The categories were chosen primarily for catch-per-unit-of-effort determinations. The terms surface, bottom, and mix, used in conjunction with other terms to describe habitat types, are subjective, and require an understanding of the factors that make them subjective. These factors are (i) intent of the vessel's captain (is there a target species?), or lack thereof; (ii) intent of the anglers (for some anglers, intent may differ from that of the captain); (iii) experience of the anglers (inexperienced anglers may have inappropriate fishing gear for the species being targeted, or may not have the expertise to fish targeted species, resulting in their fishing a category other than that intended by the captain; and (iv) catch composition, which may be composed of only a fraction of the targeted species, because of factors (ii) and/or (iii) above, or because of the inability of anglers to keep from catching unwanted species of another category.

With the above understanding, the habitat type terms are defined as follows:

a) Surface: Where the catch consisted of (i) surface species only [jacks (e.g. yellowtail), mackerels and tunas (e.g. Pacific mackerel, Pacific bonito, albacore), California barracuda, white seabass (surface in summer; bottom in winter) kelp bass, etc.] or (ii) both surface and bottom species, but surface species were targeted and made up at least 75% of the catch; or (iii) both surface and bottom species, with no species being targeted, and the catch was comprised of at least 90% surface species.

b) Bottom: Where the catch consisted of (i) bottom species only (California sheephead, ocean whitefish, lingcod, white croaker, flatfishes, most rockfish species, etc.); or (ii) both bottom and surface species, but bottom species were targeted and made up at least 75% of the catch; or (iii) both bottom and surface species, with no species being targeted, and the catch was comprised of at least 90% bottom species.

c) Mix: Where the catch consisted of both surface and bottom species, and (i) where either targeted surface or bottom species made up less than 75% of the catch; or (ii) where no species was targeted and the catch was comprised of less than 90% surface or bottom species. Intent overrided percentage in a close call, if the biologist felt circumstances warranted it.

d) **Nearshore:** Area where bottom depth is less than or equal to 73 m (40 fm).

e) **Offshore:** Area, including banks, where bottom depth is greater than 73 m (40 fm).

f) **Outer bank:** Bank where bottom depth is less than or equal to 73 m (40 fm).

g) **Coastal:** Along the mainland.

h) **Island:** Around the island.

Survey

We did randomized, on-board sampling of weekday (excluding holidays), open CPFV trips on a year-round basis. We did not sample weekend and holiday, open trips, nor any chartered trips. Although Collins and Crooke (unpublished manuscript) did sample weekend/holiday, open trips, we decided not to. Weighing heavily in that decision was the logistical problem it presented in stratifying our sampling for weekday and weekend/holiday, open trips, and possibly for chartered trips. We felt that to sample these two or three groups effectively, additional samplers would be necessary. However, additional funding was not available. Also contributing to our decision not to sample weekend/holiday, open trips is the fact that open CPFV's are usually filled to capacity on major holidays and summer weekends. Since, by law, a CPFV's carrying capacity cannot be exceeded, paying customers take precedence over non-paying samplers. We though that being forced to miss too many randomly selected weekend/holiday trips might adversely affect the randomness of our sampling. Chartered trips, on the other hand, are generally not filled to capacity, but are private outings. This being so, we felt that we might have even less success in randomly sampling this group than we would the latter.

We sampled 1/2-day, 3/4-day, and full-day type trips. Project funding allowed us to sample roughly 5% of the weekday, open CPFV trips by complex. The survey area extended from below the U.S.-Mexican border (to Mexican fishing sites within a day's range of the landings) to Point Arguello, including the Channel Islands and those offshore banks within a day's range of the landings (Figure 1). The area was divided into 11 complexes containing the following landings:

San Diego County

Complex 1: San Diego Bay

Landing 1: Fisherman's Landing

Landing 2: Point Loma Sport Fishing Association

Landing 3: H & M Landing

Complex 2: Mission Bay

Landing 1: Seaforth Sportfishing

Landing 2: Islandia Sportfishing

Complex 3: Oceanside

Landing 1: Helgren's Oceanside Sportfishing

Orange County

Complex 4: Dana Point

Landing 1: Dana Wharf Sportfishing

Complex 5: Newport Beach

Landing 1: Davey's Locker Sportfishing

Landing 2: Newport Landing Sportfishing (this landing was closed between May 1, 1987 and November 30, 1987)

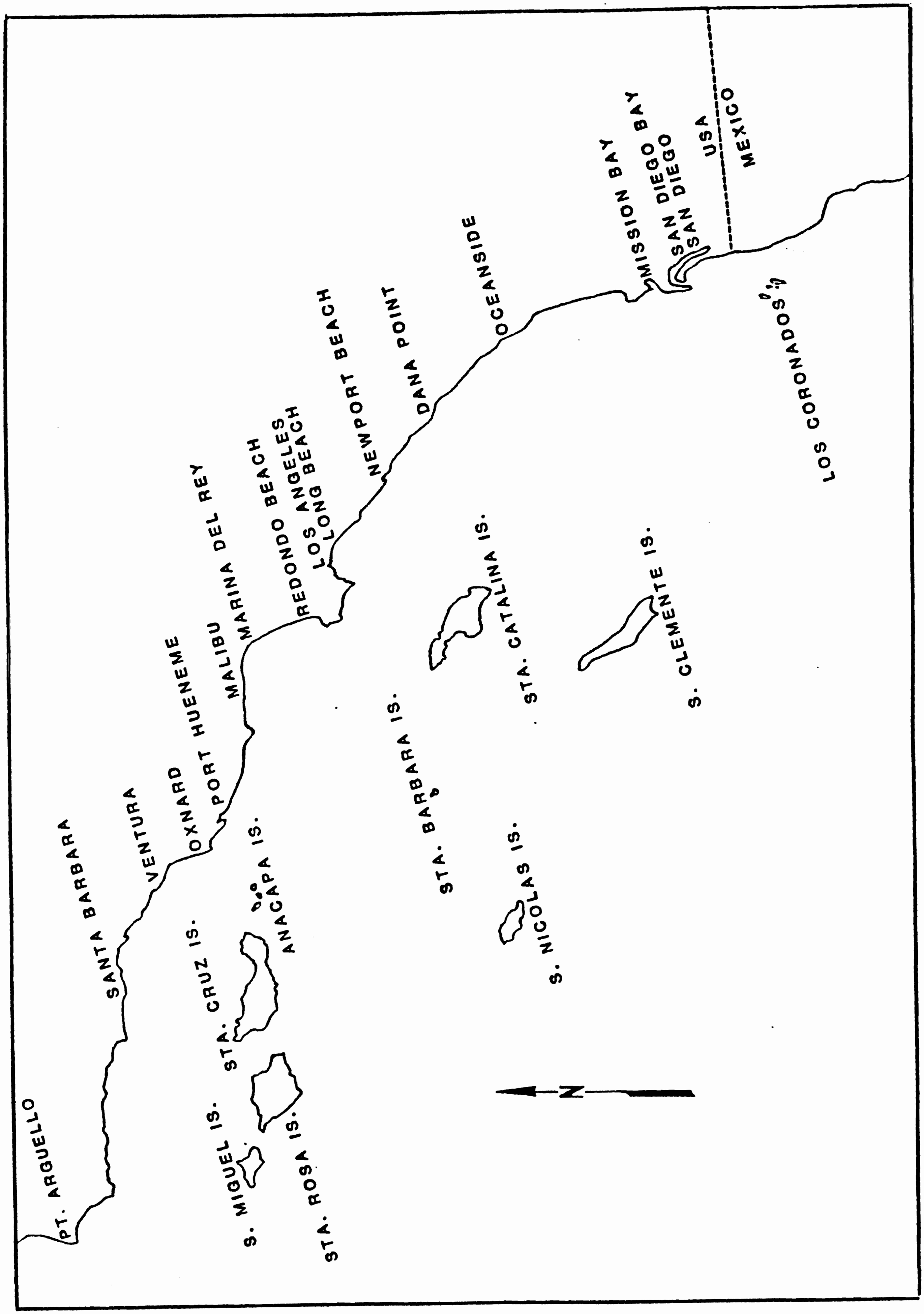



FIGURE 1. Southern California Commercial Passenger Fishing Vessel Sport Fish Project survey area.

Los Angeles County

Complex 6: Los Angeles-Long Beach

Landing 1: Seal Beach Pleasure Fishing, Inc.

Landing 2: Belmont Pier Sportfishing

Landing 3: Long Beach Sportfishing

Landing 4: L.A. Harbor Sportfishing, Inc.

Landing 5: The Skippers' 22nd Street Landing, Inc.

Complex 7: Redondo Beach

Landing 1: Redondo Sportfishing

Complex 8: Marina Del Rey

Landing 1: Marina Del Rey Sportfishing

Complex 9: Malibu

Landing 1: Malibu Pier Sportfishing

Ventura County

Complex 10: Oxnard-Ventura

Landing 1: Port Hueneme Sportfishing, Inc.

Landing 2: Captain Jack's Landing/Cisco Sportfishing

Landing 3: Ventura Sportfishing

Santa Barbara County

Complex 11: Santa Barbara

Landing 1: SEA Landing

Although Landing 1 (Seal Beach Pleasure Fishing, Inc.) in complex 6 is technically in Orange County, we considered it part of Los Angeles County because (i) it borders Los Angeles County and is under the same management as is Belmont Pier Sportfishing (Landing 2), and (ii) its CPFV's fish the same areas fished by the other landings in complex 6.

The project was divided into three units: San Diego (responsible for San Diego County), Long Beach (responsible for Orange and Los Angeles counties), and Santa Barbara (responsible for Ventura and Santa Barbara counties). Long Beach was the project headquarters.

Each unit was headed by a Marine Biologist whose duties were, in part, to (i) recruit, hire, and train (2-4 weeks) samplers, (ii) visit the landings weekly (semi-monthly in the Long Beach unit) to obtain data on all daily, open, and chartered, CPFV trips taken (by trip type), and (iii) determine each sampler's monthly boat trip schedule. To determine boat trip schedules, the biologist first obtained each landing's projected trip schedule for the following month, during the biologist's end-of-the-month visit to the landings. Then, each trip in a complex's projected total number of trips for the month was numbered consecutively. Finally, 5% (varied with sampler funding) of this total was selected for sampling from computer-generated random numbers (with replacements).

Samplers (Scientific Aids) were responsible for contacting the landings the day before their scheduled trips to ask for permission to sample. Permission was rarely denied. When it was, the reasons were usually because the boat was filled to capacity, or out of commission. When the sampler was unable to sample a scheduled trip, he/she attempted to sample another boat trip of the same type, on the same day, and at the same complex. If the attempt failed, the trip was listed as having been missed.

Samplers were provided with fish keys, data forms, fish length recording boards, coded information, and various books to aid them in their task.

Sampling priorities were to (i) count all fishes released; (ii) record the lengths of as many fishes released as possible, if activity in priority one was slow; (iii) count all fishes kept as they were being caught if activities in top two priorities were slow--otherwise, count all fishes kept (or subsample) as the boat was returning to port; and (iv) record the lengths of all fishes (or subsample) as the boat was returning to port.

In addition to the top four priorities, samplers recorded the following information on their data sheet: complex, landing, boat identification number, date, time of boat departure, trip type, whether boat fished in Mexican waters, number of anglers (including crew, if they fished), sampler's identification number, time fished in each habitat type and at each specific fishing site, and bottom depth. Fish counts for both kept and released fishes were recorded by habitat type at each stop during a trip, and by fishing site. Fish lengths for both kept and released fishes were recorded by trip.

We used total length (TL) measurements for all but two families of fishes. Fork length (FL) measurements were taken for Carangidae (Jacks: yellowtail, jack mackerel) and Scombridae (Mackerels: Pacific bonito, Pacific mackerel, and all tunas). The symbols TL and FL are not used within the text to simplify the metric with English equivalent measurement expressions.

Samplers were also required to enter their data into the microcomputer databases, and to check their data entries.

## Data Analysis

To reduce statistical variation in our estimates, we stratified the data by month and complex. Stratification by month reduces variation caused by seasonal changes in species composition, and that caused by differing seasonal angler counts. Stratification by complex reduces variation caused by clinal changes in species composition, and that caused by differing geographic angler counts.

Computer analyses of the data was done on IBM 286 AT clones, using menu driven dBASE III Plus and/or SAS programs.

In this report, we have analyzed the most important species to the CPFV industry. Importance was determined using four criteria. In priority order they are (i) species with size limits, (ii) species highly prized by anglers, (iii) species given special consideration (e.g. white croaker used in testing for toxicity from pollution along the coast), and (iv) species highly placed on an index of relative importance.

We have performed detailed analyses on 14 non-rockfish species and 12 rockfish species. In addition, we looked at all fishes as a group, as well as all rockfishes as a group. Species are presented in alphabetical order of scientific family name, and within family name, in alphabetical order of common name, except for sculpin (spotted scorpionfish), which is placed before the rockfish complex. The "all fish" group is presented first; the "all rockfishes" group heads the rockfish complex.

## Index of Relative Importance (IRI)

The IRI was developed to help us determine which of the less important species we might consider for detailed analysis. It was an especially useful tool for the rockfish species. We used raw catch counts and frequency of a species' occurrence to obtain the IRI. We felt that rank by count is twice as important as frequency of occurrence. Thus, IRI= $\frac{2A + B}{3}$, where A = the rank by count of a species, B = the rank by frequency of occurrence of a species, and 3 = the sum of the values assigned to importance.

For rockfishes, the IRI was the first step in determining which species we should consider for detailed analyses. Final ranking was based on the means of the 1985 through 1987 catch estimates, which were calculated for the top-ranking species of the IRI.

One weakness of our IRI is that it does not take desirability into account. If it did, the ranking of some species would be significantly altered.

## Catch Estimate

We calculated catch estimates in the following manner:

$$CE = \frac{F}{T_s} \times T_t$$

where CE = catch estimate

F = number of fish in the sample

$T_s$ = number of trips sampled

$T_t$ = number of trips taken by the landings.

Although we sampled only weekday, open CPFV trips, our catch estimates (in numbers of fish) were extrapolated to include the catches of all open and chartered CPFV trips for all days, but not the catches of multi-day trips and six-packs. We made the assumption that weekday, open CPFV trips are representative of both open and chartered CPFV trips taken any day of the week.

Catch estimates were calculated by month and complex. Monthly complex catch estimates were summed up to obtain annual, county and southern California catch estimates.

Catch estimates within the text are accompanied with their standard deviations.

In our analyses, we placed more importance on the kept fish and released fish categories than we did on those of legal fish and short fish, because they better represent landing estimates. Sizeable numbers of short fishes are kept by anglers, and anglers occasionally release legal fishes. However, since the catch estimate ratio of legal fish to short fish is an important indicator of the health of a resource, we also calculated estimates for these categories to determine the ratios. We also compared our legal and short catch estimates to those of Collins and Crooke (unpublished manuscript); they did not report kept and released catch estimates.

There was a limitation in calculating legal and short fish catch estimates. It was necessary to use counts of fishes measured in the equation. However, because of sampling priorities, the percentages of released fishes measured, for most species with size limits, were considerably less than those of fishes kept. This means that analyses of released fishes measured are less reliable than those of kept fishes measured.

Catch estimates for legal and short fishes were calculated as follows:

$A = E \times G$, where A = the catch estimate of legal fish kept, E = the catch estimate of fish kept, and G = the proportion of legal fish kept (from count of fish measured).

$B = F \times H$, where B = the catch estimate of legal fish released, F = the catch estimate of fish released, and H = the proportion of legal fish released (from count of fish measured).

$C = E \times I$, where C = the catch estimate of short fish kept, E = same as above, and I = the proportion of short fish kept (from count of fish measured).

$D = F \times J$, where D = the catch estimate of short fish released, F = same as above and J = the proportion of short fish released (from count of fish measured).

$A + B =$ Catch estimate of legal fish.

$C + D =$ Catch estimate of short fish.

We could have assumed that kept fish equals legal fish and released fish equals short fish, but we felt that the above method was more reliable in estimating numbers of legal and short fishes.

## Size Composition

A variable percentage of fishes kept was measured each trip. Often the percentage was high, but it was also occasionally low. It was usually low on those high catch, surface fishing boat trips in areas close to the boat's home port. This is because samplers normally measured fishes kept as the boat was returning to port. Hence, the closer a boat fished to its home port, the fewer fishes were measured.

Length data, for those species with minimum size limit regulations, were analyzed separately for the kept fish and released fish categories, because of the sizeable difference in percentages of measured fish kept and those of measured fish released mentioned in the catch estimate section above. Had analysis been done on combined data, the length frequency bar graphs would have been misleading, overemphasizing the frequency of kept fish (the bias favoring the measurement of kept fish was negligible in the case of lingcod and white seabass, which were not caught in such numbers or rapidity as to overwhelm the samplers' ability to measure released fishes). Even when analyzed separately, the length frequency bar graphs of fish released are skewed towards the upper end of the range. That is because a far greater number of short fish with lengths close to the minimum size limit were measured than those that were obviously sublegal. Generally, anglers immediately released clearly short fishes, but measured those whose legal size status was questionable. This gave samplers a greater opportunity to measure those fishes.

Samplers had another problem in measuring some fishes. A few species without size limit restrictions, although frequently caught, are far less desirable to anglers than are other species. Many of these fishes were released immediately after capture, before the sampler had a chance to measure them. However, these species are not very important to the CPFV industry, and data analysis has been performed on only one of them (white croaker).

Because our methods of analyzing length frequency data differed from those of Collins and Crooke (unpublished manuscript), only mean lengths and modes of species without size limits are compared. They did not distinguish between kept and released fishes for those species with size limits.

Effort and Catch-Per-Unit-of-Effort (CPUE)

We had hoped to report on effort (in terms of angler-hours) and CPUE (in terms of catch/angler-hour), but the necessary analytical computer programs became available only after we had completed the first draft of this report. It is anticipated that both effort and CPUE will be part of any future report based on this project's data.

## RESULTS AND DISCUSSION

We sampled an average 5.5% of the weekday, open CPFV trips taken in southern California from 1985 through 1987 (Table 1). On a county-by-county basis, however, the 3-year average sampling percentages varied from 3.9% to 9.8% (Table 1). Collins and Crooke's (unpublished manuscript) average from 1976 through 1978 was 3.1% of all open trips taken.

In our study, the average number of open CPFV trips taken per year was 19,450, 1.8% more than Collins and Crooke's (unpublished manuscript) annual average.

TABLE 1. Weekday (W), Open (O) Commercial Passenger Fishing Vessel Sampling Effort in Southern California from 1985 through 1987.

| YEAR | SOUTHERN CALIFORNIA | | | SAN DIEGO COUNTY | | | ORANGE COUNTY | | | LOS ANGELES COUNTY | | | VENTURA COUNTY | | | SANTA BARBARA COUNTY | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NO. WO TRIPS TAKEN | NO. TRIPS SUR- VEYED | % TRIPS SUR- VEYED | NO. WO TRIPS TAKEN | NO. TRIPS SUR- VEYED | % TRIPS SUR- VEYED | NO. WO TRIPS TAKEN | NO. TRIPS SUR- VEYED | % TRIPS SUR- VEYED | NO. WO TRIPS TAKEN | NO. TRIPS SUR- VEYED | % TRIPS SUR- VEYED | NO. WO TRIPS TAKEN | NO. TRIPS SUR- VEYED | % TRIPS SUR- VEYED | NO. WO TRIPS TAKEN | NO. TRIPS SUR- VEYED | % TRIPS SUR- VEYED |
| 1985 | 12,090 | 736 | 6.1 | 3,744 | 253 | 6.8 | 1,986 | 89 | 4.5 | 4,876 | 219 | 4.5 | 1,076 | 125 | 11.6 | 408 | 50 | 12.2 |
| 1986 | 12,348 | 650 | 5.3 | 3,817 | 251 | 6.6 | 2,160 | 87 | 4.0 | 4,815 | 182 | 3.8 | 1,109 | 95 | 8.6 | 447 | 35 | 7.8 |
| 1987 | 12,504 | 631 | 5.0 | 4,161 | 255 | 6.1 | 1,913 | 62 | 3.2 | 4,873 | 172 | 3.5 | 1,085 | 99 | 9.1 | 472 | 43 | 9.1 |

Our data show that the majority of open CPFV trips occurred on weekdays, while that of chartered CPFV's, with the exception of 1/2-day type trips, occurred on weekends and holidays (Tables 2 through 4). The data also show that the ratio of open CPFV trips to chartered CPFV trips is greater than 3 to 1 (Table 5 through 7). Furthermore, the majority of open CPFV trips were 1/2-day type trips, whereas those of chartered CPFV's were full-day type trips (Tables 5 through 7).

TABLE 2. Breakdown of Southern California Commercial Passenger Fishing Vessel Trips Taken in 1985 into Periods when Trips Were Taken.

| PERIOD | 1/2-DAY % | 1/2-DAY NO. | 3/4-DAY % | 3/4-DAY NO. | FULL-DAY % | FULL-DAY NO. |
|---|---|---|---|---|---|---|
| OPEN CPFV'S | | | | | | |
| Weekdays | 64 | 6,647 | 64 | 3,512 | 59 | 1,931 |
| Weekends & Holidays | 36 | 3,778 | 36 | 2,011 | 41 | 1,349 |
| All Days | 100 | 10,425 | 100 | 5,523 | 100 | 3,280 |
| CHARTERED CPFV'S | | | | | | |
| Weekdays | 54 | 128 | 36 | 393 | 44 | 2,051 |
| Weekends & Holidays | 46 | 109 | 64 | 702 | 56 | 2,635 |
| All Days | 100 | 237 | 100 | 1,095 | 100 | 4,686 |
| OPEN & CHARTERED CPFV'S | | | | | | |
| Weekdays | 64 | 6,775 | 59 | 3,905 | 50 | 3,982 |
| Weekends & Holidays | 36 | 3,887 | 41 | 2,713 | 50 | 3,984 |
| All Days | 100 | 10,662 | 100 | 6,618 | 100 | 7,966 |

TABLE 3. Breakdown of Southern California Commercial Passenger Fishing Vessel Trips Taken in 1986 into Periods when Trips Were Taken.

| PERIOD | 1/2-DAY % | 1/2-DAY NO. | 3/4-DAY % | 3/4-DAY NO. | FULL-DAY % | FULL-DAY NO. |
|---|---|---|---|---|---|---|
| **OPEN CPFV'S** | | | | | | |
| Weekdays | 64 | 7,003 | 65 | 3,591 | 57 | 1,754 |
| Weekends & Holidays | 36 | 3,915 | 35 | 1,956 | 43 | 1,309 |
| All Days | 100 | 10,918 | 100 | 5,547 | 100 | 3,063 |
| **CHARTERED CPFV'S** | | | | | | |
| Weekdays | 53 | 157 | 34 | 475 | 44 | 1,665 |
| Weekends & Holidays | 47 | 138 | 66 | 932 | 56 | 2,146 |
| All Days | 100 | 295 | 100 | 1,407 | 100 | 3,811 |
| **OPEN & CHARTERED CPFV'S** | | | | | | |
| Weekdays | 64 | 7,160 | 58 | 4,066 | 50 | 3,419 |
| Weekends & Holidays | 36 | 4,053 | 42 | 2,888 | 50 | 3,455 |
| All Days | 100 | 11,213 | 100 | 6,954 | 100 | 6,874 |

TABLE 4. Breakdown of Southern California Commercial Passenger Fishing Vessel Trips Taken in 1987 into Periods when Trips Were Taken.

| PERIOD | 1/2-DAY % | 1/2-DAY NO. | 3/4-DAY % | 3/4-DAY NO. | FULL-DAY % | FULL-DAY NO. |
|---|---|---|---|---|---|---|
| **OPEN CPFV'S** | | | | | | |
| Weekdays | 65 | 6,993 | 64 | 3,560 | 60 | 1,951 |
| Weekends & Holidays | 35 | 3,801 | 36 | 1,985 | 40 | 1,305 |
| All Days | 100 | 10,794 | 100 | 5,545 | 100 | 3,256 |
| **CHARTERED CPFV'S** | | | | | | |
| Weekdays | 52 | 175 | 40 | 667 | 42 | 1,521 |
| Weekends & Holidays | 48 | 159 | 60 | 1,019 | 58 | 2,063 |
| All Days | 100 | 334 | 100 | 1,686 | 100 | 3,584 |
| **OPEN & CHARTERED CPFV'S** | | | | | | |
| Weekdays | 64 | 7,168 | 58 | 4,227 | 51 | 3,472 |
| Weekends & Holidays | 36 | 3,960 | 42 | 3,004 | 49 | 3,368 |
| All Days | 100 | 11,128 | 100 | 7,231 | 100 | 6,840 |

TABLE 5. Breakdown of Southern California Commercial Passenger Fishing Vessel Trips Taken in 1985 into Trip Types.

| TRIP TYPE | WEEKDAYS % | WEEKDAYS NO. | WEEKENDS & HOLIDAYS % | WEEKENDS & HOLIDAYS NO. | ALL DAYS % | ALL DAYS NO. |
|---|---|---|---|---|---|---|
| OPEN CPFV'S | | | | | | |
| 1/2-Day | 55 | 6,647 | 53 | 3,778 | 54 | 10,425 |
| 3/4-Day | 29 | 3,512 | 28 | 2,011 | 29 | 5,523 |
| Full-Day | 16 | 1,931 | 19 | 1,349 | 17 | 3,280 |
| Combined | 100 | 12,090 | 100 | 7,138 | 100 | 19,228 |
| CHARTERED CPFV'S | | | | | | |
| 1/2-Day | 5 | 128 | 3 | 109 | 4 | 237 |
| 3/4-Day | 15 | 393 | 20 | 702 | 18 | 1,095 |
| Full-Day | 80 | 2,051 | 77 | 2,635 | 78 | 4,686 |
| Combined | 100 | 2,572 | 100 | 3,446 | 100 | 6,018 |
| OPEN & CHARTERED CPFV'S | | | | | | |
| 1/2-Day | 46 | 6,775 | 37 | 3,887 | 42 | 10,662 |
| 3/4-Day | 27 | 3,905 | 25 | 2,713 | 26 | 6,618 |
| Full-Day | 27 | 3,982 | 38 | 3,984 | 32 | 7,966 |
| Combined | 100 | 14,662 | 100 | 10,584 | 100 | 25,246 |

TABLE 6. Breakdown of Southern California Commercial Passenger Fishing Vessel Trips Taken in 1986 into Trip Types.

| TRIP TYPE | WEEKDAYS % | WEEKDAYS NO. | WEEKENDS & HOLIDAYS % | WEEKENDS & HOLIDAYS NO. | ALL DAYS % | ALL DAYS NO. |
|---|---|---|---|---|---|---|
| OPEN CPFV'S | | | | | | |
| 1/2-Day | 57 | 7,003 | 55 | 3,915 | 56 | 10,918 |
| 3/4-Day | 29 | 3,591 | 27 | 1,956 | 28 | 5,547 |
| Full-Day | 14 | 1,754 | 18 | 1,309 | 16 | 3,063 |
| Combined | 100 | 12,348 | 100 | 7,180 | 100 | 19,528 |
| CHARTERED CPFV'S | | | | | | |
| 1/2-Day | 7 | 157 | 4 | 138 | 5 | 295 |
| 3/4-Day | 21 | 475 | 29 | 932 | 26 | 1,407 |
| Full-Day | 72 | 1,665 | 67 | 2,146 | 69 | 3,811 |
| Combined | 100 | 2,297 | 100 | 3,216 | 100 | 5,513 |
| OPEN & CHARTERED CPFV'S | | | | | | |
| 1/2-Day | 49 | 7,160 | 39 | 4,053 | 45 | 11,213 |
| 3/4-Day | 28 | 4,066 | 28 | 2,888 | 28 | 6,954 |
| Full-Day | 23 | 3,419 | 33 | 3,455 | 27 | 6,874 |
| Combined | 100 | 14,645 | 100 | 10,396 | 100 | 25,041 |

TABLE 7. Breakdown of Southern California Commercial Passenger Fishing Vessel Trips Taken in 1987 into Trip Types.

| TRIP TYPE | WEEKDAYS % | WEEKDAYS NO. | WEEKENDS & HOLIDAYS % | WEEKENDS & HOLIDAYS NO. | ALL DAYS % | ALL DAYS NO. |
|---|---|---|---|---|---|---|
| **OPEN CPFV'S** | | | | | | |
| 1/2-Day | 56 | 6,993 | 54 | 3,801 | 55 | 10,794 |
| 3/4-Day | 28 | 3,560 | 28 | 1,985 | 28 | 5,545 |
| Full-Day | 16 | 1,951 | 18 | 1,305 | 17 | 3,256 |
| Combined | 100 | 12,504 | 100 | 7,091 | 100 | 19,595 |
| **CHARTERED CPFV'S** | | | | | | |
| 1/2-Day | 8 | 175 | 5 | 159 | 6 | 334 |
| 3/4-Day | 28 | 667 | 31 | 1,019 | 30 | 1,686 |
| Full-Day | 64 | 1,521 | 64 | 2,063 | 64 | 3,584 |
| Combined | 100 | 2,363 | 100 | 3,241 | 100 | 5,604 |
| **OPEN & CHARTERED CPFV'S** | | | | | | |
| 1/2-Day | 48 | 7,168 | 38 | 3,960 | 44 | 11,128 |
| 3/4-Day | 29 | 4,227 | 29 | 3,004 | 29 | 7,231 |
| Full-Day | 23 | 3,472 | 33 | 3,368 | 27 | 6,840 |
| Combined | 100 | 14,867 | 100 | 10,332 | 100 | 25,199 |

The mean angler counts among trip types and over time were similar (Table 8). However, higher angler counts were noted during the summer season (mid-June through mid-September) than during the off-season.

TABLE 8. Mean Angler Count on Sampled Southern California Weekday, Open Commercial Passenger Fishing Vessels by Trip Type for 1985 Through 1987.

| TRIP TYPE | 1985 MEAN | 1985 LOW | 1985 HIGH | 1986 MEAN | 1986 LOW | 1986 HIGH | 1987 MEAN | 1987 LOW | 1987 HIGH | 1985-1987 MEAN | 1985-1987 LOW | 1985-1987 HIGH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/2-Day | 25 | 4 | 88 | 27 | 4 | 71 | 28 | 3 | 93 | 26 | 3 | 93 |
| 3/4-Day | 26 | 5 | 77 | 29 | 7 | 86 | 28 | 5 | 89 | 27 | 5 | 89 |
| Full-Day | 26 | 8 | 51 | 24 | 9 | 60 | 23 | 7 | 44 | 24 | 7 | 60 |
| Combined | 25 | 4 | 88 | 27 | 4 | 86 | 27 | 3 | 93 | 26 | 3 | 93 |

Based on sampled CPFV trips for combined years 1985 through 1987, the data show that mean fishing effort on full-day boats was 40% greater than that of 3/4-day boats, and 60% greater than that of 1/2-day boats; for 3/4-day boats, mean fishing effort was 32% greater than that of 1/2-day boats (Table 9).

TABLE 9. Fishing Effort (Minutes) for Sampled Southern California Weekday, Open Commercial Passenger Fishing Vessels by Trip Type for 1985 Through 1987.

| TRIP | 1985 | | | 1986 | | | 1987 | | | 1985-1987 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TYPE | MEAN | LOW | HIGH | MEAN | LOW | HIGH | MEAN | LOW | HIGH | MEAN | LOW | HIGH |
| 1/2-Day | 172 | 34 | 288 | 175 | 56 | 334 | 178 | 19 | 330 | 175 | 19 | 334 |
| 3/4-Day | 248 | 28 | 458 | 268 | 75 | 437 | 261 | 69 | 411 | 258 | 28 | 458 |
| Full-Day | 382 | 48 | 770 | 450 | 64 | 863 | 451 | 99 | 865 | 432 | 48 | 865 |
| Combined | 217 | 28 | 770 | 244 | 56 | 863 | 244 | 19 | 865 | 234 | 19 | 865 |

Some of our sampled southern California CPFV trips fished in Mexican waters. Our data show that almost all of those trips originated at San Diego Bay landings. Based on data for combined years 1985 through 1987, 38% of all San Diego Bay Complex CPFV trips fished in Mexican waters (Table 10).

TABLE 10. Percentages and Sample Size (N) of Sampled San Diego Bay Complex Weekday, Open Commercial Passenger Fishing Vessel Trips to Mexican Waters by Trip Type for 1985 Through 1987.

| TRIP TYPE | 1985 | | 1986 | | 1987 | | 1985-1987 | |
|---|---|---|---|---|---|---|---|---|
| | % | N | % | N | % | N | % | N |
| 1/2-Day | 0 | 71 | 0 | 50 | 0 | 54 | 0 | 175 |
| 3/4-Day | 56 | 16 | 31 | 16 | 58 | 19 | 49 | 51 |
| Full-Day | 84 | 19 | 89 | 47 | 100 | 44 | 93 | 110 |
| Combined | 24 | 106 | 42 | 113 | 47 | 117 | 38 | 336 |

We encountered 180 species of fishes on board southern California CPFV's between 1985 and 1987, including 49 species of rockfishes (Table 11). Collins and Crooke (unpublished manuscript) reported having encountered 156 species during their survey.

TABLE 11. Species Encountered On Board Southern California Commercial Passenger Fishing Vessels Between 1985 and 1987

| COMMON NAME | SCIENTIFIC NAME |
|---|---|
| Albacore | *Thunnus alalunga* |
| Barracuda, California | *Sphyraena argentea* |
| Bass, Barred Sand | *Paralabrax nebulifer* |
| Bass, Kelp | *Paralabrax clathratus* |
| Bass, Spotted Sand | *Paralabrax maculatofasciatus* |
| Blacksmelt, Pacific | *Bathylagus pacificus* |
| Blacksmith | *Chromis punctipinnis* |
| Bocaccio | *Sebastes paucispinis* |
| Bonito, Pacific | *Sarda chiliensis* |
| Butterfish, Pacific | *Peprilus simillimus* |
| Cabezon | *Scorpaenychthys marmoratus* |
| Chilipepper | *Sebastes goodei* |
| Combfish, Shortspine | *Zaniolepsis frenata* |
| Corbina, California | *Menticirrhus undulatus* |
| Cowcod | *Sebastes levis* |
| Croaker, Black | *Cheilotrema saturnum* |
| Croaker, Spotfin | *Roncador stearnsi* |
| Croaker, White | *Genyonemus lineatus* |
| Croaker, Yellowfin | *Umbrina roncador* |
| Cusk-eel, Basketweave | *Ophidion scrippsae* |
| Dogfish, Spiny | *Squalus acanthias* |
| Dolphinfish | *Coryphaena hippurus* |
| Flyingfish, California | *Cypselurus californicus* |
| Fringehead, Sarcastic | *Neoclinus blanchardi* |
| Garibaldi | *Hypsypops rubicundus* |
| Greenling, Painted | *Oxylebius pictus* |
| Grouper, Gulf | *Mycteroperca jordani* |
| Grouper, Snowy | *Epinephelus niveatus* |
| Guitarfish, Shovelnose | *Rhinobatos productus* |
| Gulf Sierra | *Scomberomorus concolor* |
| Hagfish, Black | *Eptatretus deani* |
| Hagfish, Pacific | *Eptatretus stouti* |
| Hake, Pacific | *Merluccius productus* |
| Halfmoon | *Medialuna californiensis* |
| Halibut, California | *Paralichthys californicus* |
| Hammerhead, Smooth | *Sphyrna zygaena* |
| Herring, Round | *Etrumeus teres* |
| Herring, Pacific | *Clupea harengus* |
| Jacksmelt | *Atherinopsis californiensis* |
| Kelpfish, Giant | *Heterostichus rostratus* |
| Kelpfish, Striped | *Gibbonsia metzi* |
| Lingcod | *Ophiodon elongatus* |
| Lizardfish, California | *Synodus lucioceps* |
| Mackerel, Bullet | *Auxis rochei* |
| Mackerel, Jack | *Trachurus symmetricus* |
| Mackerel, Pacific | *Scomber japonicus* |
| Midshipman, Plainfin | *Porichthys notatus* |
| Midshipman, Specklefin | *Porichthys myriaster* |
| Monkeyface Prickleback | *Cebidichthys violaceus* |
| Moray, California | *Gymnothorax mordax* |
| Needlefish, California | *Strongylura exilis* |

TABLE 11 continued

| COMMON NAME | SCIENTIFIC NAME |
|---|---|
| Ocean Sunfish | *Mola mola* |
| Opaleye | *Girella nigricans* |
| Pomfret, Bigscale | *Taractichthys steindachneri* |
| Queenfish | *Seriphus politus* |
| Ratfish | *Hydrolagus colliei* |
| Ray, Bat | *Myliobatis californica* |
| Ray, Pacific Electric | *Torpedo californica* |
| Rockfish, Aurora | *Sebastes aurora* |
| Rockfish, Bank | *Sebastes rufus* |
| Rockfish, Black | *Sebastes melanops* |
| Rockfish, Black-and-Yellow | *Sebastes chrysomelas* |
| Rockfish, Blackgill | *Sebastes melanostomus* |
| Rockfish, Blue | *Sebastes mystinus* |
| Rockfish, Bronzespotted | *Sebastes gilli* |
| Rockfish, Brown | *Sebastes auriculatus* |
| Rockfish, Calico | *Sebastes dalli* |
| Rockfish, Canary | *Sebastes pinniger* |
| Rockfish, Chameleon | *Sebastes phillipsi* |
| Rockfish, China | *Sebastes nebulosus* |
| Rockfish, Copper | *Sebastes caurinus* |
| Rockfish, Darkblotched | *Sebastes crameri* |
| Rockfish, Flag | *Sebastes rubrivinctus* |
| Rockfish, Freckled | *Sebastes lentiginosus* |
| Rockfish, Gopher | *Sebastes carnatus* |
| Rockfish, Grass | *Sebastes rastrelliger* |
| Rockfish, Greenblotched | *Sebastes rosenblatti* |
| Rockfish, Greenspotted | *Sebastes chlorostictus* |
| Rockfish, Greenstriped | *Sebastes elongatus* |
| Rockfish, Halfbanded | *Sebastes semicinctus* |
| Rockfish, Honeycomb | *Sebastes umbrosus* |
| Rockfish, Kelp | *Sebastes atrovirens* |
| Rockfish, Mexican | *Sebastes macdonaldi* |
| Rockfish, Olive | *Sebastes serranoides* |
| Rockfish, Pink | *Sebastes eos* |
| Rockfish, Pinkrose | *Sebastes simulator* |
| Rockfish, Redbanded | *Sebastes babcocki* |
| Rockfish, Redstripe | *Sebastes proriger* |
| Rockfish, Rosethorn | *Sebastes helvomaculatus* |
| Rockfish, Rosy | *Sebastes rosaceus* |
| Rockfish, Sharpchin | *Sebastes zacentrus* |
| Rockfish, Shortbelly | *Sebastes jordani* |
| Rockfish, Speckled | *Sebastes ovalis* |
| Rockfish, Splitnose | *Sebastes diploproa* |
| Rockfish, Squarespot | *Sebastes hopkinsi* |
| Rockfish, Starry | *Sebastes constellatus* |
| Rockfish, Stripetail | *Sebastes saxicola* |
| Rockfish, Swordspine | *Sebastes ensifer* |
| Rockfish, Tiger | *Sebastes nigrocinctus* |
| Rockfish, Vermilion | *Sebastes miniatus* |
| Rockfish, Widow | *Sebastes entomelas* |
| Rockfish, Yelloweye | *Sebastes ruberrimus* |

no quillback

TABLE 11 continued

| COMMON NAME | SCIENTIFIC NAME |
|---|---|
| Rockfish, Yellowtail | *Sebastes flavidus* |
| Ronquil, Smooth | *Rathbunella hypoplecta* |
| Sablefish | *Anoplopoma fimbria* |
| Salema | *Xenistius californiensis* |
| Salmon, King | *Oncorhynchus tshawytscha* |
| Sanddab, Longfin | *Citharichthys xanthostigma* |
| Sanddab, Pacific | *Citharichthys sordidus* |
| Sanddab, Speckled | *Citharichthys stigmaeus* |
| Sardine, Pacific | *Sardinops sagax* |
| Sargo | *Anisotremus davidsoni* |
| Scad, Mexican | *Decapterus hypodus* |
| Sculpin (California Scorpionfish) | *Scorpaena guttata* |
| Sculpin, Fringed | *Icelinus fimbriatus* |
| Sculpin, Staghorn | *Leptocottus armatus* |
| Sculpin, Threadfin | *Icelinus filamentosus* |
| Sea Bass, Giant | *Stereolepis gigas* |
| Seabass, White | *Atractoscion nobilis* |
| Senorita | *Oxyjulis californica* |
| Shark, Blue | *Prionace glauca* |
| Shark, Bonito | *Isurus oxyrinchus* |
| Shark, Horn | *Heterodontus francisci* |
| Shark, Leopard | *Triakis semifasciata* |
| Shark, Pacific Angel | *Squatina californica* |
| Shark, Sixgill | *Hexanchus griseus* |
| Shark, Soupfin | *Galeorhinus zyopterus* |
| Shark, Swell | *Cephaloscyllium ventriosum* |
| Shark, Thresher | *Alopias vulpinus* |
| Sheephead, California | *Semicossyphus pulcher* |
| Sierra, Pacific | *Scomberomorus sierra* |
| Skate, Big | *Raja binoculata* |
| Skate, California | *Raja inornata* |
| Skate, Longnose | *Raja rhina* |
| Skate, Starry | *Raja stellulata* |
| Skipjack | *Katsuwonus pelamis* |
| Skipjack, Black | *Euthynnus lineatus* |
| Skipjack, Wavyback (Kawakawa) | *Euthynnus affinis* |
| Smoothhound, Brown | *Mustelus henlei* |
| Smoothhound, Gray | *Mustelus californicus* |
| Sole, Bigmouth | *Hippoglossina stomata* |
| Sole, Butter | *Isopsetta isolepis* |
| Sole, English | *Parophrys vetulus* |
| Sole, Fantail | *Xystreurys liolepis* |
| Sole, Flathead | *Hippoglossoides elassodon* |
| Sole, Petrale | *Eopsetta jordani* |
| Sole, Rex | *Glyptocephalus zachirus* |
| Sole, Rock | *Lepidopsetta bilineata* |
| Sole, Sand | *Psettichthys melanostictus* |
| Sole, Slender | *Lyopsetta exilis* |

TABLE 11 continued

| COMMON NAME | SCIENTIFIC NAME |
|---|---|
| Stargazer, Smooth | *Kathetostoma averruncus* |
| Stingray, Diamond | *Dasyatis dipterura* |
| Stingray, Pelagic | *Dasyatis violacea* |
| Stingray, Round | *Urolophus halleri* |
| Surfperch, Barred | *Amphistichus argenteus* |
| Surfperch, Black | *Embiotoca jacksoni* |
| Surfperch, Pile (Pile Perch) | *Damalichthys vacca* |
| Surfperch, Rainbow | *Hypsurus caryi* |
| Surfperch, Rubberlip | *Rhacochilus toxotes* |
| Surfperch, Sharpnose | *Phanerodon atripes* |
| Surfperch, Shiner (Shiner Perch) | *Cymatogaster aggregata* |
| Surfperch, Striped | *Embiotoca lateralis* |
| Surfperch, Walleye | *Hyperprosopon argenteum* |
| Surfperch, White | *Phanerodon furcatus* |
| Thornback | *Platyrhinoidis triseriata* |
| Thornyhead, Shortspine | *Sebastolobus alascanus* |
| Tomcod, Pacific | *Microgadus proximus* |
| Topsmelt | *Atherinops affinis* |
| Treefish | *Sebastes serriceps* |
| Triggerfish, Finescale | *Balistes polylepis* |
| Triggerfish, Redtail | *Xanthichthys mento* |
| Tuna, Bigeye | *Thunnus obesus* |
| Tuna, Bluefin | *Thunnus thynnus* |
| Tuna, Yellowfin | *Thunnus albacares* |
| Turbot, C-O (C-O Sole) | *Pleuronichthys coenosus* |
| Turbot, Diamond | *Hypsosetta guttulata* |
| Whitefish, Ocean | *Caulolatilus princeps* |
| Wolf-eel | *Anarrhichthys ocellatus* |
| Wrasse, Rock | *Halichoeres semicinctus* |
| Yellowtail | *Seriola lalandei* |

## All Fishes

### Catch Estimates

Southern California. Based on our IRI, Pacific mackerel, kelp bass, and barred sand bass were the three most important species caught by southern California CPFV's from 1985 through 1987 (Table 12).

The estimated total catch of all fishes for southern California was 3,772,941 fish ± 113,188 in 1985, 4,603,498 ± 92,069 in 1986, and 4,240,369 ± 127,211 in 1987 (Table 13). The estimated number of fishes kept increased by 25% from 1985 to 1986; 1986 and 1987 figures were similar (Table 13). The estimated number of released fishes increased by 16% from 1985 to 1986, then declined by 22% from 1986 to 1987 (Table 13). The overall kept to released ratio steadily increased from 1.8 to 1 in 1985 to 2.4 to 1 in 1987. The catch distribution shows that 50% of the fishes were taken from June through September (Figure 2).

Our annual, estimated total catches for 1985 through 1987 were higher than those reported by Collins and Crooke (unpublished manuscript) for 1976 through 1978, and had less variability. Their estimates were 2,726,930 ± 81,499 for 1976, 2,907,512 ± 86,994 for 1977, and 4,089,640 ± 117,073 for 1978. Also, surface species were more important in our survey than they were in theirs; they found mixed depth and bottom species taken with greater frequency.

Counties. Based on our IRI, Pacific mackerel, kelp bass, and barred sand bass were the most important components of the catch in San Diego, Orange and Los Angeles counties (Tables 14 through 16). In Ventura and Santa Barbara counties, bocaccio and olive rockfish shared

TABLE 12. Top 20 Ranks, Based on an Index of Relative Importance, of Sport Fish Species Observed On Board Southern California Based Commercial Passenger Fishing Vessels in 1985, 1986, and 1987.

| RANK | 1985 | 1986 | 1987 |
|---|---|---|---|
| 1 | Pacific mackerel | Kelp bass | Pacific mackerel |
| 2 | Kelp bass | Pacific mackerel | Kelp bass |
| 3 | Barred sand bass | Barred sand bass | Barred sand bass |
| 4 | California barracuda | Pacific bonito | Pacific bonito |
| 5 | Pacific bonito | California barracuda | California barracuda |
| 6 | Bocaccio | Ocean whitefish | Sculpin (California scorpionfish) |
| | | Sculpin (California scorpionfish) | |
| 7 | Ocean whitefish | White croaker | Vermilion rockfish |
| 7 | Sculpin (California scorpionfish) | | Ocean whitefish |
| 8 | Starry rockfish | Bocaccio | California halibut |
| 9 | California halibut | California halibut | Bocaccio |
| 10 | Vermilion rockfish | Vermilion rockfish | Olive rockfish |
| 11 | Greenspotted rockfish | Starry rockfish | White croaker |
| 12 | Rosy rockfish | Halfmoon | California sheephead |
| 13 | Chilipepper | California sheephead | Chilipepper |
| 13 | Honeycomb rockfish | | |
| 14 | Squarespot rockfish | Calico rockfish | Copper rockfish |
| 15 | Blue rockfish | Honeycomb rockfish | Starry rockfish |
| 15 | White croaker | | |
| 15 | Calico rockfish | | |
| 16 | Flag rockfish | Olive rockfish | Halfmoon |
| 17 | Olive rockfish | Chilipepper | Greenspotted rockfish |
| 17 | | Jack mackerel | |
| 18 | Pacific sanddab | Greenspotted rockfish | Yellowtail |
| 19 | Yellowtail | Rosy rockfish | Blue rockfish |
| 19 | | | Honeycomb rockfish |
| 20 | California lizardfish | California lizardfish | California lizardfish |
| 20 | | | Gopher rockfish |

TABLE 13. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of All Fishes from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| AREA | FISHES KEPT | | | | | | FISHES RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 687,455 | 9 | 890,638 | 5 | 927,073 | 4 | 250,877 | 7 | 363,706 | 6 | 291,120 | 6 | 938,333 | 7 | 1,254,344 | 4 | 1,218,193 | 4 |
| Orange County | 262,822 | 9 | 476,556 | 8 | 429,968 | 11 | 258,903 | 8 | 387,320 | 9 | 268,769 | 9 | 521,725 | 6 | 863,875 | 7 | 698,737 | 9 |
| Los Angeles County | 966,957 | 4 | 1,038,125 | 4 | 989,711 | 6 | 744,698 | 7 | 631,188 | 6 | 501,642 | 6 | 1,711,655 | 5 | 1,669,313 | 3 | 1,491,352 | 5 |
| Ventura County | 432,631 | 6 | 546,975 | 5 | 572,924 | 6 | 75,137 | 11 | 153,263 | 8 | 134,272 | 10 | 507,769 | 5 | 700,238 | 5 | 707,197 | 6 |
| Santa Barbara County | 66,524 | 16 | 74,240 | 13 | 95,661 | 19 | 26,936 | 9 | 41,488 | 19 | 29,228 | 14 | 93,459 | 11 | 115,728 | 14 | 124,890 | 13 |
| Southern California | 2,416,389 | 3 | 3,026,532 | 3 | 3,015,337 | 3 | 1,356,551 | 5 | 1,576,966 | 4 | 1,225,032 | 4 | 3,772,941 | 3 | 4,603,498 | 2 | 4,240,369 | 3 |

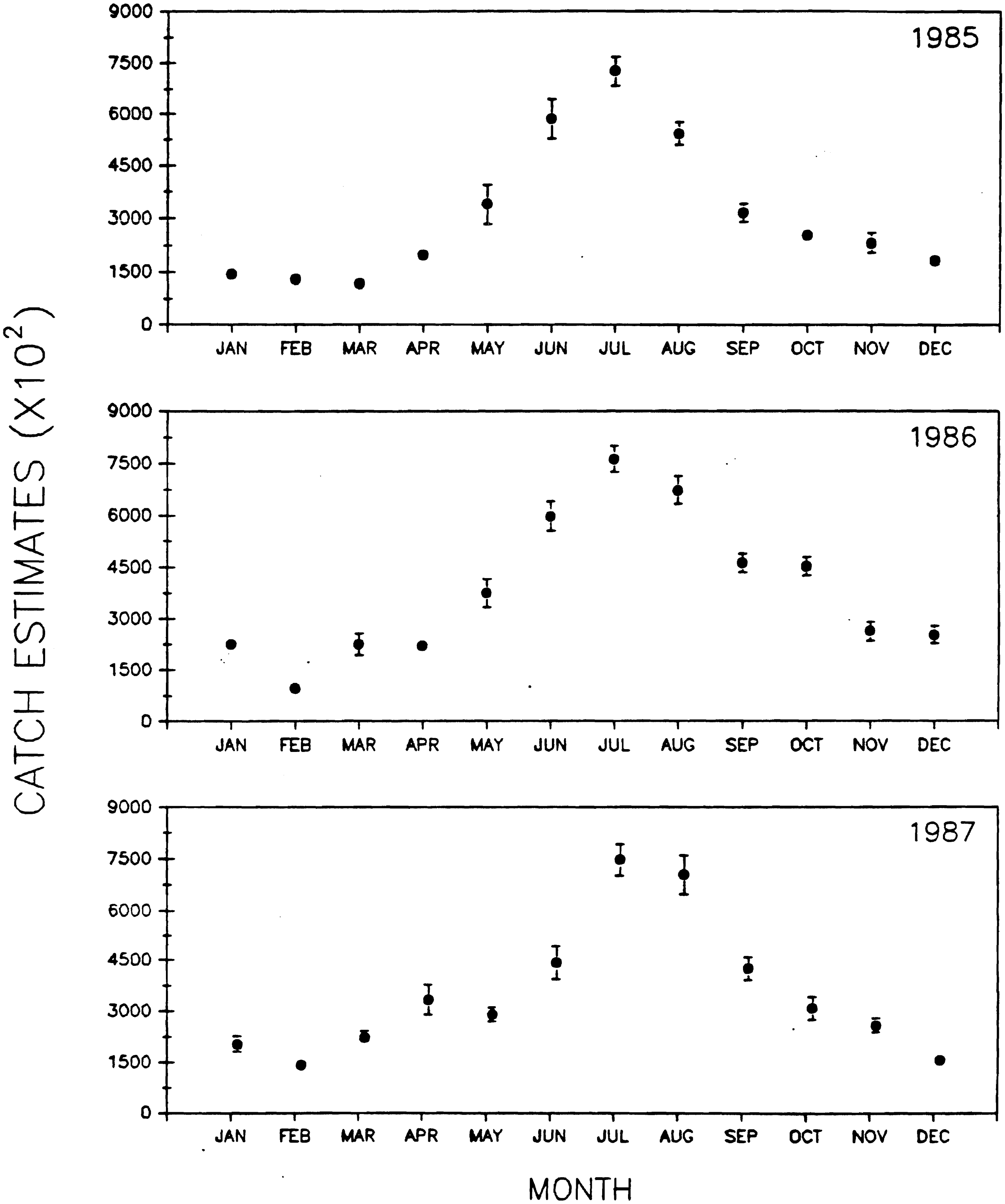



FIGURE 2. Monthly total catch estimates (number of fish) and standard deviations of all fishes from on-board observations of southern California commercial passenger fishing vessels.

TABLE 14. Top 20 Ranks, Based on an Index of Relative Importance, of Sport Fish Species Observed On Board San Diego County Based Commercial Passenger Fishing Vessels in 1985, 1986, and 1987.

| RANK | 1985 | 1986 | 1987 |
|---|---|---|---|
| 1 | Pacific mackerel | Pacific mackerel | Pacific mackerel |
| 2 | California barracuda | Kelp bass | Kelp bass |
| 3 | Kelp bass | California barracuda | Pacific bonito |
| 4 | Barred sand bass | Pacific bonito | California barracuda |
| 5 | Pacific bonito | Barred sand bass | Barred sand bass |
| 6 | Honeycomb rockfish | Ocean whitefish | Ocean whitefish |
| 6 | Sculpin (California scorpionfish) | | Sculpin (California scorpionfish) |
| 7 | Ocean whitefish | Calico rockfish | Olive rockfish |
| 8 | Starry rockfish | Honeycomb rockfish | Honeycomb rockfish |
| 8 | Calico rockfish | | |
| 9 | Albacore | Sculpin (California scorpionfish) | Vermilion rockfish |
| 10 | Flag rockfish | Olive rockfish | California sheephead |
| 10 | Gopher rockfish | | |
| 11 | Treefish | Jack mackerel | Yellowtail |
| 12 | Squarespot rockfish | Vermilion rockfish | Calico rockfish |
| 12 | Yellowtail | | Treefish |
| 13 | Bocaccio | Starry rockfish | Starry rockfish |
| 14 | Blue rockfish | Treefish | White croaker |
| 15 | Vermilion rockfish | White croaker | California halibut |
| 15 | | Yellowtail | |
| 16 | Brown rockfish | California sheephead | Lingcod |
| 16 | California sheephead | | |
| 17 | California halibut | Gopher rockfish | Gopher rockfish |
| 18 | Greenspotted rockfish | California halibut | Flag rockfish |
| 19 | Rosy rockfish | Bocaccio | Chilipepper |
| 19 | | Squarespot rockfish | |
| 20 | Bank rockfish | Skipjack | Skipjack |
| 20 | | Flag rockfish | |

TABLE 15. Top 20 Ranks, Based on an Index of Relative Importance, of Sport Fish Species Observed On Board Orange County Based Commercial Passenger Fishing Vessels in 1985, 1986, and 1987.

| RANK | 1985 | 1986 | 1987 |
|---|---|---|---|
| 1 | Barred sand bass | Pacific mackerel | Barred sand bass |
| 2 | Pacific mackerel | Barred sand bass | Pacific mackerel |
| 3 | Kelp bass | Kelp bass | Kelp bass |
| 3 | | | California barracuda |
| 4 | California barracuda | Pacific bonito | Pacific bonito |
| 5 | Sculpin (California scorpionfish) | California barracuda | Sculpin (California scorpionfish) |
| 6 | Bocaccio | White croaker | Vermilion rockfish |
| 7 | Pacific bonito | Sculpin (California scorpionfish) | White croaker |
| 7 | White croaker | | |
| 8 | California halibut | Bank rockfish | California lizardfish |
| 8 | | Halfmoon | |
| 9 | California lizardfish | Chilipepper | California sheephead |
| 10 | Halfmoon | California halibut | Bocaccio |
| 10 | | | California halibut |
| 11 | Greenspotted rockfish | California lizardfish | Chilipepper |
| 11 | | | Halfmoon |
| 12 | Starry rockfish | Bocaccio | White seabass |
| 13 | Flag rockfish | Yellowtail | Flag rockfish |
| 13 | Vermilion rockfish | | |
| 14 | Rosy rockfish | California sheephead | Olive rockfish |
| 14 | | | Senorita |
| 15 | Honeycomb rockfish | Pacific sanddab | Ocean whitefish |
| 16 | Bank rockfish | Ocean whitefish | Pacific sanddab |
| 17 | Ocean whitefish | Greenblotched rockfish | Yellowtail |
| 18 | California sheephead | Vermilion rockfish | Bank rockfish |
| 19 | Squarespot rockfish | Greenstriped rockfish | Calico rockfish |
| 20 | Yellowtail | Calico rockfish | Blacksmith |
| 20 | | | Fantail sole |

TABLE 16. Top 20 Ranks, Based on an Index of Relative Importance, of Sport Fish Species Observed On Board Los Angeles County Based Commercial Passenger Fishing Vessels in 1985, 1986, and 1987.

| RANK | 1985 | 1986 | 1987 |
|---|---|---|---|
| 1 | Pacific mackerel | Kelp bass | Barred sand bass |
| 1 | | | Pacific mackerel |
| 2 | Kelp bass | Pacific mackerel | Kelp bass |
| 2 | Barred sand bass | | |
| 3 | California barracuda | Barred sand bass | Pacific bonito |
| 4 | Pacific bonito | California barracuda | California barracuda |
| 5 | California halibut | Pacific bonito | Sculpin (California scorpionfish) |
| 6 | Sculpin (California scorpionfish) | California halibut | California halibut |
| 7 | Ocean whitefish | Sculpin (California scorpionfish) | White croaker |
| 8 | Bocaccio | White croaker | Vermilion rockfish |
| 9 | White croaker | Bocaccio | Ocean whitefish |
| 10 | California lizardfish | Halfmoon | Bocaccio |
| 10 | | Ocean whitefish | California lizardfish |
| 11 | Squarespot rockfish | California sheephead | Halfmoon |
| 11 | Yellowtail | | |
| 12 | Starry rockfish | California lizardfish | California sheephead |
| 13 | Vermilion rockfish | Vermilion rockfish | Yellowtail |
| 14 | California sheephead | Starry rockfish | Spiny dogfish |
| 14 | Rosy rockfish | | |
| 15 | Calico rockfish | Squarespot rockfish | Starry rockfish |
| 16 | Honeycomb rockfish | Blacksmith | Olive rockfish |
| 17 | Greenspotted rockfish | Calico rockfish | Calico rockfish |
| 18 | Flag rockfish | Flag rockfish | Greenspotted rockfish |
| 19 | Treefish | Rosy rockfish | Chilipepper |
| 19 | | | Pacific sanddab |
| 20 | Jack mackerel | Honeycomb rockfish | Rosy rockfish |

top three positions with Pacific mackerel and kelp bass (Tables 17 and 18).

Los Angeles County showed the highest estimated catches throughout our survey, but a declining trend was evident, down 13% from 1985 to 1987 (Table 13). San Diego and Orange counties showed strong catch increases in 1986, followed by a decline in 1987 (Table 13). Ventura and Santa Barbara counties showed rapid catch increases from 1985 to 1987, up 39% and 34%, respectively (Table 13). There was a general increase in the ratio of kept to released fishes during the survey in all counties.

TABLE 17. Top 20 Ranks, Based on an Index of Relative Importance, of Sport Fish Species Observed On Board Ventura County Based Commercial Passenger Fishing Vessels in 1985, 1986, and 1987.

| RANK | 1985 | 1986 | 1987 |
|---|---|---|---|
| 1 | Bocaccio | Kelp bass | Kelp bass |
| 2 | Pacific mackerel | Pacific mackerel | Pacific mackerel |
| 3 | Kelp bass | Bocaccio | Barred sand bass |
| 4 | Greenspotted rockfish | Ocean whitefish | Bocaccio |
| 5 | Pacific sanddab | Greenspotted rockfish | Pacific bonito |
| 5 | | California barracuda | |
| 6 | Ocean whitefish | Chilipepper | Chilipepper |
| 7 | Chilipepper | Halfmoon | Olive rockfish |
| 7 | Starry rockfish | | |
| 8 | Rosy rockfish | Starry rockfish | Vermilion rockfish |
| 9 | Vermilion rockfish | Vermilion rockfish | Greenspotted rockfish |
| 10 | California barracuda | Copper rockfish | Copper rockfish |
| 10 | | California sheephead | |
| 11 | Greenstriped rockfish | Rosy rockfish | Ocean whitefish |
| 12 | Blue rockfish | Blue rockfish | California halibut |
| 12 | | Greenstriped rockfish | |
| 13 | Copper rockfish | Kelp rockfish | Blue rockfish |
| 14 | Flag rockfish | Sculpin (California scorpionfish) | Sculpin (California scorpionfish) |
| 15 | Speckled rockfish | Pacific sanddab | White croaker |
| 15 | | | California barracuda |
| 16 | Gopher rockfish | California halibut | Gopher rockfish |
| 17 | Barred sand bass | Olive rockfish | California sheephead |
| 18 | California sheephead | Gopher rockfish | Halfmoon |
| 19 | Olive rockfish | Blacksmith | Greenstriped rockfish |
| 20 | Pacific bonito | Pacific bonito | Starry rockfish |

TABLE 18. Top 20 Ranks, Based on an Index of Relative Importance, of Sport Fish Species Observed On Board Santa Barbara County Based Commercial Passenger Fishing Vessels in 1985, 1986, and 1987.

| | 1985 | 1986 | 1987 |
|---|---|---|---|
| 1 | Kelp bass | Kelp bass | Pacific mackerel |
| 1 | Pacific mackerel | | |
| 2 | Olive rockfish | Pacific mackerel | Kelp bass |
| 3 | Bocaccio | Barred sand bass | Copper rockfish |
| 4 | Blue rockfish | Olive rockfish | Vermilion rockfish |
| 4 | | | Olive rockfish |
| 5 | Vermilion rockfish | Blue rockfish | Barred sand bass |
| 6 | Barred sand bass | California barracuda | Blue rockfish |
| 7 | California barracuda | Copper rockfish | Pacific bonito |
| 8 | Copper rockfish | White croaker | Bocaccio |
| 9 | Starry rockfish | Vermilion rockfish | Widow rockfish |
| 10 | Greenspotted rockfish | Pacific bonito | Kelp rockfish |
| 11 | Calico rockfish | Bocaccio | Ocean whitefish |
| 11 | | | Gopher rockfish |
| 12 | Pacific bonito | Greenspotted rockfish | California barracuda |
| 12 | | Brown rockfish | |
| 13 | Rosy rockfish | Yellowtail rockfish | Lingcod |
| 14 | Yellowtail rockfish | California halibut | Starry rockfish |
| 14 | | | California halibut |
| 15 | Squarespot rockfish | Starry rockfish | Greenspotted rockfish |
| 16 | Widow rockfish | Lingcod | Brown rockfish |
| 17 | Speckled rockfish | Sculpin (California scorpionfish) | Sculpin (California scorpionfish) |
| 18 | Ocean whitefish | Ocean whitefish | White croaker |
| 18 | Lingcod | | |
| 19 | Gopher rockfish | Widow rockfish | Rosy rockfish |
| 20 | White croaker | Rosy rockfish | Canary rockfish |

## Ocean Whitefish (Branchiostegidae)

### Catch Estimates

Southern California. Ocean whitefish, a shallow-water-dwelling species, is usually caught in depths of 11 to 92 m (6 to 50 fm) over rocky reefs and offshore banks (Eschmeyer et al. 1983). In the southern California CPFV fishery, ocean whitefish is normally an incidental catch species on trips targeting shallow-water rockfishes.

The total catch estimates for ocean whitefish ranged from 72,846 fish ± 9,470 in 1987 to 94,786 ± 13,270 in 1986 (Table 19). In Collins and Crooke (unpublished manuscript), ocean whitefish total catch estimates ranged from 40,354 ± 5,567 in 1978 to 58,959 ± 8,009 in 1977. The CPFV log records show a trend of increasing ocean whitefish landings, starting in 1965 and peaking in 1985 (Paul Gregory, California Department of Fish and Game, Marine Resources Division, pers. comm).

The catch-by-month analysis showed that, in 1985 and 1986, total catches peaked in the summer months, while in 1987, total catches peaked in October (Figure 3). This seasonal distribution is governed by CPFV fishing patterns, which dictate that shallow-water rockfish fishing occurs during the summer months. Most of the ocean whitefish catch is incidental to rockfishes on these trips. The October catch peak in 1987 might be a result of changes in normal fishing patterns.

Counties. San Diego, Los Angeles, and Ventura Counties supplied an average of 96% of the ocean whitefish catch. The distribution of ocean whitefish catches was due primarily to the geographic location of ocean whitefish habitat areas: the San Diego County catch came almost

TABLE 19. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of Ocean Whitefish from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| AREA | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 23,880 | 35 | 27,969 | 31 | 31,065 | 19 | 465 | 45 | 1,448 | 84 | 256 | 46 | 24,345 | 35 | 29,417 | 34 | 31,321 | 19 |
| Orange County | 1,155 | 44 | 1,097 | 36 | 2,833 | 43 | 17 | 97 | 1,625 | 90 | 31 | 98 | 1,173 | 43 | 2,722 | 65 | 2,864 | 43 |
| Los Angeles County | 31,690 | 29 | 32,850 | 21 | 20,484 | 25 | 877 | 47 | 863 | 44 | 1,209 | 27 | 32,568 | 29 | 33,713 | 20 | 21,693 | 25 |
| Ventura County | 21,885 | 24 | 27,256 | 20 | 11,850 | 29 | 54 | 98 | 432 | 46 | 282 | 48 | 21,939 | 24 | 27,688 | 19 | 12,132 | 28 |
| Santa Barbara County | 471 | 37 | 1,245 | 78 | 4,836 | 68 | 12 | 96 | 0 | 0 | 0 | 0 | 484 | 36 | 1,245 | 78 | 4,836 | 68 |
| Southern California | 79,082 | 17 | 90,418 | 14 | 71,068 | 13 | 1,426 | 33 | 4,368 | 45 | 1,777 | 21 | 80,508 | 17 | 94,786 | 14 | 72,846 | 13 |

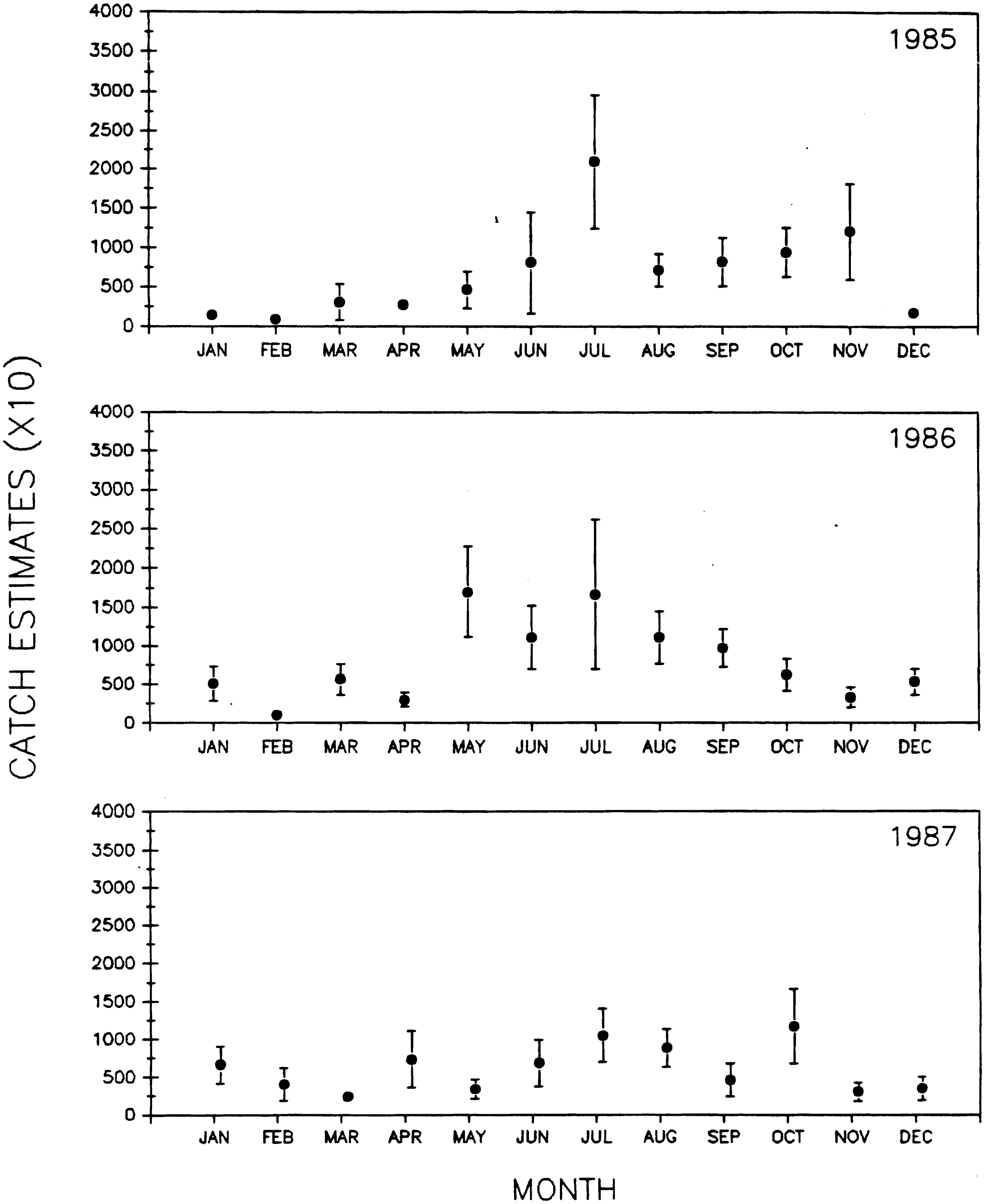



FIGURE 3. Monthly total catch estimates (number of fish) and standard deviations of ocean whitefish from on-board observations of southern California commercial passenger fishing vessels.

exclusively from the Coronado Islands in 1986 and 1987; San Clemente Island, Santa Barbara Island, and Horseshoe Kelp were the sites contributing most of the Los Angeles County ocean whitefish catches; and Anacapa Island and the east end of Santa Cruz Island were the fishing sites where most of the Ventura County ocean whitefish catches occurred (Ally et al. 1988).

Size Composition

Southern California. Our analyses of ocean whitefish length frequency data show a single modal group that is probably composed of a single, strong year class (Figure 4). Based on the length at age relationships described by Cooksey (1980), this mode represents 1983 year class ocean whitefish.

Counties. Two trends were apparent in our analyses of the ocean whitefish length frequencies by county; one pattern, of a dependence on a single strong year class, was reflected in the southern California ocean whitefish length frequency analysis. The San Diego, Los Angeles, Ventura, and Santa Barbara County length frequencies all display this uni-modal pattern (Figures 5 through 8). In the case of Orange County, the relatively small number of length measurements available did not define a single, dominant length mode (Figure 9). The second trend is a south to north cline in which larger, older ocean whitefish were more heavily represented in catches from the northern most counties. This was most obvious in the Ventura and Santa Barbara County catches. The mean lengths of ocean whitefish from Santa Barbara CPFV's were generally greater than those from the other four counties (Figure 10). The Santa Barbara County ocean whitefish catch revealed, especially in

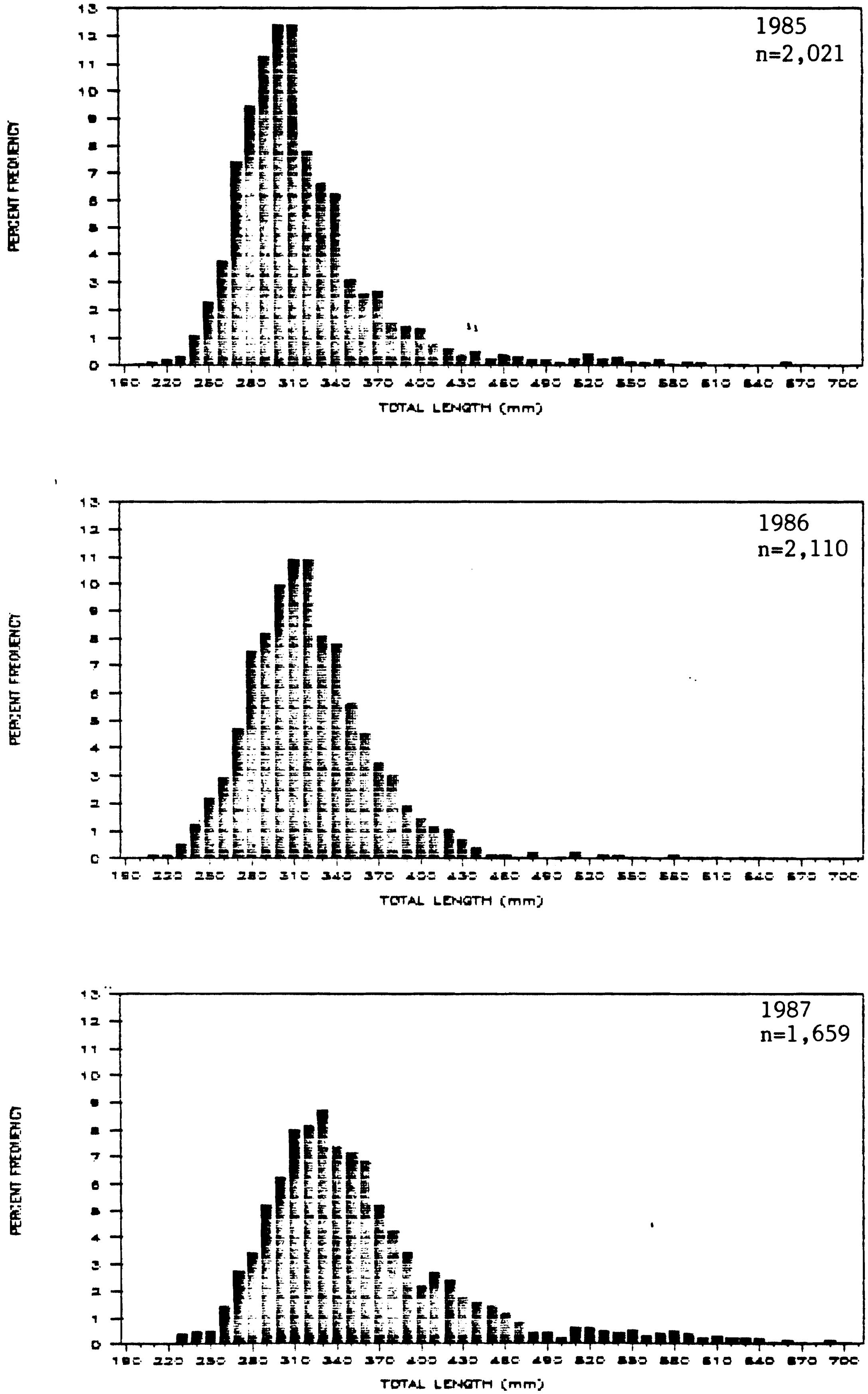



FIGURE 4. Size composition of ocean whitefish from on-board observations of southern California commercial passenger fishing vessels.

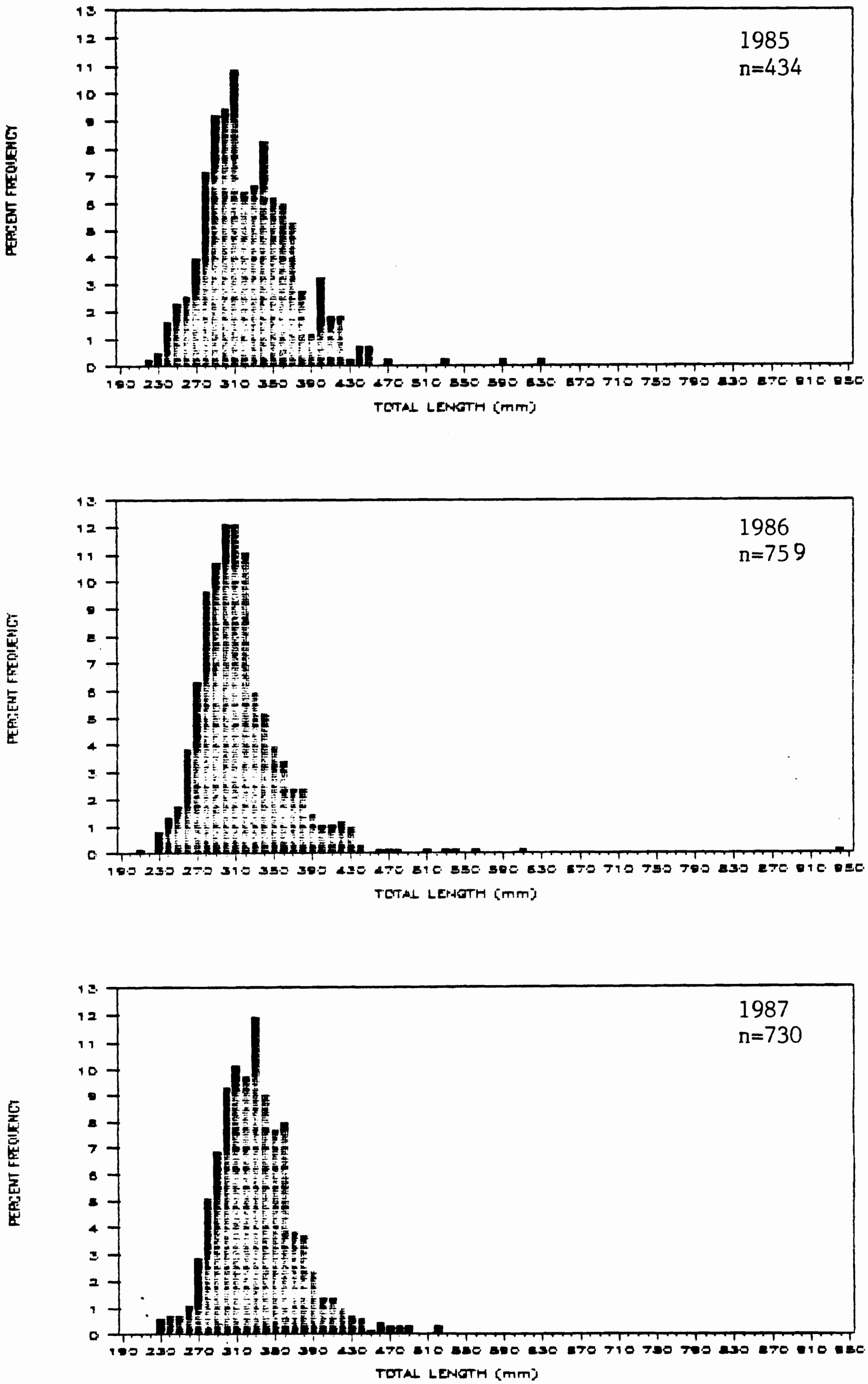



FIGURE 5. Size composition of ocean whitefish from on-board observations of San Diego County commercial passenger fishing vessels.

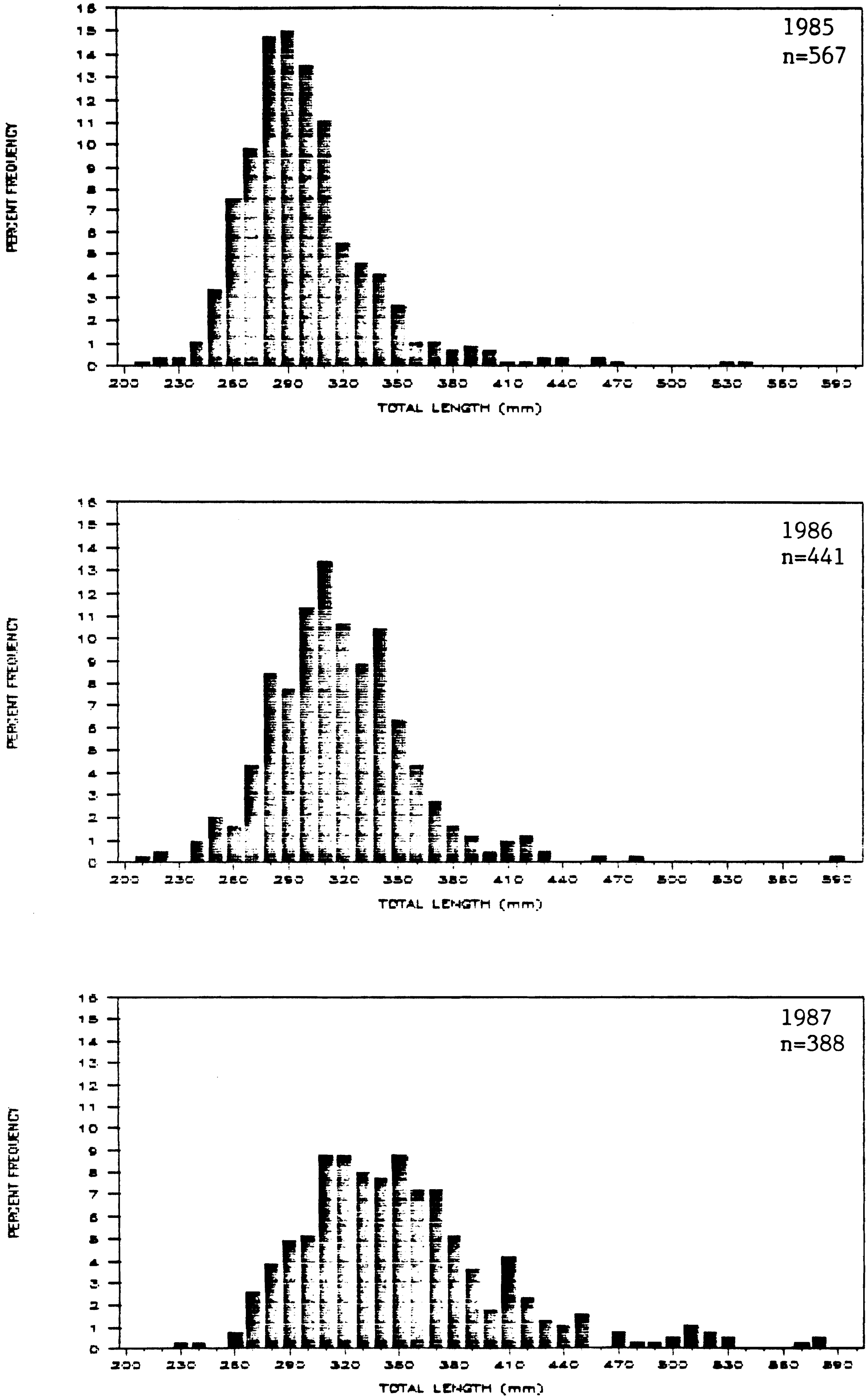



FIGURE 6. Size composition of ocean whitefish from on-board observations of Los Angeles County commercial passenger fishing vessels.

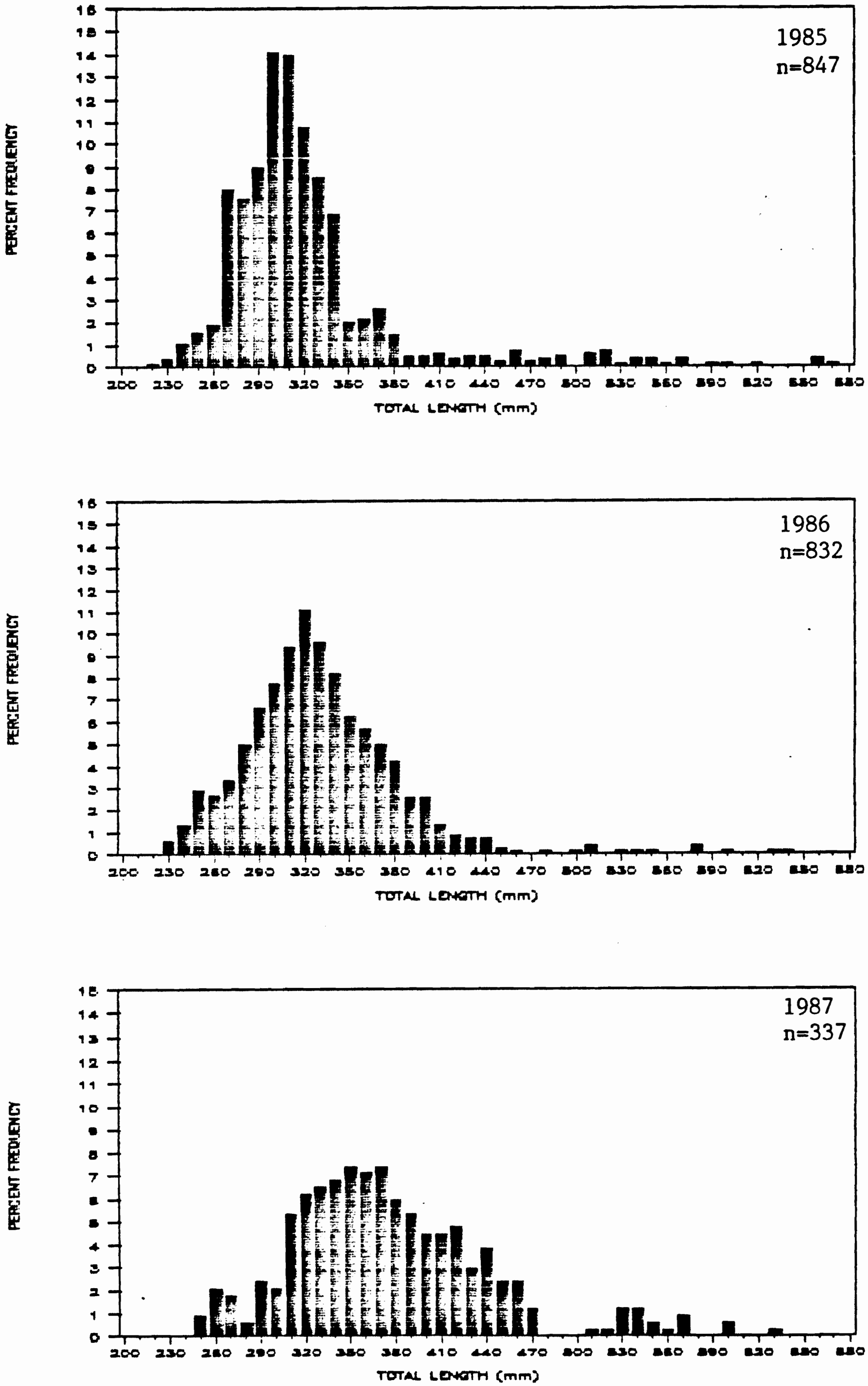



FIGURE 7. Size composition of ocean whitefish from on-board observations of Ventura County commercial passenger fishing vessels.

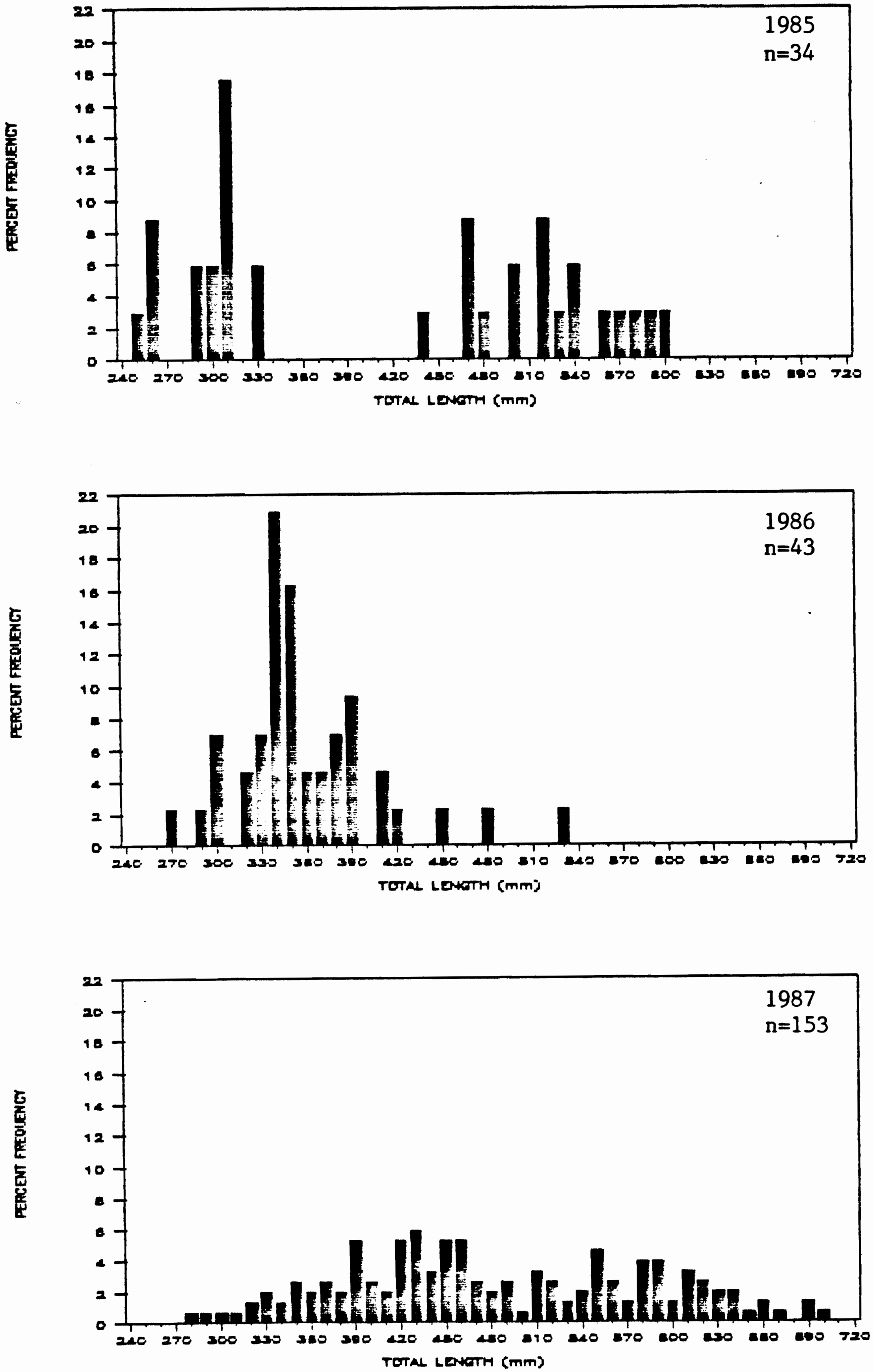



FIGURE 8. Size composition of ocean whitefish from on-board observations of Santa Barbara County commercial passenger fishing vessels.

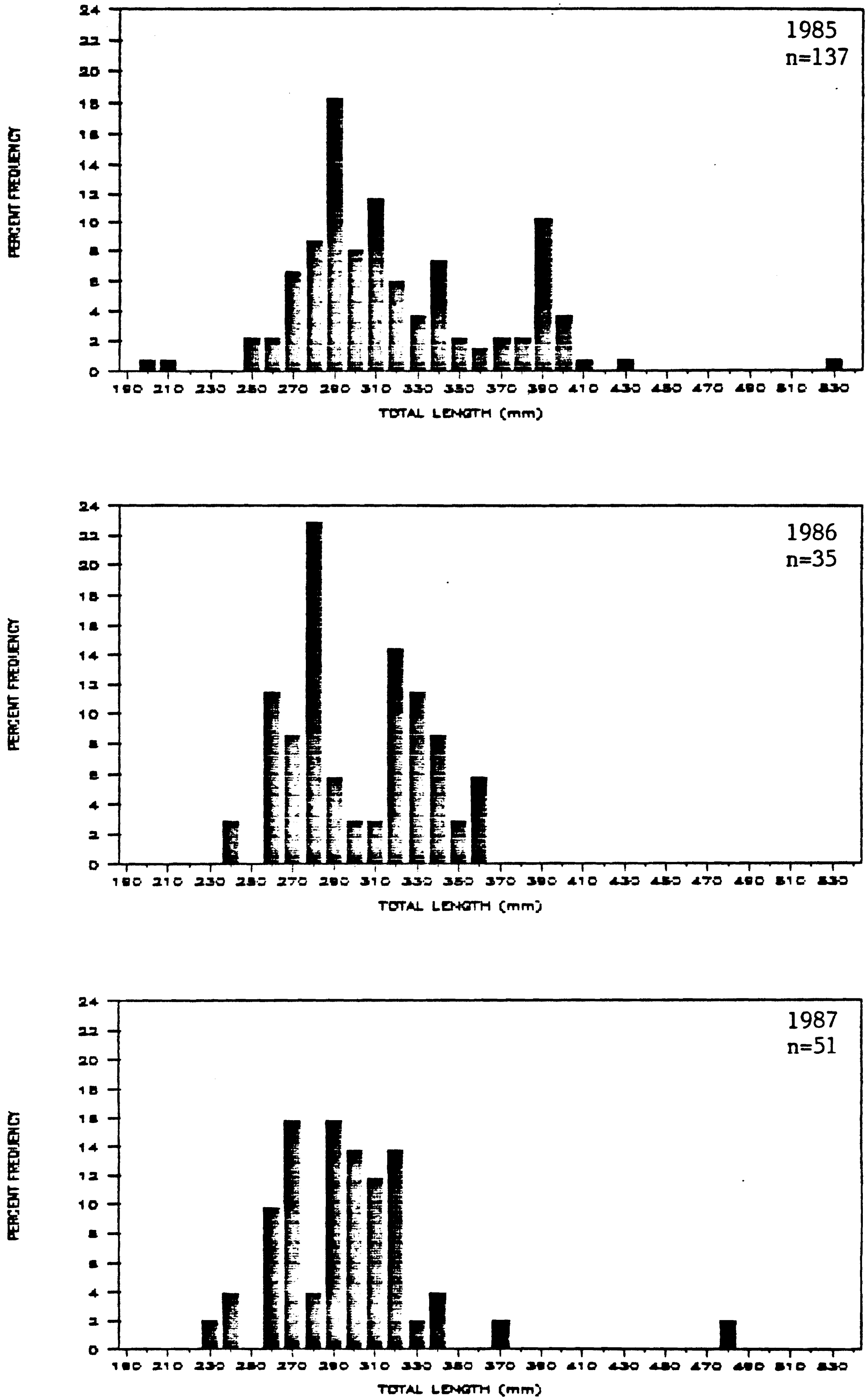



FIGURE 9. Size composition of ocean whitefish from on-board observations of Orange County commercial passenger fishing vessels.

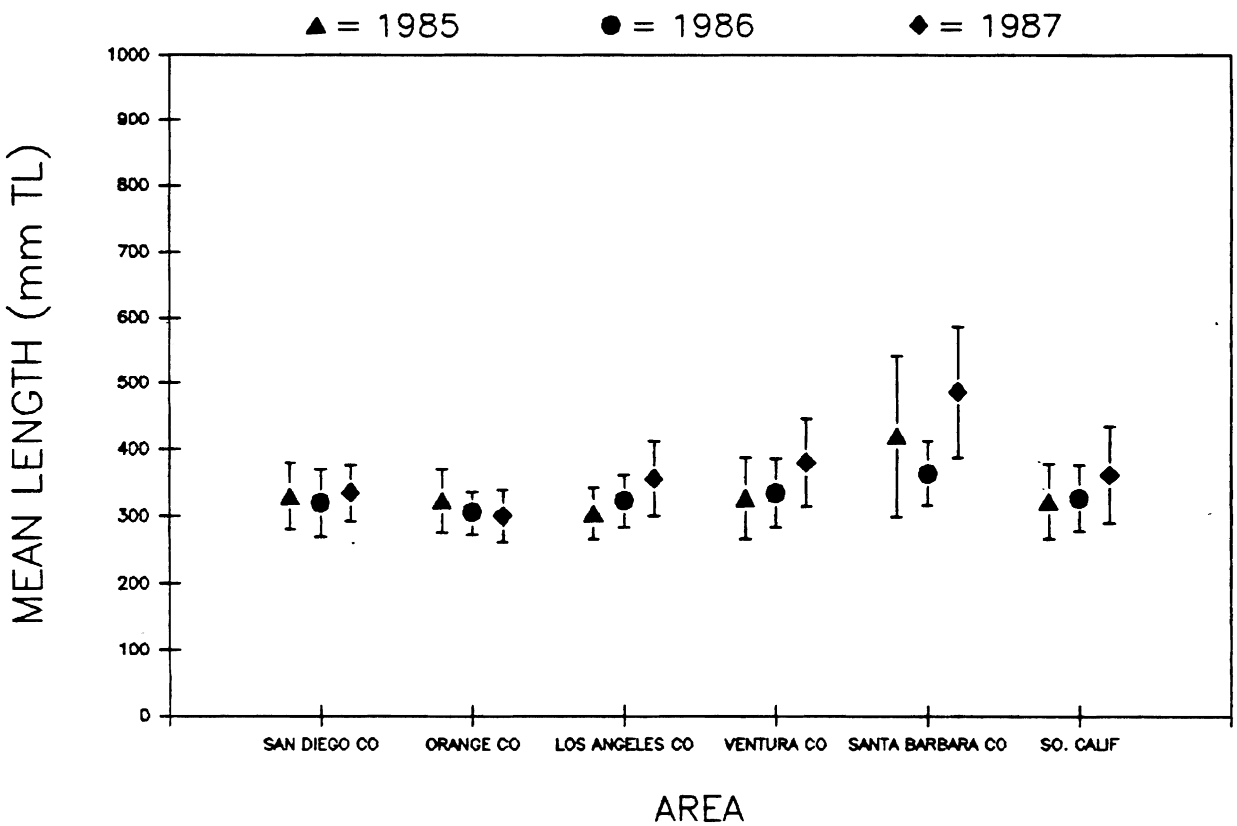



FIGURE 10. Mean lengths and standard deviations of ocean whitefish measured on-board southern California commercial passenger fishing vessels.

1985 and 1987, that quantities of ocean whitefish greater than 400 mm (16 in.) in length were caught that shifted the length frequency mean upward (Figure 8). The presence of large ocean whitefish at San Miguel Island, one of the prime fishing sites for Santa Barbara County CPFV's (Ally, et al.), was the source of the 400-mm and larger fish in the frequency distribution.

Management Recommendations

In the past ocean whitefish was not highly prized, either as a gamefish or for its edibility (Fitch and Lavenberg 1971), but the catch trend since 1965 has been increasing steadily. A decreased availability of the more desirable rockfish species may be one major reason for the increased catches of ocean whitefish. In situations where shallow-water rockfishes cannot be found or coaxed to bite, ocean whitefish may frequently be found schooled nearby in large numbers; they can be caught on the same terminal gear and baits, and do not require sophisticated angling techniques.

Although the ocean whitefish catch has been increasing over the past 20 years, our study showed a 29% decline in the ocean whitefish catch between 1986 and 1987. Our length frequency analyses reveal that a large portion of the current catch is composed of immature fish that have not reached spawning age. If the observed trend continues, ocean whitefish catches over the next several years may show a declining trend until another strong year class is recruited into the CPFV fishery. The ocean whitefish population segment in southern California may fit a pattern described by Rothschild (1986), in which Very Large Year Classes dominate a sequence of recruitment data. Another factor affecting recruitment of ocean whitefish is the fact that southern

California is at the northern edge of the range for the species (Miller and Lea 1972). Physical conditions may only be marginally or cyclically suitable for successful recruitment and survival so far north of their central, subtropical home range.

Based on our results, we recommend that a longer time series of current catch and length frequency data be available before any new regulations are considered for the ocean whitefish sport fishery. The CPFV catch estimates generated by our survey, plus the fact that the commercial fishery for ocean whitefish is currently very limited, leads us to believe that the sport fishery can be sustained under the existing management regulations.

## California Halibut (Bothidae)

### Catch Estimates

Southern California. The estimated total catch of California halibut (henceforth referred to as halibut) remained stable between 1985 and 1987 (Table 20). Estimated landings of halibut rose steadily from 1985 to 1987, but not enough to alter the stable trend exhibited by the halibut total catch (Table 20). The estimated number of released halibut remained stable from 1985 to 1987 (Table 20). The ratio of kept to released halibut was 0.2 to 1 from 1985 through 1987. February through May was the time of peak catches (Figure 11).

Estimated annual catches of halibut have increased since the mid-1970's. The 1976 through 1978 estimated mean annual catch of legal halibut [≥559 mm (22 in.)] increased from 5,148 fish ± 935 (Collins and Crooke unpublished manuscript) to our 3-year study's estimate of 7,415 ± 1,248; the estimated mean annual catch of short halibut increased from 14,951 ± 2,417 (Collins and Crooke unpublished manuscript), to our 3-year study's estimate of 52,151 ± 5,344. The ratio of legal to short halibut was 0.1 to 1 in both 1985 and 1986, and 0.2 to 1 in 1987. Collins and Crooke (unpublished manuscript) found that the ratio of legal to short halibut was 1.1 to 1 in 1976, 0.3 to 1 in 1977, and 0.2 to 1 in 1978.

The annual estimated catch of short halibut increased sharply from 1976 to 1978, but stabilized at some point thereafter. Collins and Crooke (unpublished manuscript) felt that halibut benefited greatly from the 1971 law that prohibited the take of halibut less than 559 mm

TABLE 20. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of California Halibut from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| AREA | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 658 | 52 | 439 | 38 | 634 | 27 | 3,394 | 19 | 2,784 | 13 | 3,547 | 21 | 4,053 | 22 | 3,223 | 14 | 4,181 | 18 |
| Orange County | 583 | 29 | 241 | 44 | 421 | 17 | 5,195 | 19 | 4,782 | 20 | 3,758 | 28 | 5,778 | 17 | 5,022 | 19 | 4,179 | 26 |
| Los Angeles County | 5,304 | 26 | 6,153 | 18 | 5,059 | 25 | 34,916 | 10 | 37,366 | 15 | 29,243 | 13 | 40,220 | 12 | 43,519 | 15 | 34,303 | 13 |
| Ventura County | 395 | 31 | 1,435 | 35 | 3,382 | 27 | 1,911 | 36 | 8,182 | 41 | 10,004 | 28 | 2,306 | 33 | 9,617 | 39 | 13,386 | 26 |
| Santa Barbara County | 53 | 59 | 186 | 37 | 521 | 60 | 239 | 39 | 784 | 36 | 735 | 44 | 291 | 34 | 970 | 36 | 1,256 | 39 |
| Southern California | 6,993 | 20 | 8,453 | 15 | 10,017 | 16 | 45,654 | 8 | 53,898 | 12 | 47,288 | 10 | 52,648 | 10 | 62,351 | 12 | 57,305 | 10 |

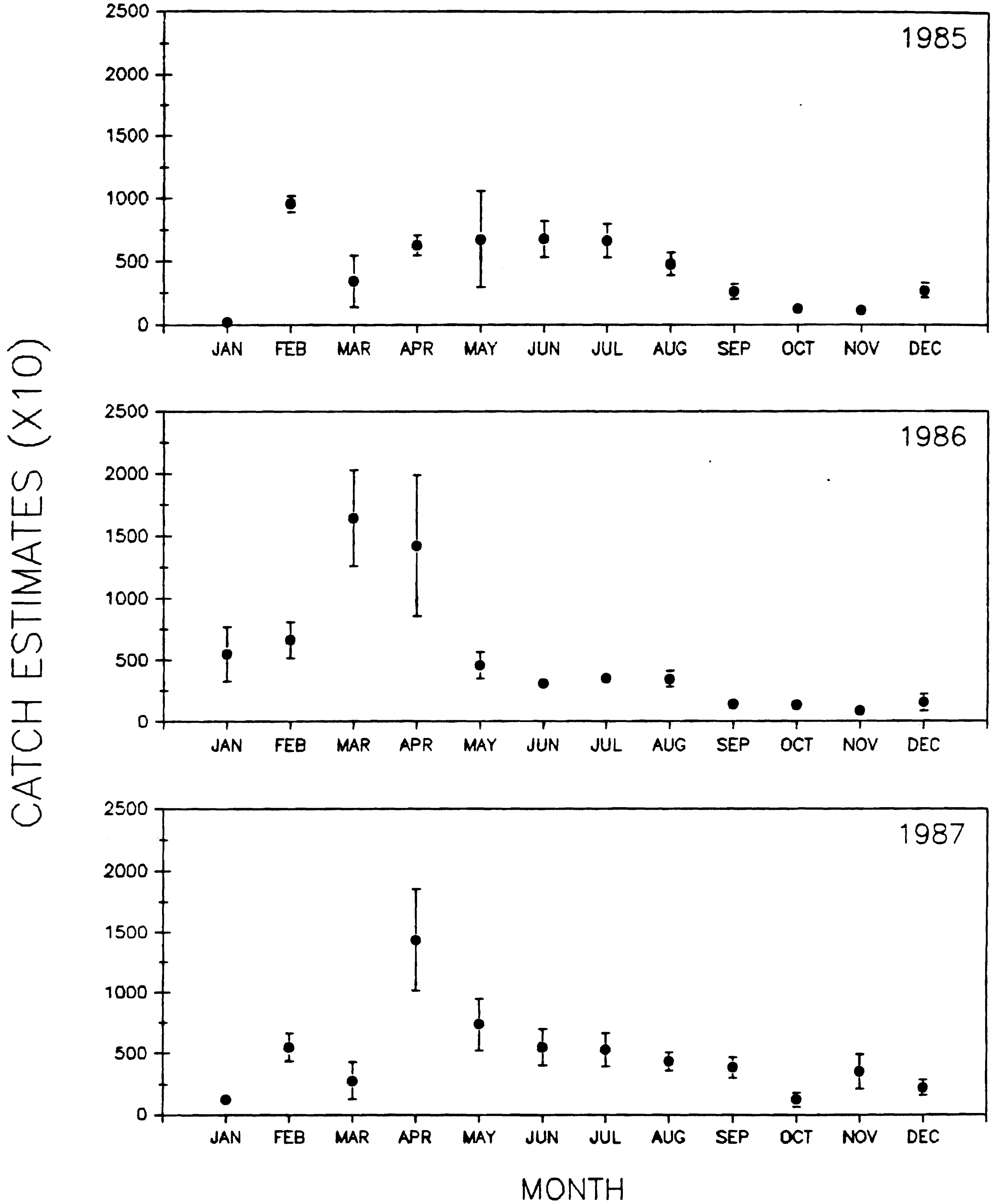



FIGURE 11. Monthly total catch estimates (number of fish) and standard deviations of California halibut from on-board observations of southern California commercial passenger fishing vessels.

(22 in.). Our data show that there has been a large increase in the number of short halibut since the mid 1970's, probably due, in part, to the same law.

The mean catch of legal halibut increased by roughly 45% between the 1976 to 1978 survey and our survey. This is well below the increased mean catch of short halibut between the two surveys (roughly 250%). Although CPFV anglers caught more than three times as many short halibut during our survey as they did during the 1976 to 1978 survey, they have not experienced the same success with legal halibut. If we assume that the number of halibut caught by CPFV anglers is an indication of the population size, then either the population of legal size halibut has not grown at the same rate as the population of short halibut, or other modes of fishing such as private boat sport fishing and/or commercial fishing is/are benefiting more from the increased availability of legal halibut.

Counties. More halibut were caught in Los Angeles County than in any other southern California county during each year of our survey (Table 20). Ventura County had the second highest catch of halibut in 1986 and 1987 (Table 20). We do not have site-specific catch estimates for 1985, but the area from Port Hueneme, Ventura County, to Palos Verdes Point, Los Angeles County, produced an estimated 60% of the CPFV halibut landings, and 71% of the CPFV halibut total catch in 1986 and 1987 (Ally et al. 1988). Los Angeles County's contribution to the southern California halibut total catch dropped from 76% in 1985, to 70% in 1986, and to 60% in 1987. Conversely, Ventura County showed an increase in its contribution towards the southern California halibut total catch from 4% in 1985, to 15% in 1986, to 23% in 1987. There was a still greater change between Los Angeles and Ventura counties in terms of kept halibut. Los Angeles County contributed 76%, 73% and 51% to the southern California halibut landings from 1985 to 1987, respectively, while Ventura County contributed 6%, 17%, and 34% during the same period. Most of the increased landings in Ventura County from 1986 to 1987 were due to increased landings from its two southernmost sites (Ally et al. 1988). The decreased landings in Los Angeles County were due to decreased landings throughout Los Angeles County, including Santa Monica Bay. Even though the data show a shift in halibut landings from Los Angeles County to Ventura County, most of the changes are within the Port Hueneme to Palos Verdes Point area.

Other counties contributed relatively little to the southern California CPFV halibut catch.

Ventura County had the highest kept to released ratio, averaging 0.4 to 1 over the 3 years. Orange County had the lowest kept to released ratio with a 3-year average of 0.1 to 1.

Size Composition

Southern California. Annual mean lengths of kept halibut rose slightly in southern California between 1985 and 1987 (Figure 12). Most of the kept halibut were close to the minimum 559 mm (22 in.) size limit (Figure 13). The modal size class for kept halibut was 560 to 579 mm (22.0 to 22.8 in.) in 1985 and 1986 (Figure 13). Modal size classes were 560 to 579 mm (22.0 to 22.8 in.) and 580 to 599 mm (22.8 to 23.6 in.) in 1987 (Figure 13). Approximately 35% of the measured kept halibut were 560 to 599 mm (22.0 to 23.5 in.), and 60% to 70% of

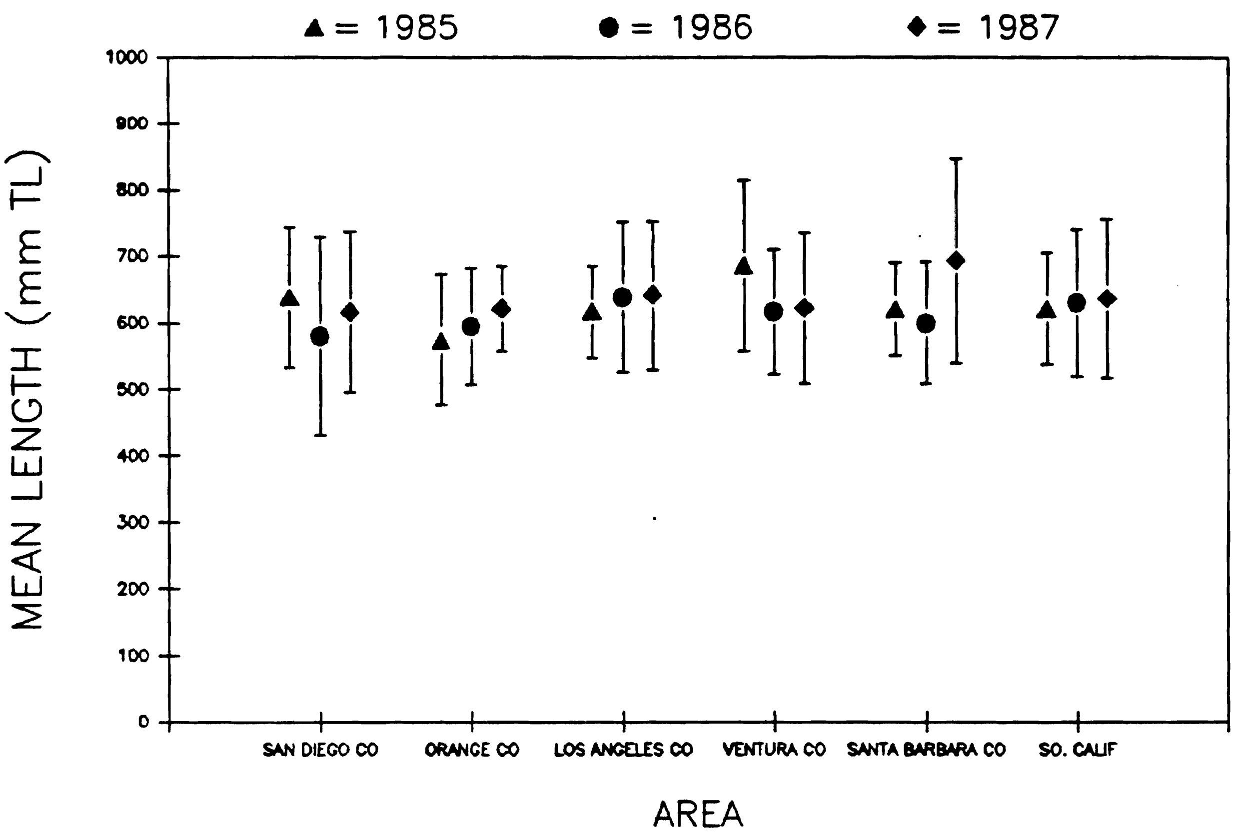



FIGURE 12. Mean lengths and standard deviations of kept California halibut measured on board southern California commercial passenger fishing vessels. Size limit = 559 mm (22 in.).

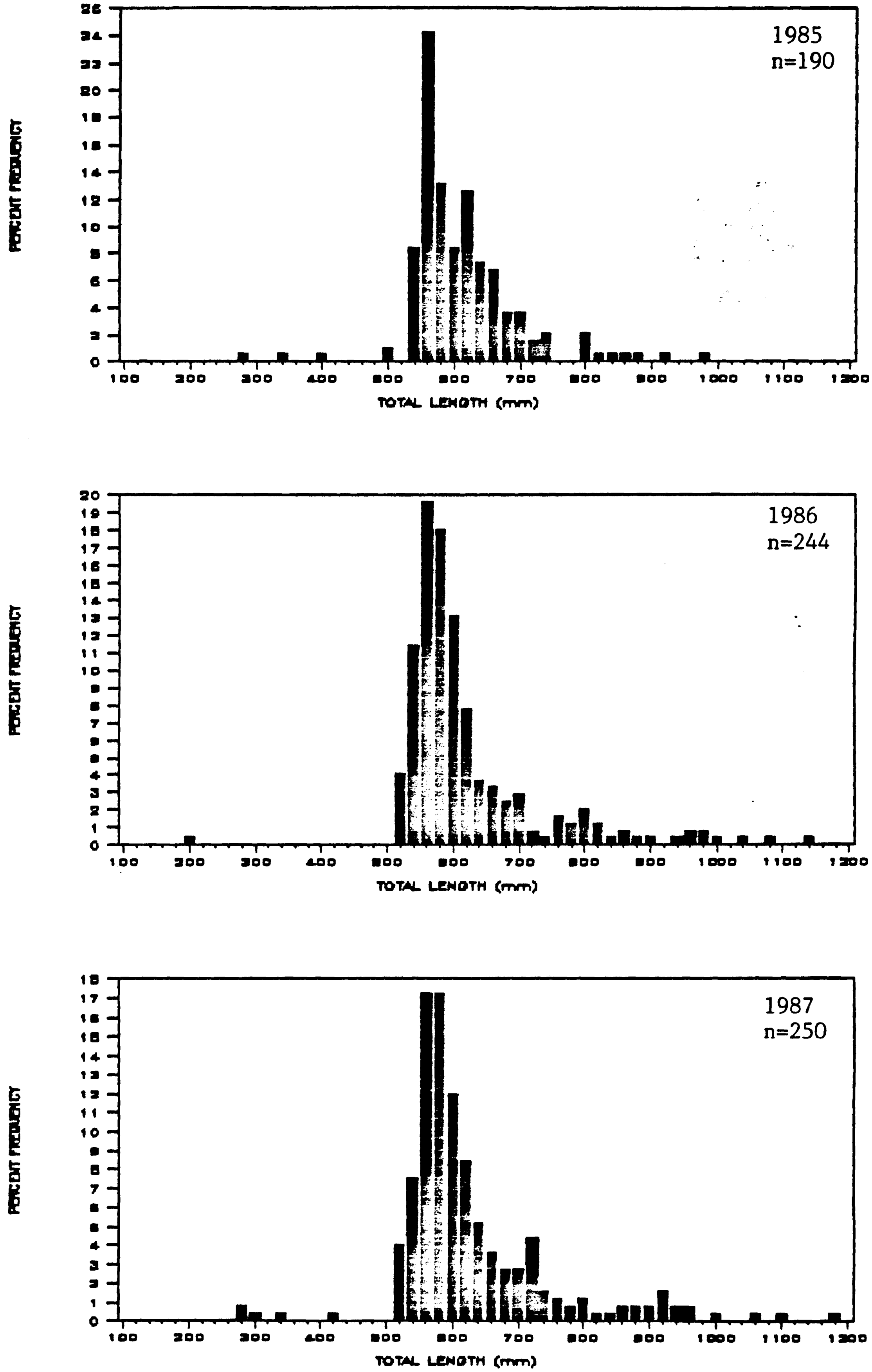



FIGURE 13. Size composition of kept California halibut from on-board observations of southern California commercial passenger fishing vessels. Size limit = 559 mm (22 in.).

the kept halibut were 560 to 659 mm (22.0 to 25.9 in.). This means that the majority of the CPFV halibut landings are dependent on a very narrow range of year classes, and the CPFV fleet is probably susceptible to decreased landings with the failure of even one year class.

Modal size classes of released halibut were 420 to 439 mm (16.5 to 17.3 in.) in 1985, 480 to 499 mm (18.9 to 19.6 in.) in 1986, and 340 to 359 mm (13.4 to 14.1 in.) in 1987 (Figure 14). The emergence of the 340 to 359 mm (13.4 to 14.1 in.) halibut as the modal class in 1987 may mean another strong year class is being recruited into the CPFV halibut fishery.

Halibut less than the minimum size limit accounted for 11.1% to 15.2% of the annual CPFV halibut landings between 1985 and 1987. Most of the sublegal halibut kept were within 20 mm (0.8 in.) of the minimum size limit. Halibut less than 540 mm (21.2 in.) made up 2.6% of the measured kept halibut in 1985, 4.5% in 1986, and 6.0% in 1987. This suggests that inaccurate measuring (by anglers and/or samplers), and/or fish shrinkage, and/or the temptation to keep a barely short halibut, rather than mis-identifying the fish or not knowing the minimum size regulations is/are responsible for most of the sublegal halibut being kept by CPFV anglers.

Counties. Mean lengths of kept halibut varied little between counties or years (Figure 12). Length frequency patterns for Los Angeles and Ventura counties are similar to those of southern California (Figures 15 and 16). Other than those for Los Angeles County and Ventura County, sample sizes of measured halibut in the three other counties were very small.

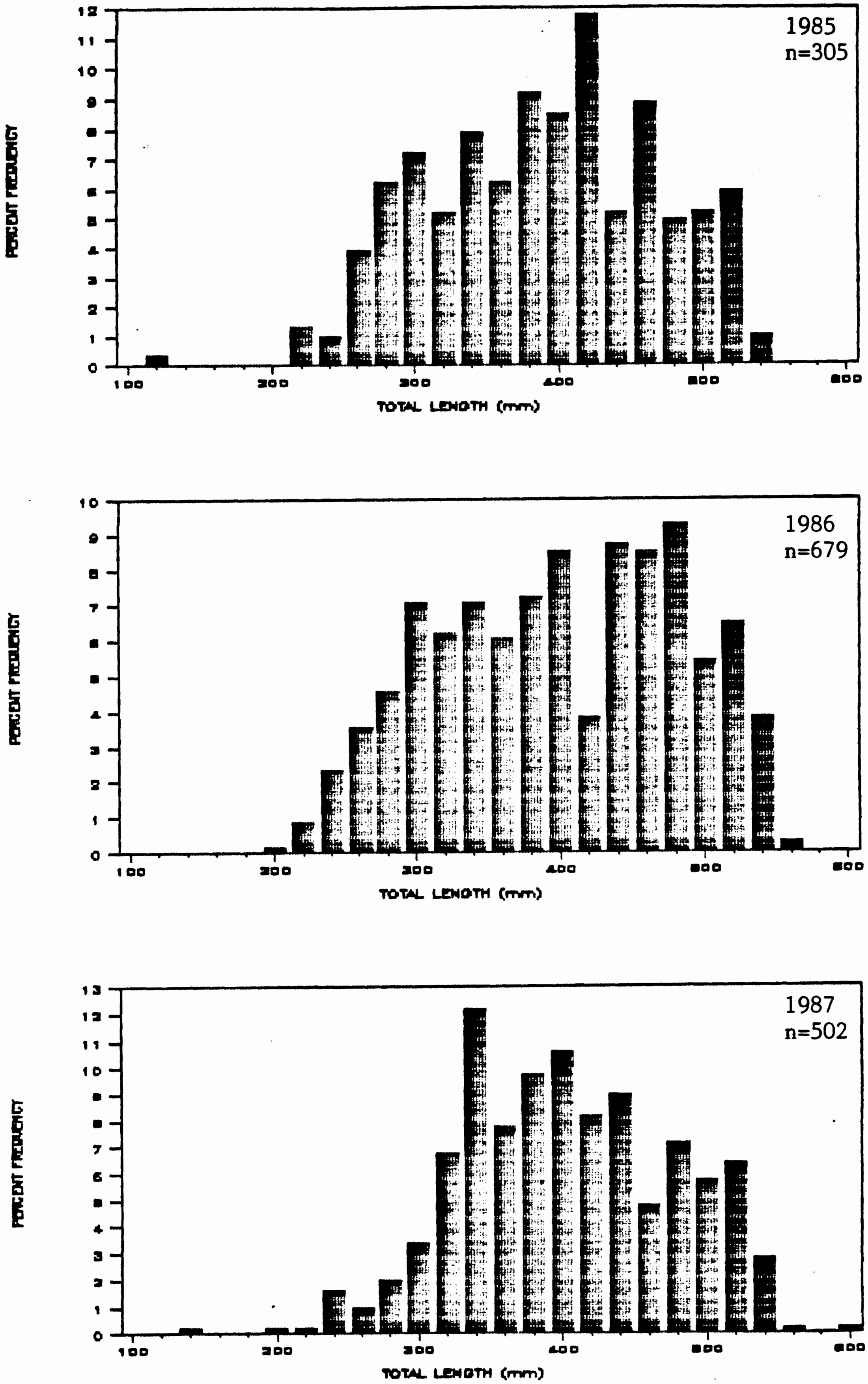



FIGURE 14. Size composition of released California halibut from on-board observations of southern California commercial passenger fishing vessels. Size limit = 559 mm (22 in.).

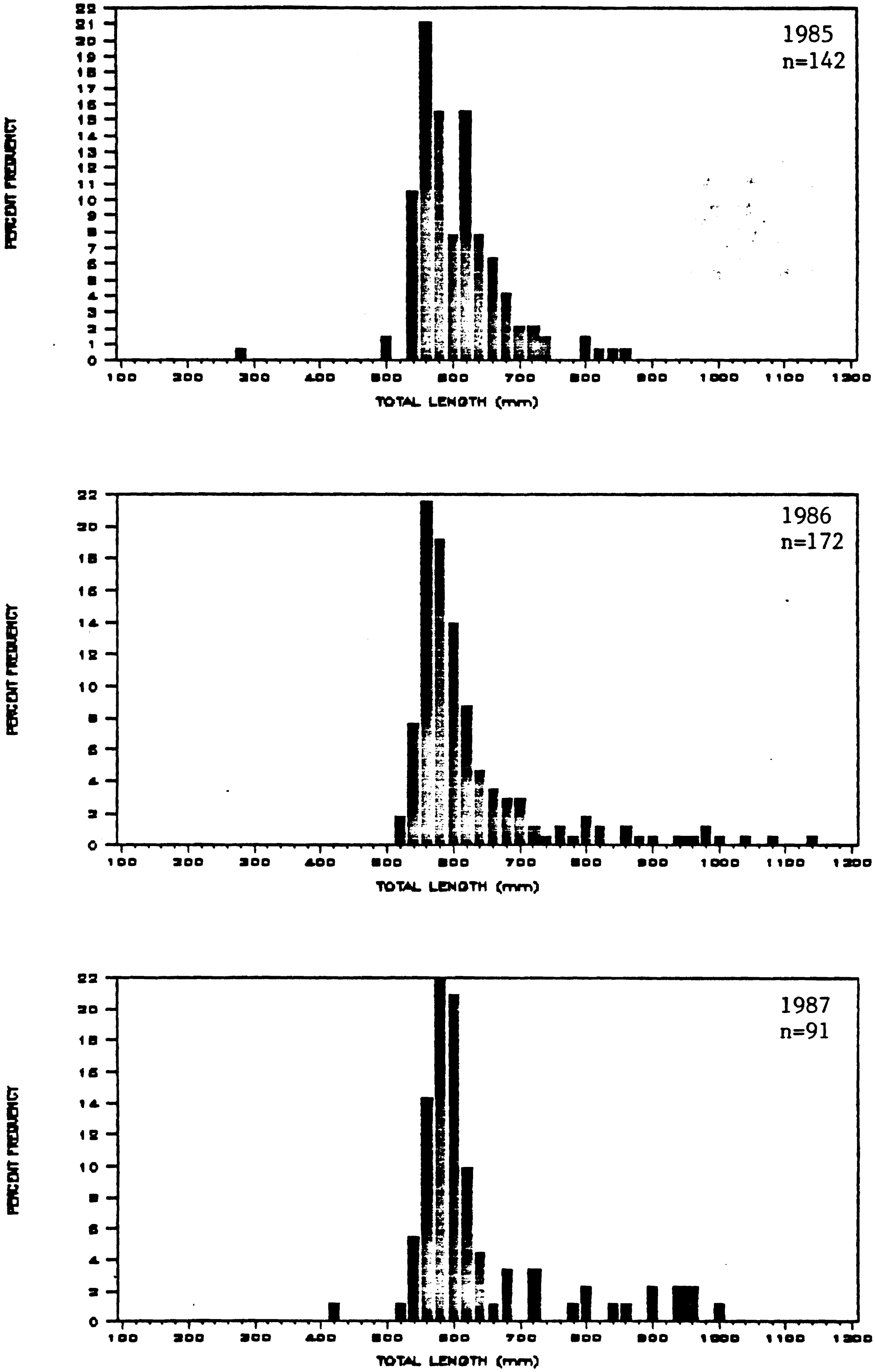



FIGURE 15. Size composition of kept California halibut from on-board observations of Los Angeles County commercial passenger fishing vessels. Size limit = 559 mm (22 in.).

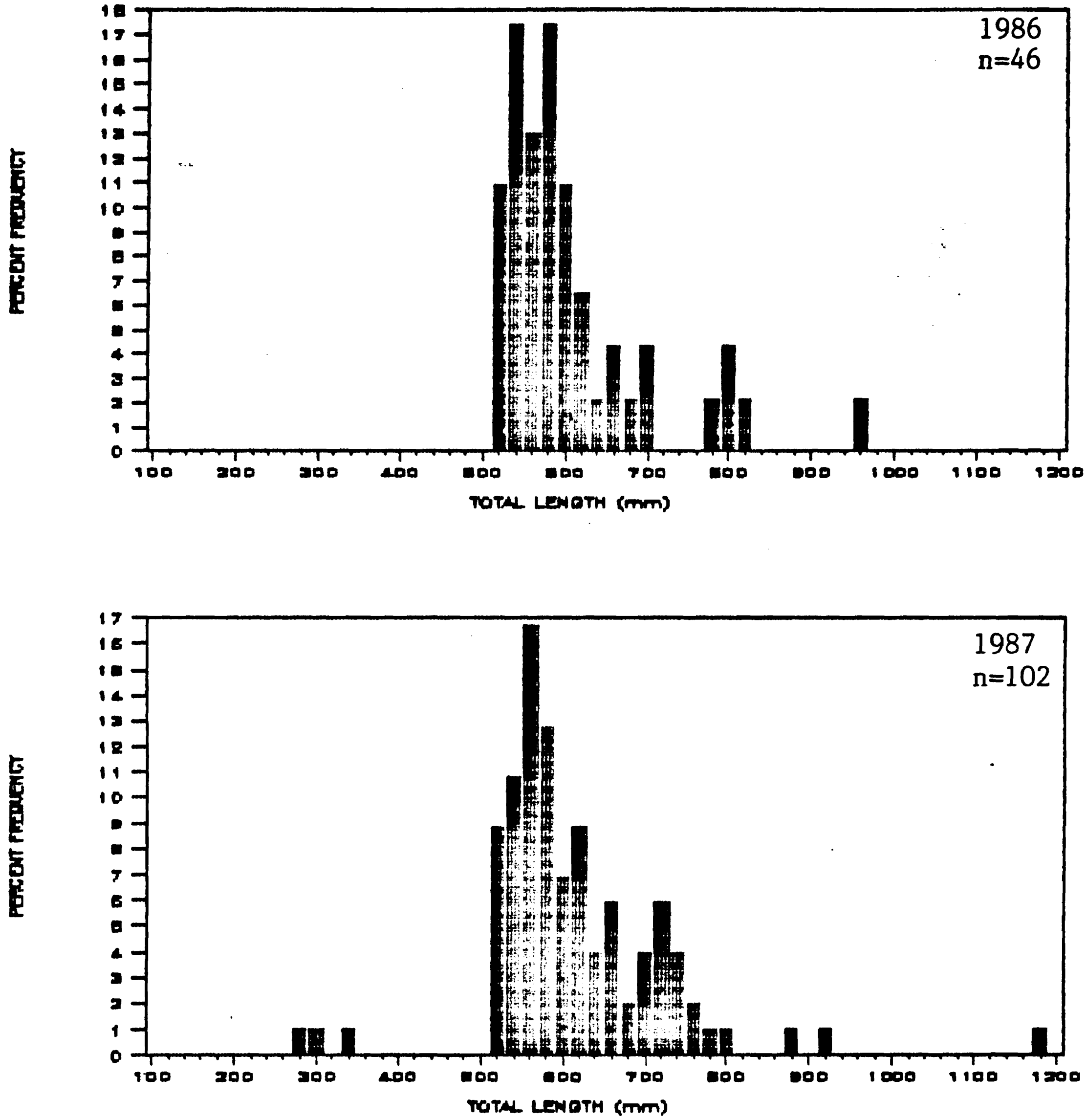



FIGURE 16. Size composition of kept California halibut from on-board observations of Ventura County commercial passenger fishing vessels. Size limit = 559 mm (22 in.).

The percent of sublegal halibut kept by Los Angeles County CPFV anglers decreased from 11.4% in 1985, to 6.6% in 1987. There was no trend in Ventura County. From 1985 through 1987, 9.0% of the Los Angeles County halibut landings were shorter than the size limit. During the same time period, 22.0% of the Ventura County halibut landings were sublegal fish.

The remaining counties had too small a sample size for analysis.

Management Recommendations

The minimum size limit should remain in place to protect the young halibut and allow them to spawn at least once before they are recruited into the sport fishery. We need to develop a good CPUE estimate for CPFV trips targeting halibut. Finally, we need to more closely monitor the catch of short halibut, because this information could give us an indication of the number of halibut recruiting into the fishery, and provide an early warning of a diminishing halibut stock.

## Yellowtail (Carangidae)

### Catch Estimates

Southern California. This surface gamefish is one of the most highly prized species found off our coast. Yellowtail is highly esteemed by anglers, and ranked among the top 20 fishes in our IRI for San Diego, Orange and Los Angeles counties from 1985 through 1987 (Tables 14 through 16).

The estimated total catches of yellowtail were 33,701 fish ± 5,392 in 1985, 19,724 ± 2,957 in 1986, and 33,197 ± 5,312 in 1987 (Table 21). A high percentage of the yellowtail total catch is kept by anglers (Table 21).

In 1986 and 1987, most yellowtail were caught from May through September; in 1985, the season ran from March through November (Figure 17).

Recreational sport fishing for yellowtail is almost entirely dependent upon a yearly migration of fish from Baja California waters (Crooke 1983). Consequently, the catch of yellowtail by southern California CPFV's can be expected to fluctuate widely in response to their availability in local waters.

Counties. San Diego County had the highest estimated catches in both 1986 and 1987, accounting for 51% and 61% of the yellowtail catches, respectively (Table 21). Los Angeles County led the other counties in 1985 with 54% (Table 21).

Historical catch records indicate the Coronado Islands, located a few miles south of San Diego County, have consistently provided the best fishing for yellowtail (Frey 1971 and Maxwell 1977).

TABLE 21. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of Yellowtail from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| AREA | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 8,649 | 34 | 10,051 | 20 | 20,129 | 21 | 0 | 0 | 0 | 0 | 37 | 99 | 8,649 | 34 | 10,051 | 20 | 20,166 | 21 |
| Orange County | 3,109 | 54 | 5,762 | 25 | 2,632 | 37 | 0 | 0 | 0 | 0 | 0 | 0 | 3,109 | 54 | 5,762 | 25 | 2,632 | 37 |
| Los Angeles County | 18,021 | 21 | 3,692 | 38 | 7,888 | 25 | 107 | 99 | 63 | 99 | 2,511 | 99 | 18,128 | 21 | 3,755 | 39 | 10,399 | 31 |
| Ventura County | 3,678 | 51 | 157 | 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3,678 | 51 | 157 | 45 | 0 | 0 |
| Santa Barbara County | 137 | 87 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 137 | 87 | 0 | 0 | 0 | 0 |
| Southern California | 33,594 | 16 | 19,662 | 15 | 30,649 | 15 | 107 | 99 | 63 | 99 | 2,548 | 97 | 33,701 | 16 | 19,724 | 15 | 33,197 | 16 |

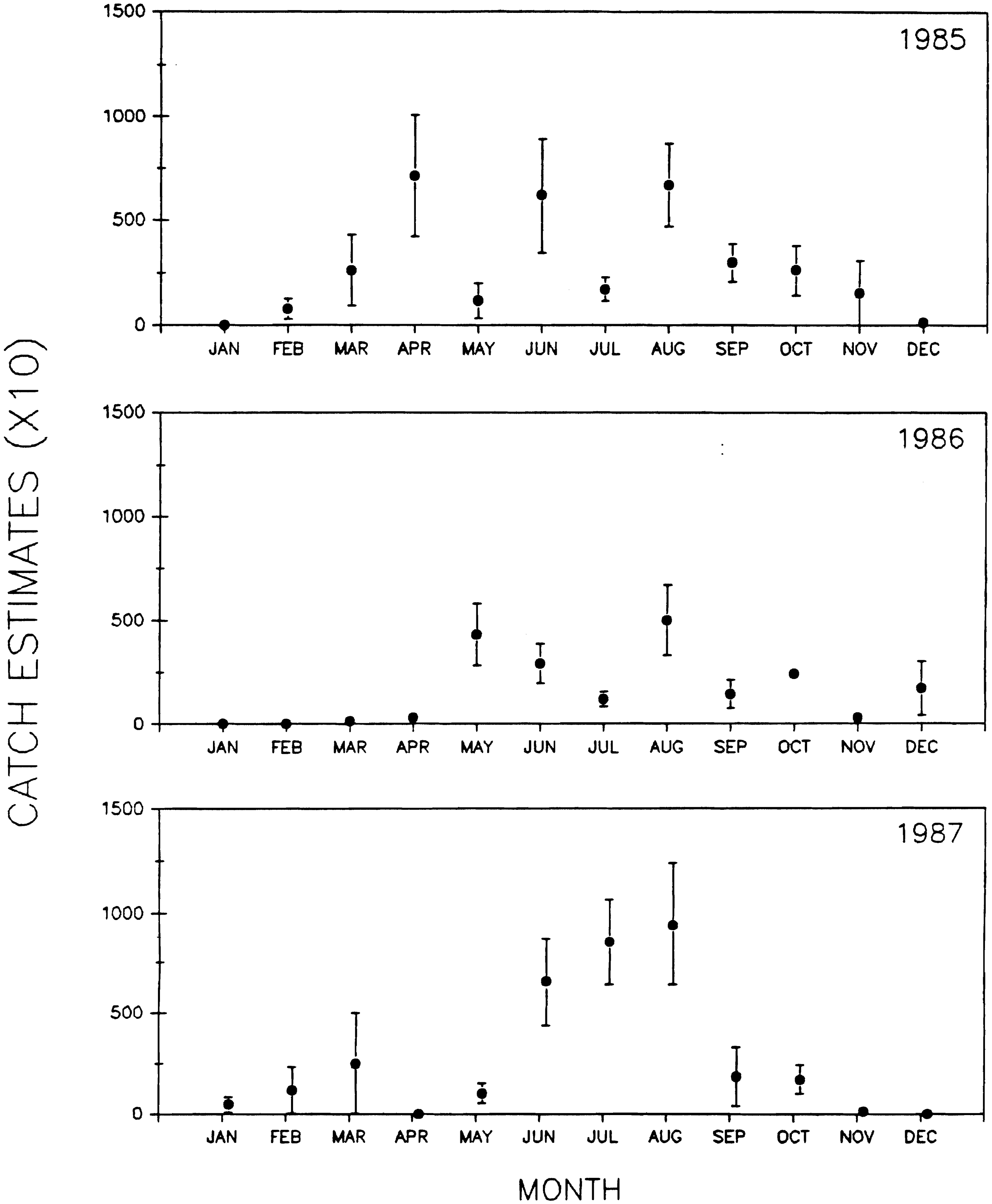



FIGURE 17. Monthly total catch estimates (number of fish) and standard deviations of yellowtail from on-board observations of southern California commercial passenger fishing vessels.

## Size Composition

Southern California. There was little variation in mean lengths of yellowtail during the survey: 714 mm (28.1 in.) in 1985, 717 mm (28.2 in.) in 1986, and 710 mm (27.9 in.) in 1987 (Figure 18).

The analysis of length frequencies revealed tri-modal size classes of 500-519 mm (19.7-20.4 in.), 660-679 mm (25.9-26.7 in.), and 760-779 mm (29.9-30.7 in.) in 1985, bi-modal classes of 600-659 mm (23.6-25.9 in.), and 800-819 mm (31.5-32.2 in.) in 1986, and a modal class of 700-719 mm (27.6-28.3 in) in 1987 (Figure 19). According to Baxter (1960) these size classes represent mainly 1- to 7-year-old fish. Two- to three-year-old yellowtail composed most of the catch in 1987, while a wider range of age classes contributed to the catches in 1985 and 1986. According to Baxter (1960), some 2-year-old, and all 3-year-old and older yellowtail are able to spawn. This means the fishery is taking many immature fish.

On a comparative basis, yellowtail size composition from 1985 through 1987 is similar to that reported by Maxwell (1977). He found that 99% of the 1972 through 1974 yellowtail catch was composed of 1- to 6-year-old fish.

Counties. The size composition of yellowtail for San Diego County closely resembled that for southern California (Figures 20 and 19, respectively). The largest yellowtail were found in Orange and Los Angeles counties; the smallest, in Ventura County (Figures 21 through 23).

## Management Recommendations

At the present time no management action is recommended, though a word of caution is warranted. The southern California sport fishery for

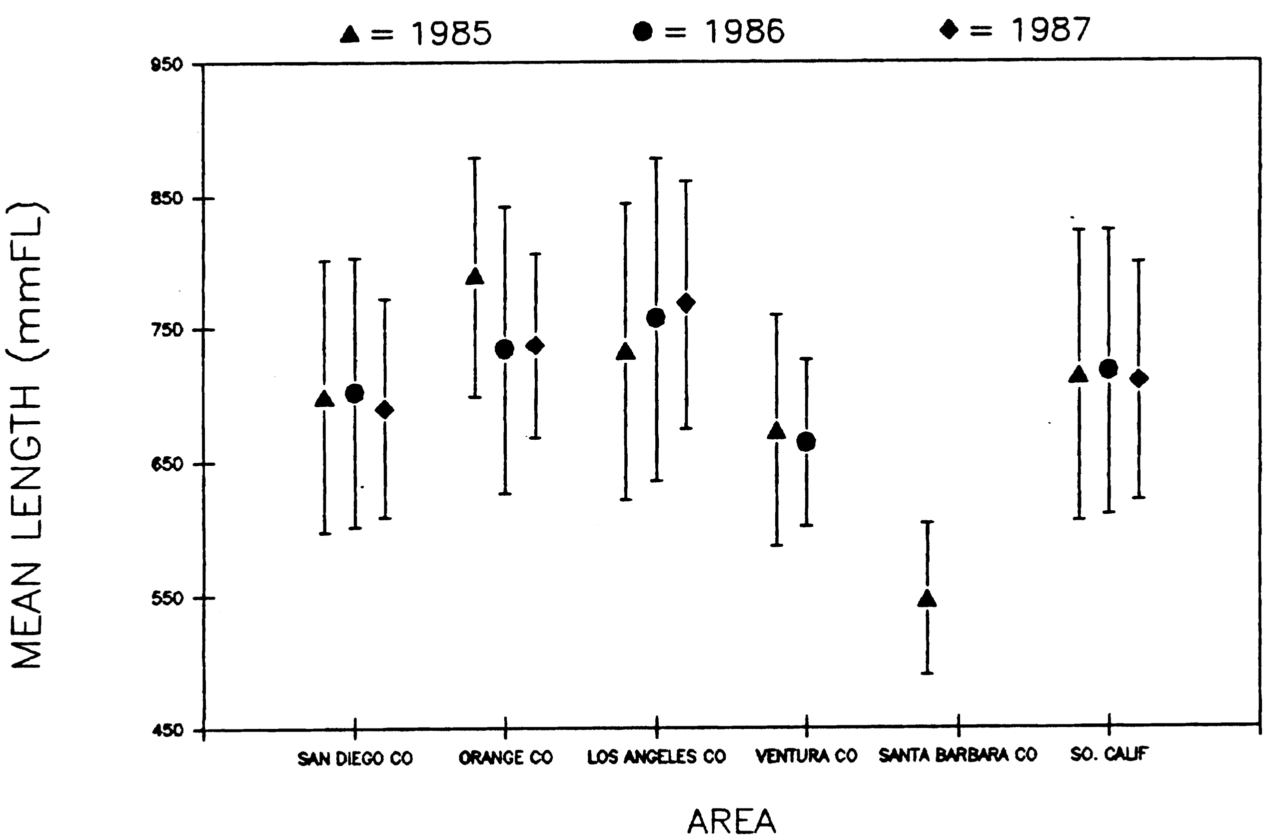



FIGURE 18. Mean lengths and standard deviations of yellowtail measured on board southern California commercial passenger fishing vessels.

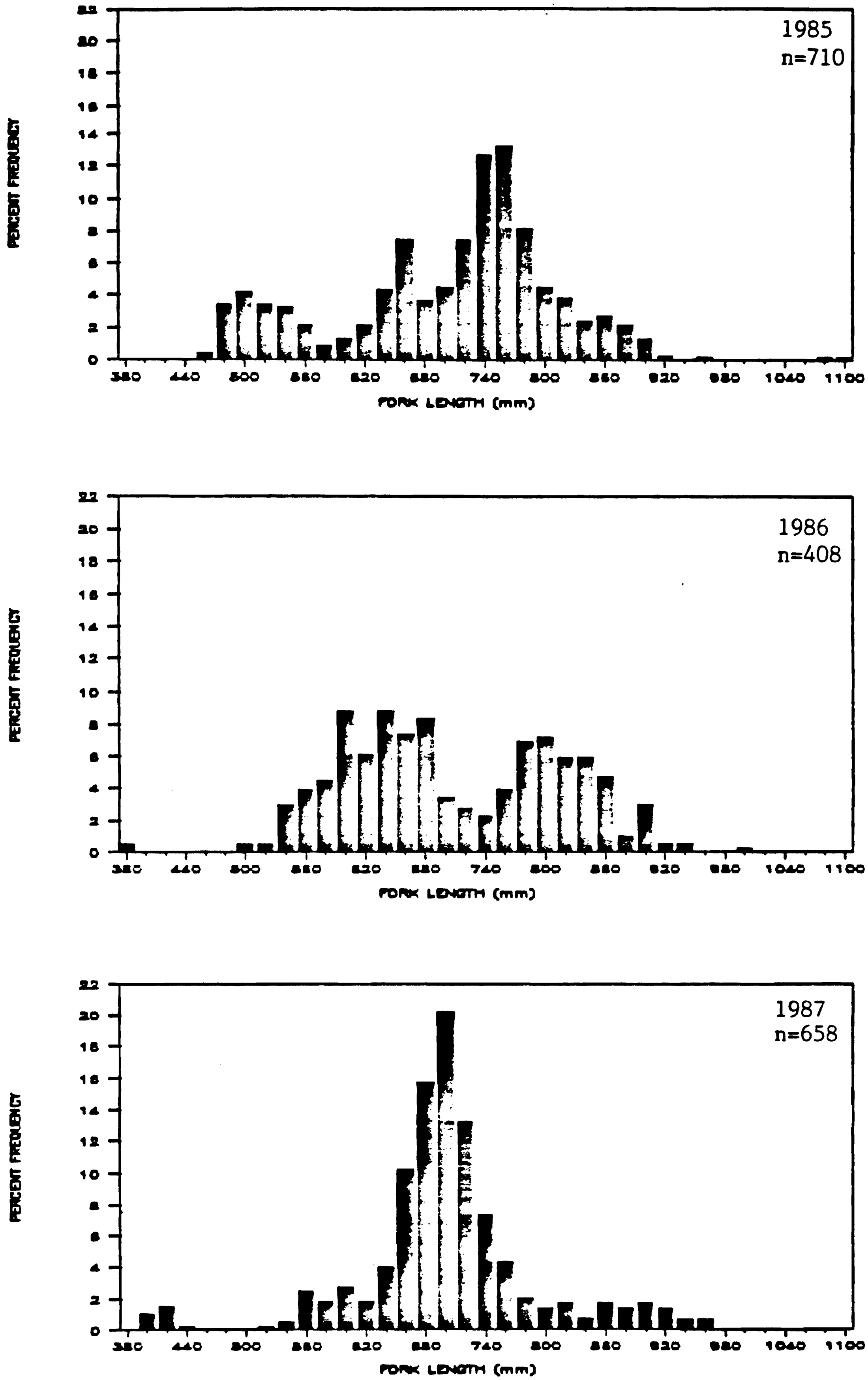



FIGURE 19. Size composition of yellowtail from on-board observations of southern California commercial passenger fishing vessels.

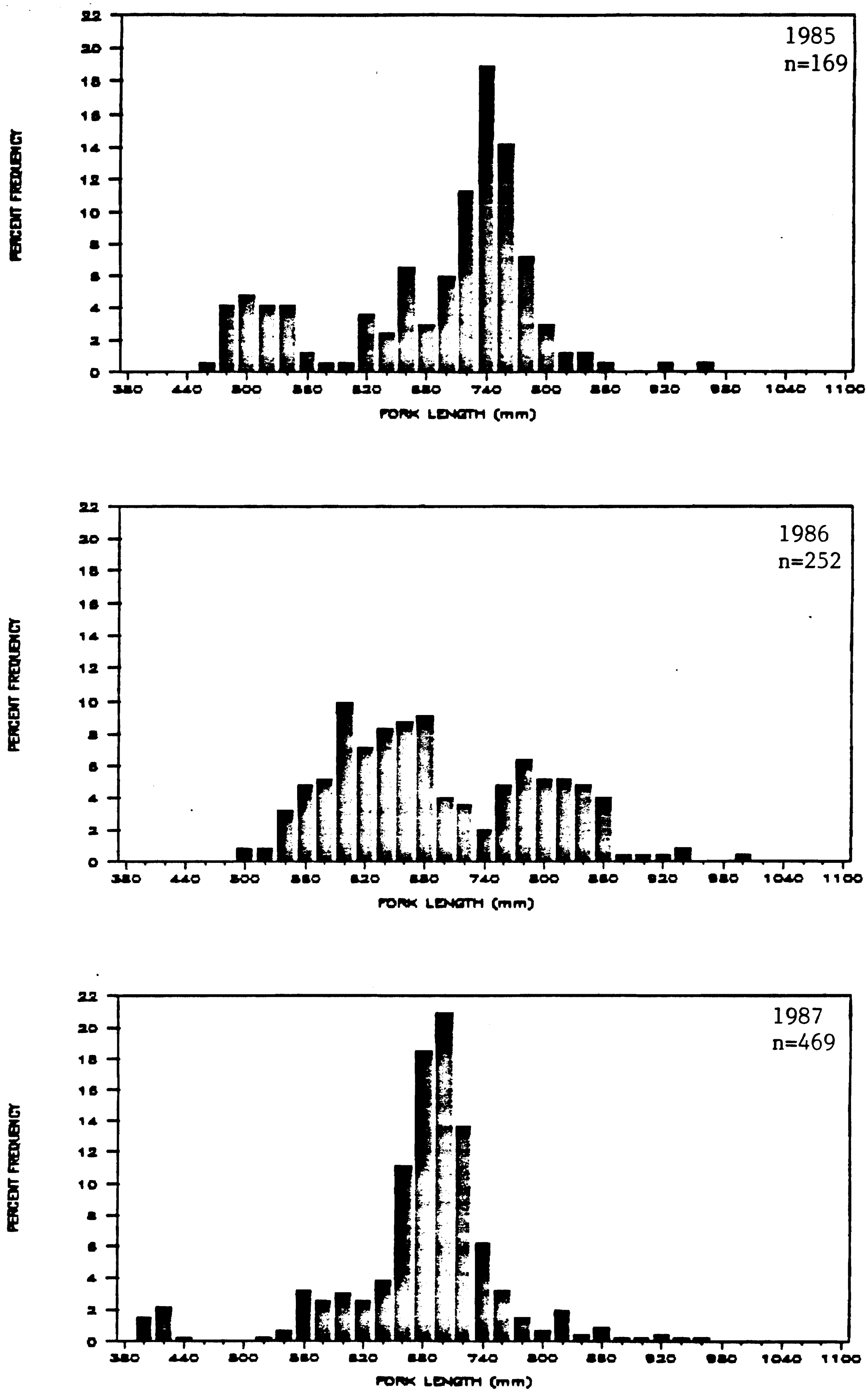



FIGURE 20. Size composition of yellowtail from on-board observations of San Diego County commercial passenger fishing vessels.

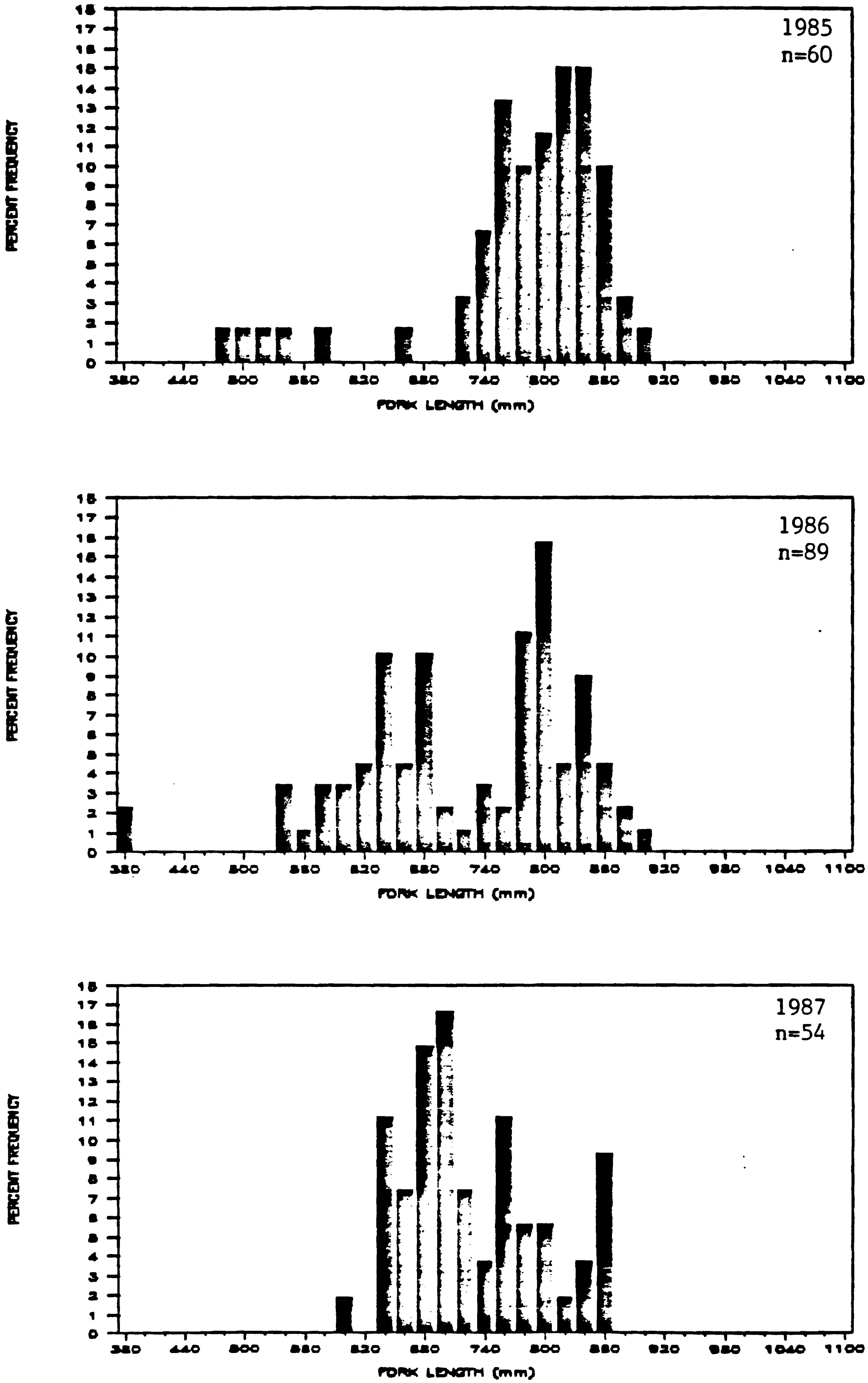



FIGURE 21. Size composition of yellowtail from on-board observations of Orange County commercial passenger fishing vessels.

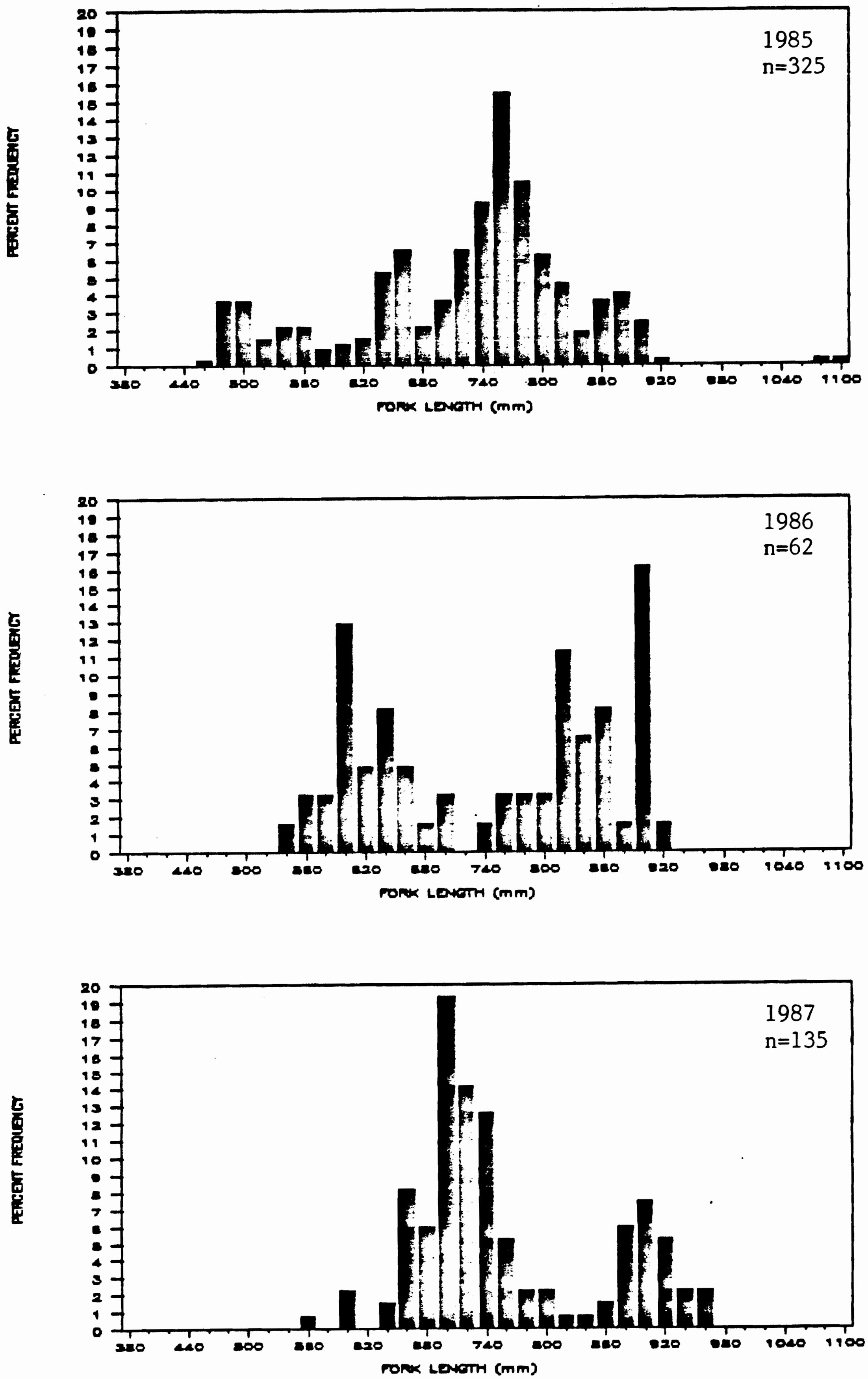



FIGURE 22. Size composition of yellowtail from on-board observations of Los Angeles County commercial passenger fishing vessels.

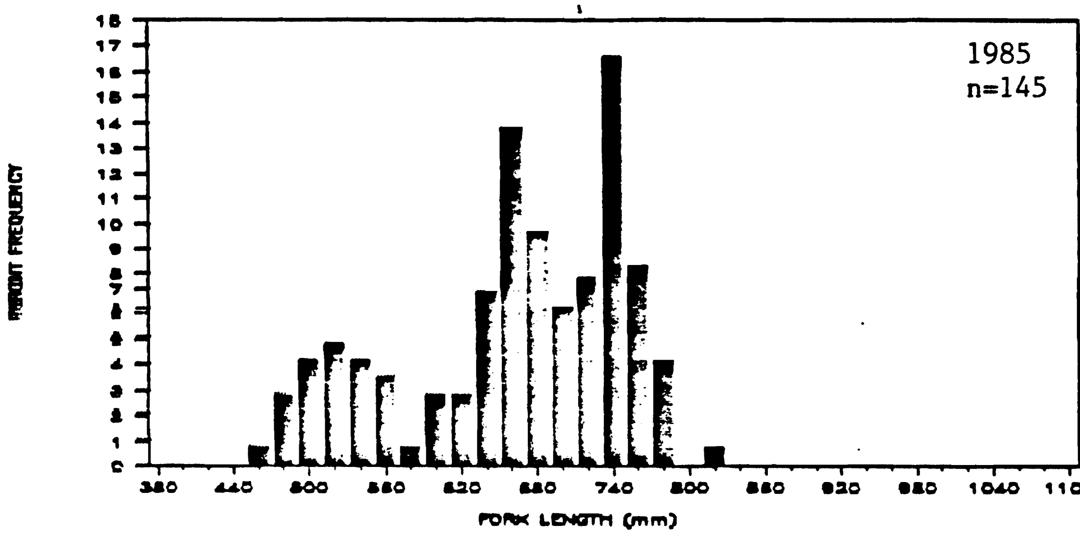



FIGURE 23. Size composition of yellowtail from on-board observations of Ventura County commercial passenger fishing vessels.

yellowtail is almost entirely dependent on annual migrants from central and northern Baja California (Crooke 1983). Therefore, the California fishery has little effect on the main population of yellowtail. However, a large expansion of the commercial and/or recreational catch off central Baja California could reduce yellowtail availability to anglers in southern California waters.

## Lingcod (Hexagrammidae)

### Catch Estimates

Southern California. Lingcod total catch estimates ranged from 2,936 fish ± 440 in 1985 to 8,712 ± 958 in 1987 (Table 22). Collins and Crooke (unpublished manuscript) reported lingcod total catch estimates from 4,879 ± 805 to 10,690 ± 2,209 in their study.

The catch distribution showed that in 1985 there were no dramatic trends or peaks in the lingcod total catch (Figure 24). A May total catch of 399 lingcod was the highest of several small monthly peaks. In 1986 there was a major total catch peak of 1,220 in November, and secondary peaks in January and August. The high November catch (88% of which came from San Diego County) coincided with the October through January lingcod migration and spawning period (Jow and Hardwick 1979). In 1987 a very large estimated total catch of 2,182 occurred in July, and the October through December catch was comparatively minor. Most of the 1987 total catch occurred in San Diego County, and consisted of sublegal [<559 mm (22 in.)], released fish. The presence of a strong year class or classes of immature lingcod in the CPFV fishery accounted for the July catch peak, and the unexpectedly low lingcod catch in October through December could be explained by unusually harsh weather conditions that limited CPFV bottom fishing effort.

Counties. The lingcod catch was distributed fairly evenly throughout the five counties, except for Orange County, where the total catch estimates ranged from only 103 to 548 fish. San Diego County had the highest estimated total catch at 4,340, of which 3,453 were released;

TABLE 22. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of Lingcod from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| AREA | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 323 | 68 | 335 | 36 | 886 | 32 | 118 | 51 | 1,918 | 10 | 3,453 | 14 | 441 | 60 | 2,253 | 10 | 4,340 | 16 |
| Orange County | 103 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 548 | 22 | 541 | 35 | 103 | 0 | 548 | 22 | 541 | 55 |
| Los Angeles County | 343 | 29 | 77 | 73 | 297 | 50 | 148 | 0 | 898 | 49 | 1,008 | 30 | 491 | 20 | 975 | 46 | 1,304 | 28 |
| Ventura County | 611 | 26 | 225 | 36 | 434 | 36 | 788 | 27 | 554 | 47 | 952 | 28 | 1,399 | 21 | 779 | 36 | 1,386 | 28 |
| Santa Barbara County | 292 | 46 | 61 | 48 | 374 | 52 | 210 | 23 | 456 | 25 | 768 | 23 | 502 | 30 | 517 | 23 | 1,142 | 26 |
| Southern California | 1,672 | 19 | 698 | 23 | 1,990 | 20 | 1,264 | 18 | 4,374 | 13 | 6,722 | 11 | 2,936 | 15 | 5,072 | 12 | 8,712 | 11 |

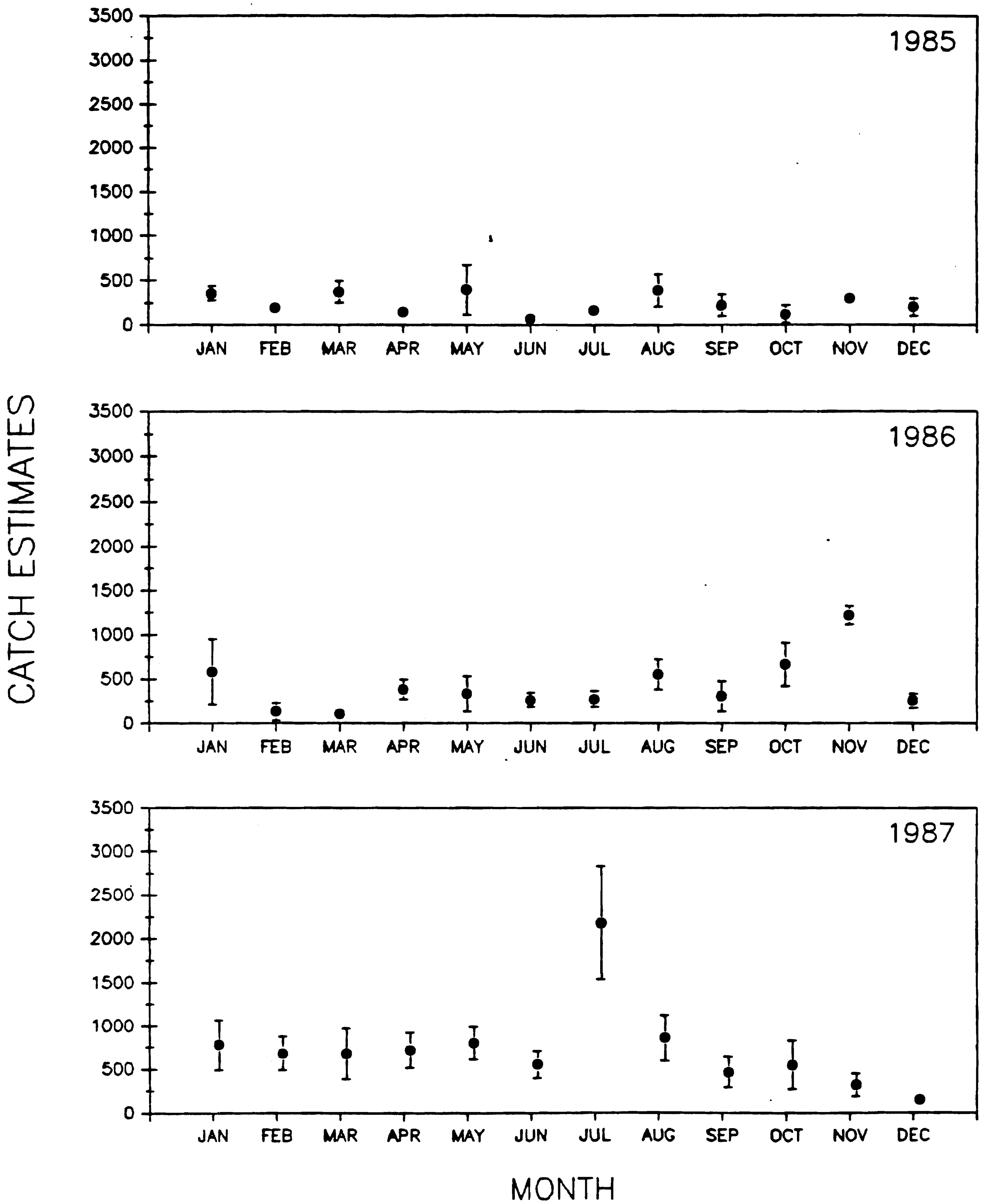



FIGURE 24. Monthly total catch estimates (number of fish) and standard deviations of lingcod from on-board observations of southern California commercial passenger fishing vessels.

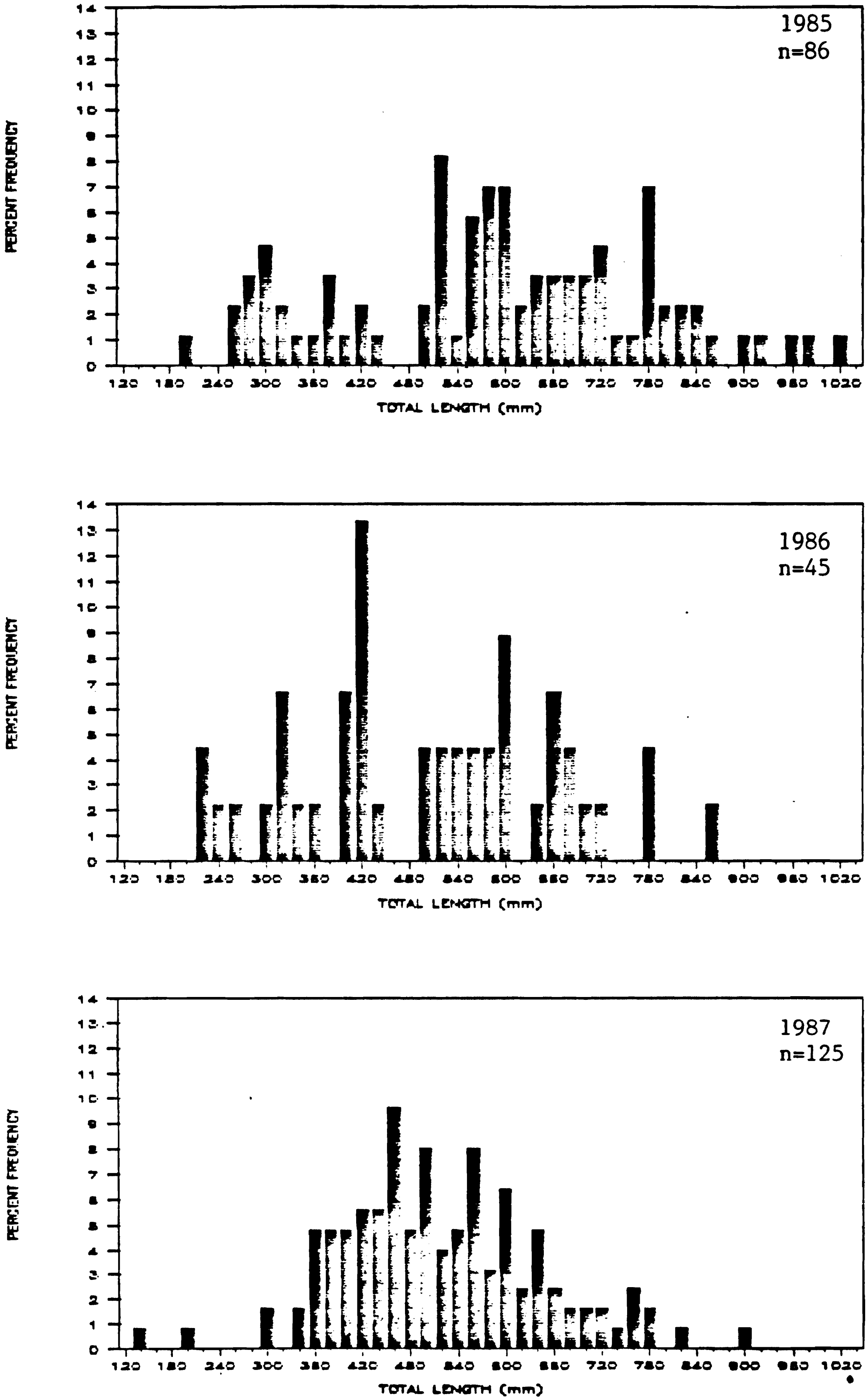
the San Diego catch represented 50% of the 1987 estimated lingcod total catch. Collins and Crooke (unpublished manuscript) found that the bulk of the lingcod total catch came from Santa Barbara and Ventura counties; in 1978, 79% of the southern California lingcod total catch originated from those two counties.

Size Composition

Southern California. Our length frequency analyses for lingcod show a progressive shift towards younger, sublegal age classes when successive years are compared (Figure 25). In 1985 63% of the measured lingcod were legal size [>559 mm (22 in.)]. That percentage dropped to 44% in 1986 and 39% in 1987. It appears that one or more strong year classes were recruited into the CPFV fishery during 1986 and 1987, causing the above described shift in the lingcod size structure toward smaller fish. In 1986 the major mode [420 to 439 mm (16.5 to 17.3 in.)] represented 2-year-old lingcod (Miller and Geibel 1973). In 1987 the primary mode [460 to 479 mm (18.1 to 18.9 in.)] was representative of 3-year old lingcod.

The mean length of southern California kept lingcod (Figure 26) showed annual decreases, from 698 mm in 1985 to 625 mm in 1987 (27.5 to 25.0 in.). This was largely due to the previously described shift to younger age class modes. The mean lengths of released lingcod remained relatively static between 1985 and 1986, and increased from 390 to 441 mm (15.4 to 17.4 in.) from 1986 to 1987 (Figure 27).

Counties. The quantity of length frequency data was inadequate to provide a meaningful descriptive analysis of the size composition for Orange, Los Angeles, and Santa Barbara counties. The 1987 San Diego




includes released fish

FIGURE 25. Size composition of lingcod from on-board observations of southern California commercial passenger fishing vessels. Size limit = 559 mm (22 in.).

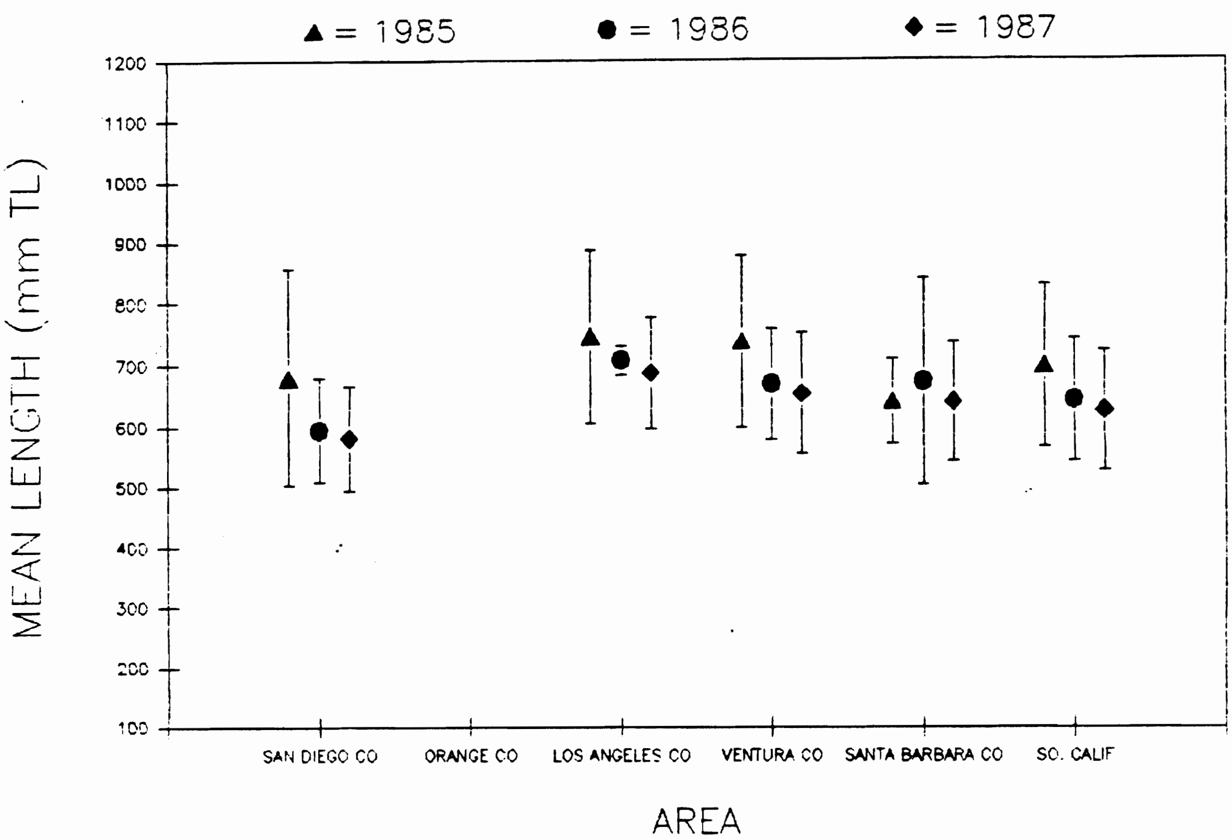



FIGURE 26. Mean lengths and standard deviations of kept lingcod measured on-board southern California commercial passenger fishing vessels. Size limit = 559 mm (22 in.).

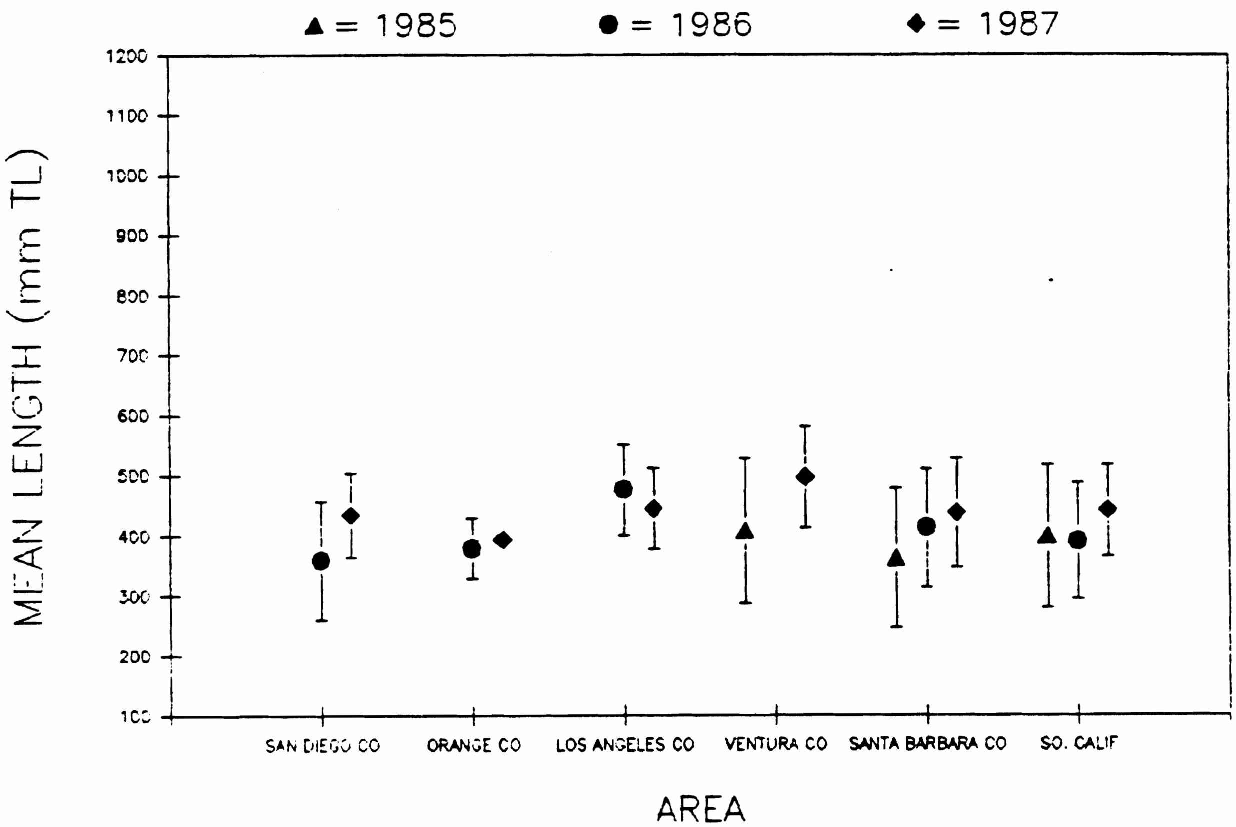



FIGURE 27. Mean lengths and standard deviations of released lingcod measured on board southern California commercial passenger fishing vessels. Size limit = 559 mm (22 in.).

County lingcod catch displayed a prominent length frequency mode at 460 to 479 mm (18.1 to 18.9 in.), which is indicative of a strongly recruited group of 2- to 3-year-old lingcod (Figure 28). Only 27% of the measured lingcod in 1987 were legal sized. The 1985 Ventura County lingcod catch (Figure 29) displayed three prominent length modes: 300 to 319 mm (11.8 to 12.6 in.), 560 to 599 mm (22.1 to 23.6 in.), and 780 to 799 mm (30.7 to 31.5 in.). These roughly correspond to young of the year, 3-, and 7-year-old lingcod, respectively (Miller and Geibel 1973). More than 61% of the Ventura County lingcod were legal sized. The wide ranges of sizes, and the preponderance of larger [$\geq$559 mm (22 in.)] lingcod in the Ventura County catch indicate that the portion of the stock exploited by this complex is healthy and self-sustaining.

Management Recommendations

Lingcod is an inshore, rocky bottom-dwelling species that ranges from Kodiak Island, Alaska to Baja California (Eschmeyer, et al. 1983). It is sought by both sport and commercial fishermen throughout the state, but the catch south of Pt. Arguello is a relatively small component of both fisheries.

Miller and Geibel (1973) stated that lingcod survival and recruitment depended more on overall oceanographic conditions than on the utilization of local stocks. They discussed three management options that could be implemented if fishing mortality were to continue to increase: (i) a minimum size limit, (ii) a reduced bag limit (from the then current 10 lingcod), and (iii) a spawning season closure. At the present time, only the spawning season closure option has not been implemented.

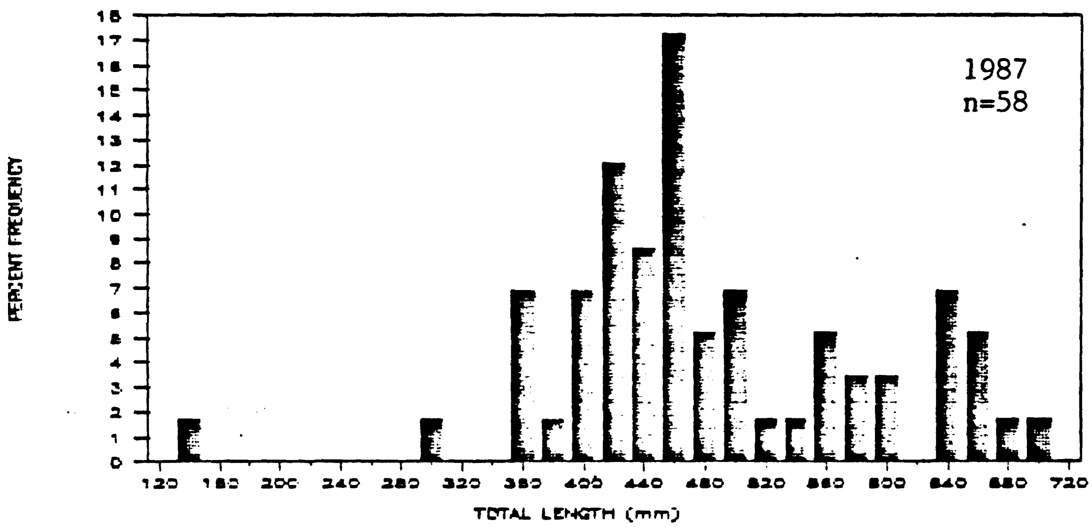



FIGURE 28. Size composition of lingcod from on-board observations of San Diego County commercial passenger fishing vessels. Size limit = 559 mm (22 in.).

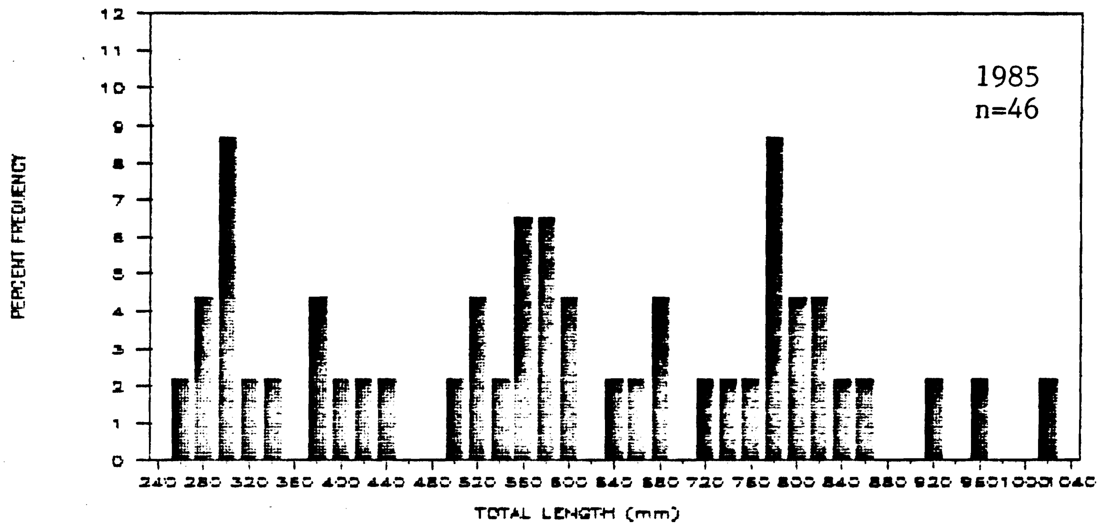



FIGURE 29. Size composition of lingcod from on-board observations of Ventura County commercial passenger fishing vessels. Size limit = 559 mm (22 in.)

The current minimum size limit for lingcod was imposed in 1982 in order to protect the spawning stock. The size limit, along with a five-lingcod bag limit instituted in 1979, would seem to adequately protect the southern California lingcod stock under existing levels of exploitation. Our catch estimates and CPFV log data show an increasing lingcod catch since 1985.

If environmental conditions and/or increasing fishing pressure should, some time in the future, seriously threaten the lingcod stock, several steps can be taken to reduce or redirect the sport and commercial effort on lingcod. Miller and Geibel (1973) proposed that a lingcod size limit of 610 mm (24 in.) be implemented, in stages, over several years, in order to maintain an adequate spawning biomass. They pointed out that the size limit would also provide a quality, or trophy, lingcod fishery. Another management option discussed (and rejected) by Miller and Geibel (1973) was a spawning season closure. Such a December through February closure would not be useful or effective, they concluded, unless fishing effort in shallow-water spawning areas increased dramatically. In southern California, the major lingcod spawning areas are located around the margins of offshore islands, a factor limiting fishing effort at spawning sites.

Area closures are a management option that can be considered. Lingcod are not a highly migratory species (Fitch and Lavenberg 1971). Therefore, portions of the lingcod stock that are fished by each sport fishing complex can be treated as separate populations, for management purposes. If, for example, a particular lingcod stock, such as at an offshore island, is being overfished, then a sport/commercial fishing closure at the island site would allow replenishment of the spawning component of the population. Eventually, after 2 or more years, the closure could be lifted and lingcod fishing resumed.

## California Sheephead (Labridae)

### Catch Estimates

Southern California. California sheephead (henceforth referred to as sheephead) is a bottom-dwelling species esteemed by sport anglers and sport divers. It is caught year-round, though peak catches occur from August through October (Figure 30).

The estimated total catch of sheephead increased by 75% from 1985 to 1986, then declined by 17% from 1986 to 1987 (Table 23). However, the sheephead's contribution to the total catch of combined fishes was very consistent during the survey: 0.6% in 1985, 0.8% in 1986, and 0.7% in 1987 (Tables 13 and 23). Ninety-seven percent of the sheephead total catch was kept by anglers each year of our survey.

On a comparative basis, the annual sheephead total catch rate during our survey was more stable than that during Collins and Crooke's (unpublished manuscript) survey. Their survey reported a sheephead total catch increase of 297% from 1976 to 1978: 7,568 fish ± 1,089 in 1976, 26,022 ± 3,702 in 1977, and 30,016 ± 5,885 in 1978. Their reported catch increase also corresponded to an increase in sheephead's contribution to the total catch of combined fishes, from 0.3% in 1976 to 0.7% in 1978.

Based on statistical analysis of combined CPFV and spearfishing data from 1947 through 1971, Ames (unpublished manuscript) found no decline in the sheephead stock, but did not rule it out, especially in localized areas. According to Fitch and Lavenberg (1971), pollution, disappearance of kelp beds, fishing pressure, and other unfavorable factors have caused a decrease in the numbers of sheephead along our mainland coast, as well

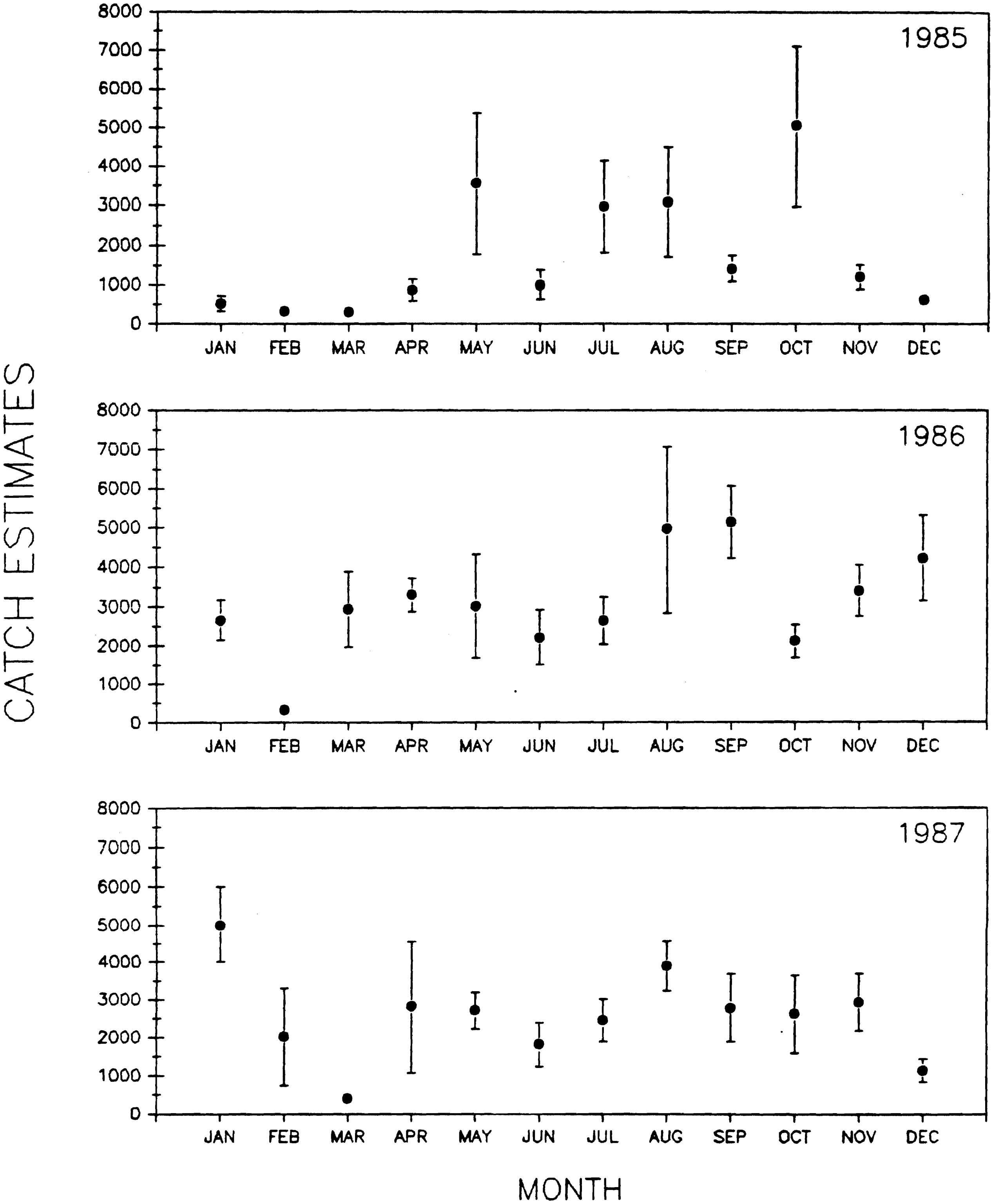



FIGURE 30. Monthly total catch estimates (number of fish) and standard deviations of California sheephead from on-board observations of southern California commercial passenger fishing vessels.

TABLE 23. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of California Sheephead from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| AREA | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 4,001 | 23 | 6,527 | 32 | 8,393 | 13 | 39 | 70 | 55 | 70 | 190 | 46 | 4,041 | 23 | 6,582 | 32 | 8,583 | 13 |
| Orange County | 1,379 | 25 | 3,982 | 19 | 3,948 | 22 | 96 | 73 | 265 | 70 | 301 | 42 | 1,475 | 26 | 4,247 | 19 | 4,249 | 20 |
| Los Angeles County | 11,050 | 27 | 16,936 | 13 | 9,805 | 22 | 569 | 42 | 465 | 22 | 342 | 65 | 11,619 | 27 | 17,401 | 13 | 10,147 | 23 |
| Ventura County | 3,660 | 19 | 8,090 | 13 | 7,195 | 20 | 54 | 98 | 139 | 79 | 82 | 76 | 3,714 | 18 | 8,229 | 13 | 7,277 | 20 |
| Santa Barbara County | 150 | 51 | 334 | 67 | 330 | 41 | 0 | 0 | 0 | 0 | 0 | 0 | 150 | 51 | 334 | 67 | 330 | 41 |
| Southern California | 20,240 | 16 | 35,868 | 9 | 29,670 | 10 | 758 | 34 | 924 | 26 | 916 | 30 | 20,999 | 16 | 36,793 | 9 | 30,587 | 10 |

as a decrease in the percentage of large individuals around the islands.

Counties. Los Angeles County had the highest estimated total catches from 1985 through 1987, accounting for 55%, 47% and 33% of the sheephead catches, respectively (Table 23). All counties except Los Angeles County recorded a total catch increase ranging from 96% to 188% from 1985 to 1987 (Table 23). Orange and Los Angeles county anglers released a higher proportion of the sheephead catch than those of the other counties during this survey (Table 23).

Size Composition

Southern California. There was little variation in mean length of sheephead during this survey: 371 mm (14.6 in.) in 1985, 378 mm (14.9 in.) in 1986, and 389 mm (15.3 in.) in 1987 (Figure 31). Most sheephead measurements from 1985 through 1987 ranged between 250 and 489 mm (9.8 in. and 19.3 in.); also, there were no unique modal size classes (Figure 32). According to Warner (1975), this size range represents 4- through 14-year-old fish.

Sheephead, according to Warner (1975), is a protogynous hermaphrodite, and, as such, most females will mature by 203 mm (8 in.) and transform into males by 305 mm (12 in.); some slow-growing females may not transform at all. He also states that sheephead have very long life spans (an estimated 50 or more years), although exact age determination is difficult for large and old individuals; and that size at age distribution can vary for different geographic areas. The long-lived nature of sheephead suggests population stability. However, the reproductive biology of this species, along with it's growth variability by area, make inferences about the stability of the southern

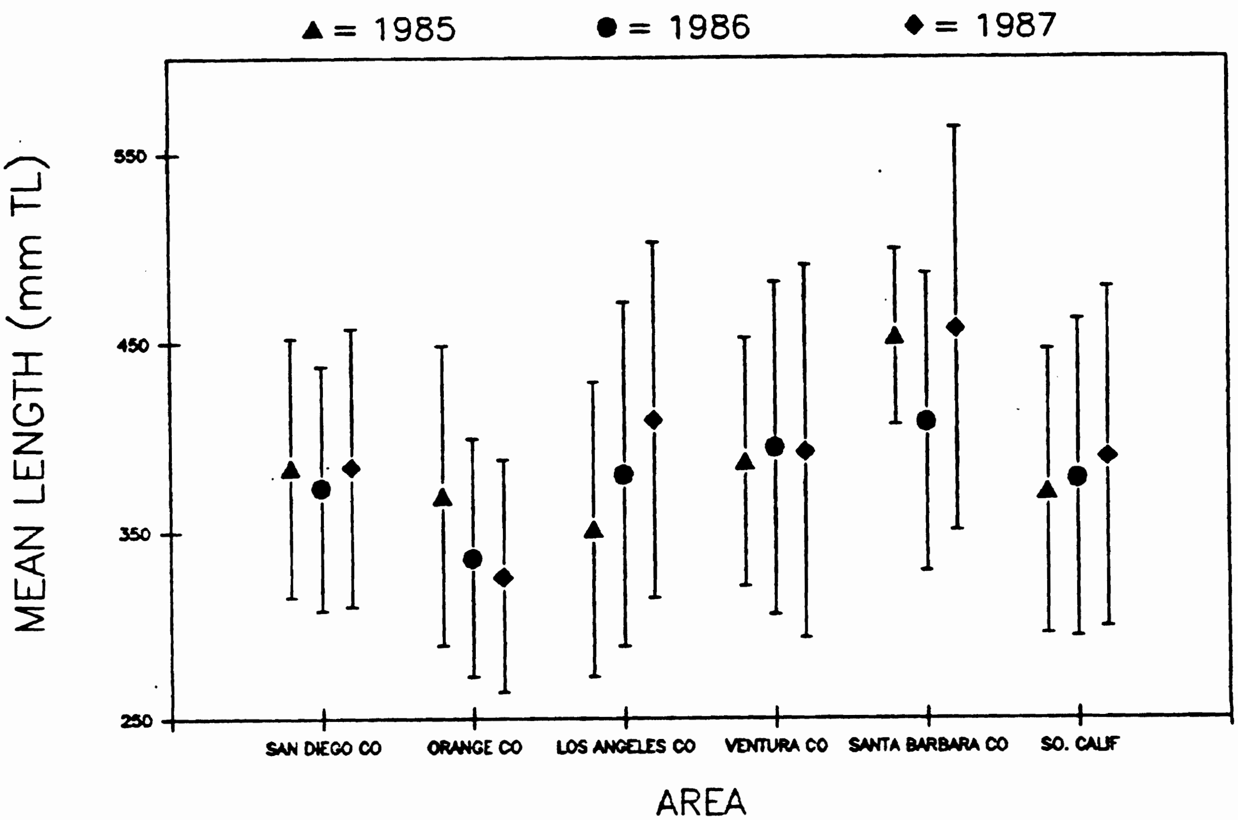



FIGURE 31. Mean lengths and standard deviations of California sheephead, measured on board southern California commercial passenger fishing vessels.

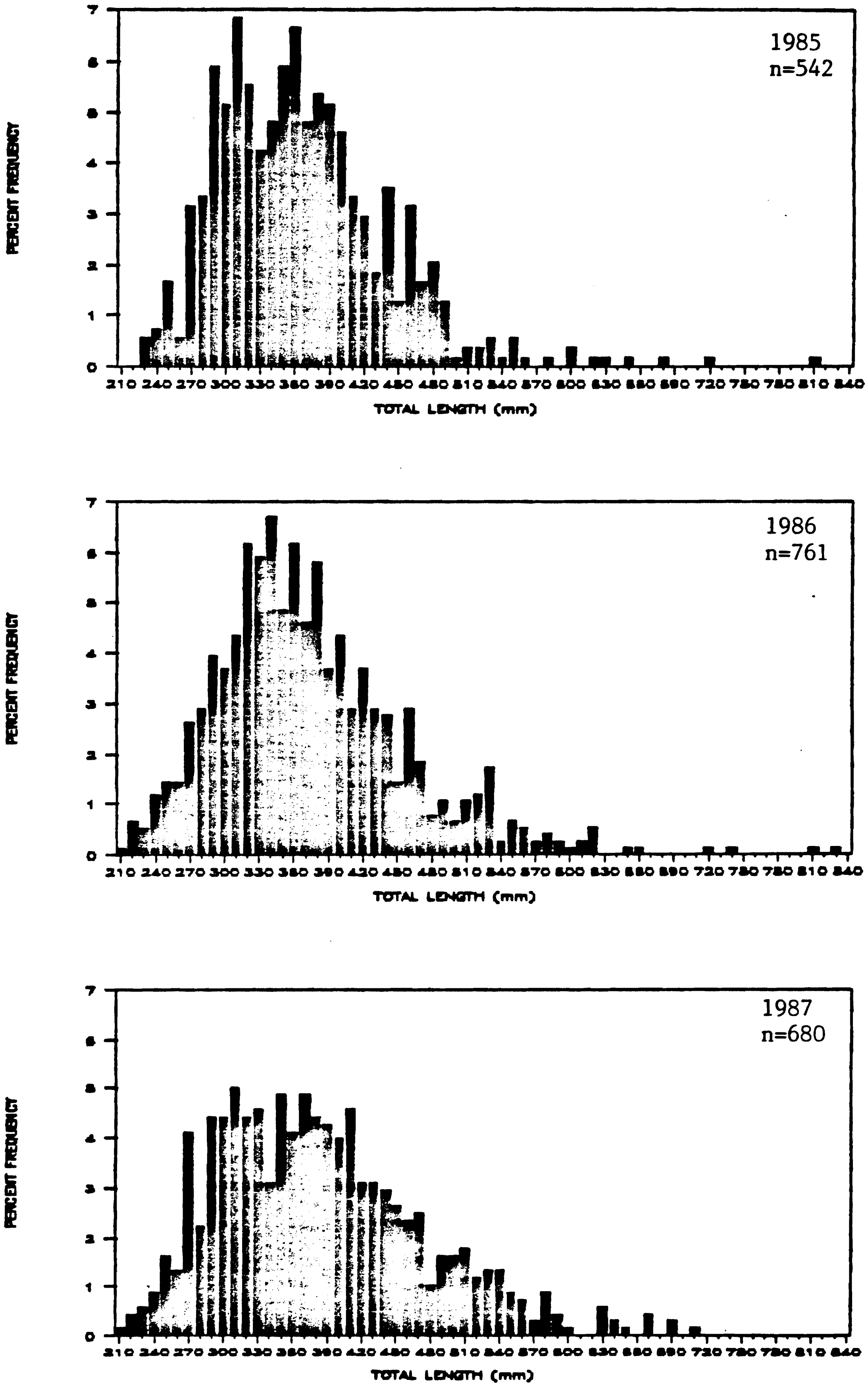



FIGURE 32. Size composition of California sheephead from on-board observations of southern California commercial passenger fishing vessels.

California population difficult. In our study, we assumed the existence of population stability in sheephead over the geographic range of our survey.

Counties. From 1985 through 1987, the largest sheephead were concentrated in Los Angeles, Ventura and Santa Barbara counties (Figure 31). The smallest sheephead occurred in Orange County.

Size composition of sheephead among counties was similar (Figures 33 through 36). There were insufficient data for size composition analysis of sheephead from Santa Barbara County.

## Management Recommendations

We do not see the need for special management action on sheephead at this time. Our data reveal a consistent size composition and total catch stability for the sheephead population exploited by the CPFV fishery.

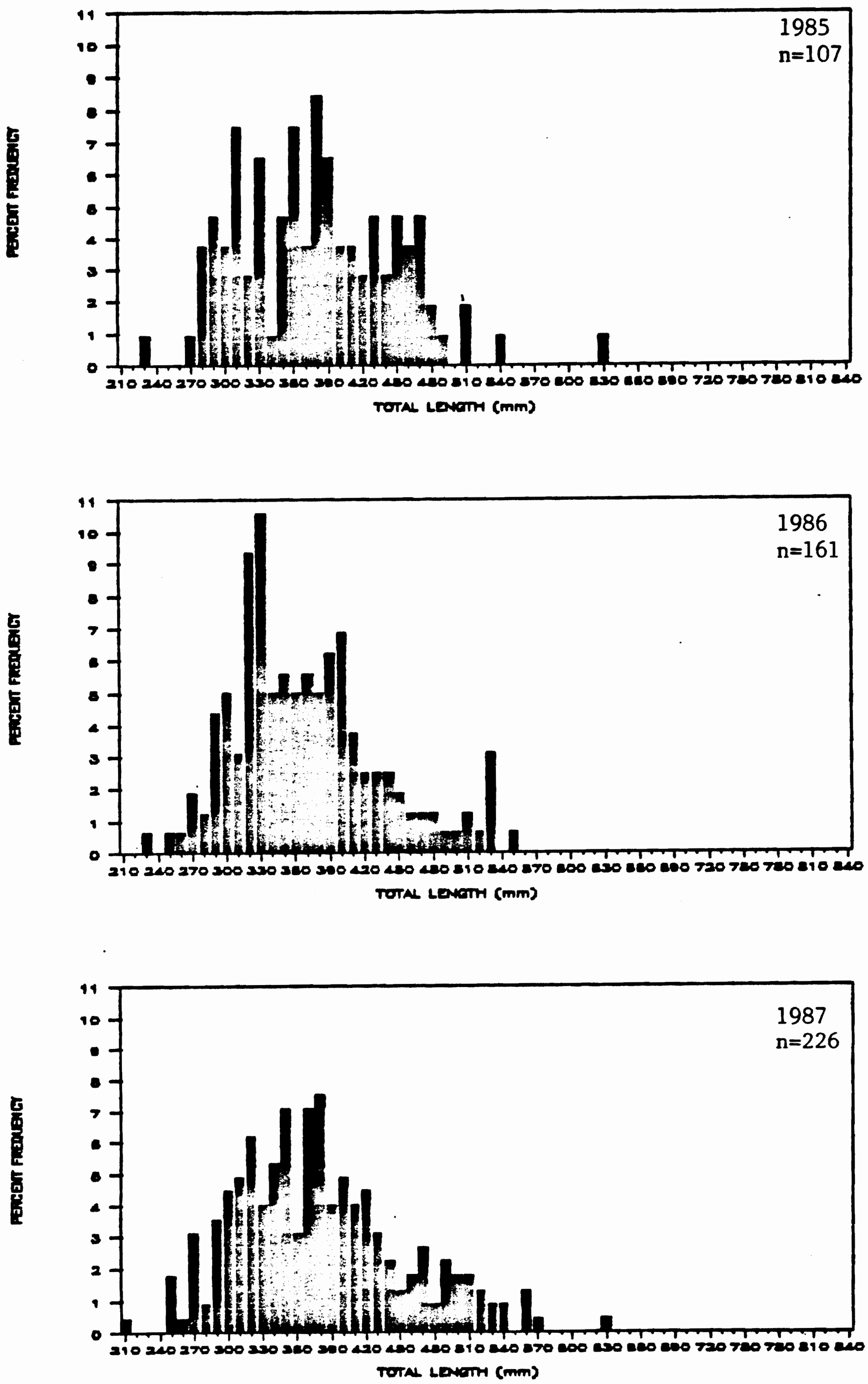



FIGURE 33. Size composition of California sheephead from on-board observations of San Diego County commercial passenger fishing vessels.

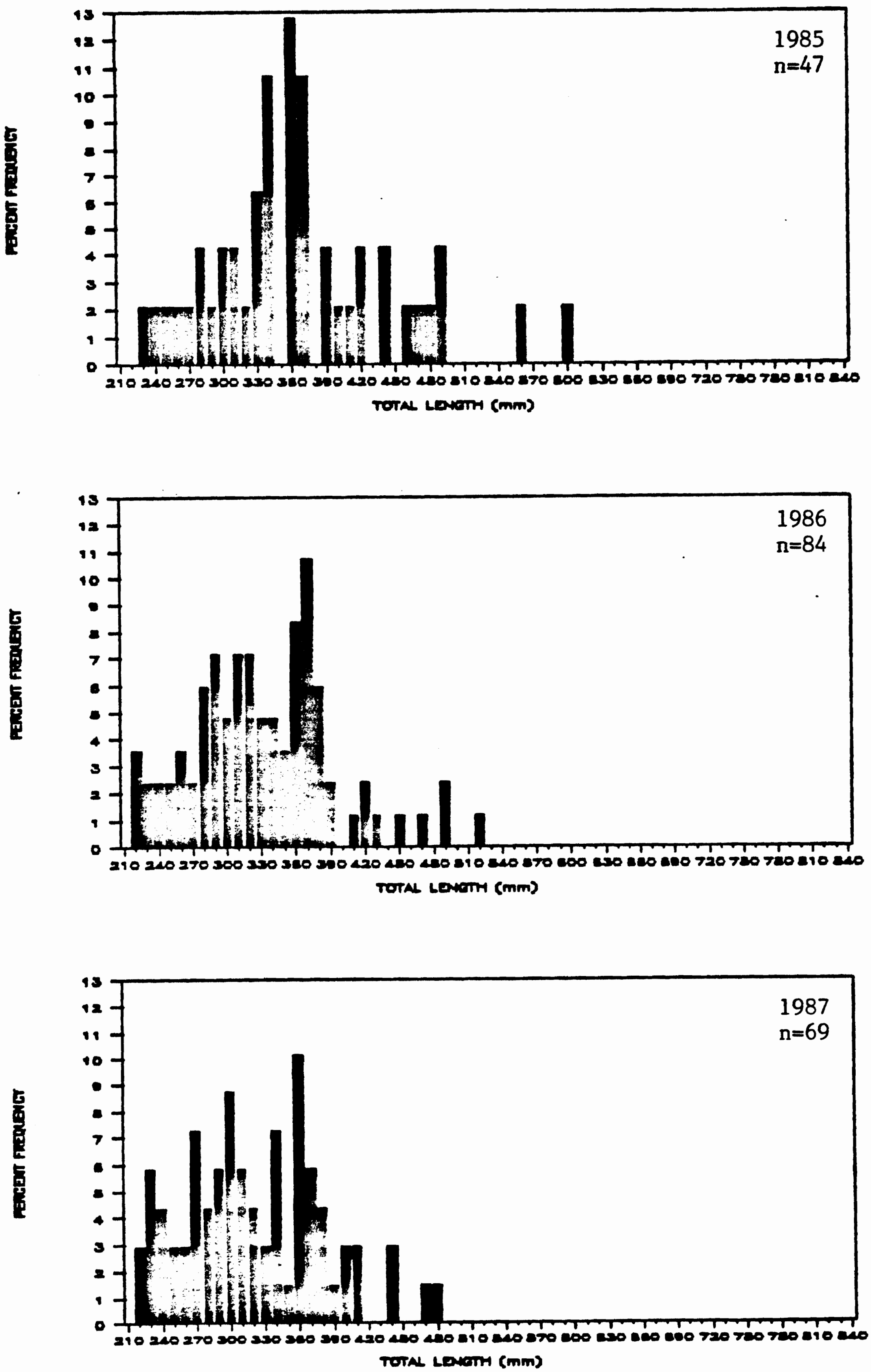



FIGURE 34. Size composition of California sheephead from on-board observations of Orange County commercial passenger fishing vessels.

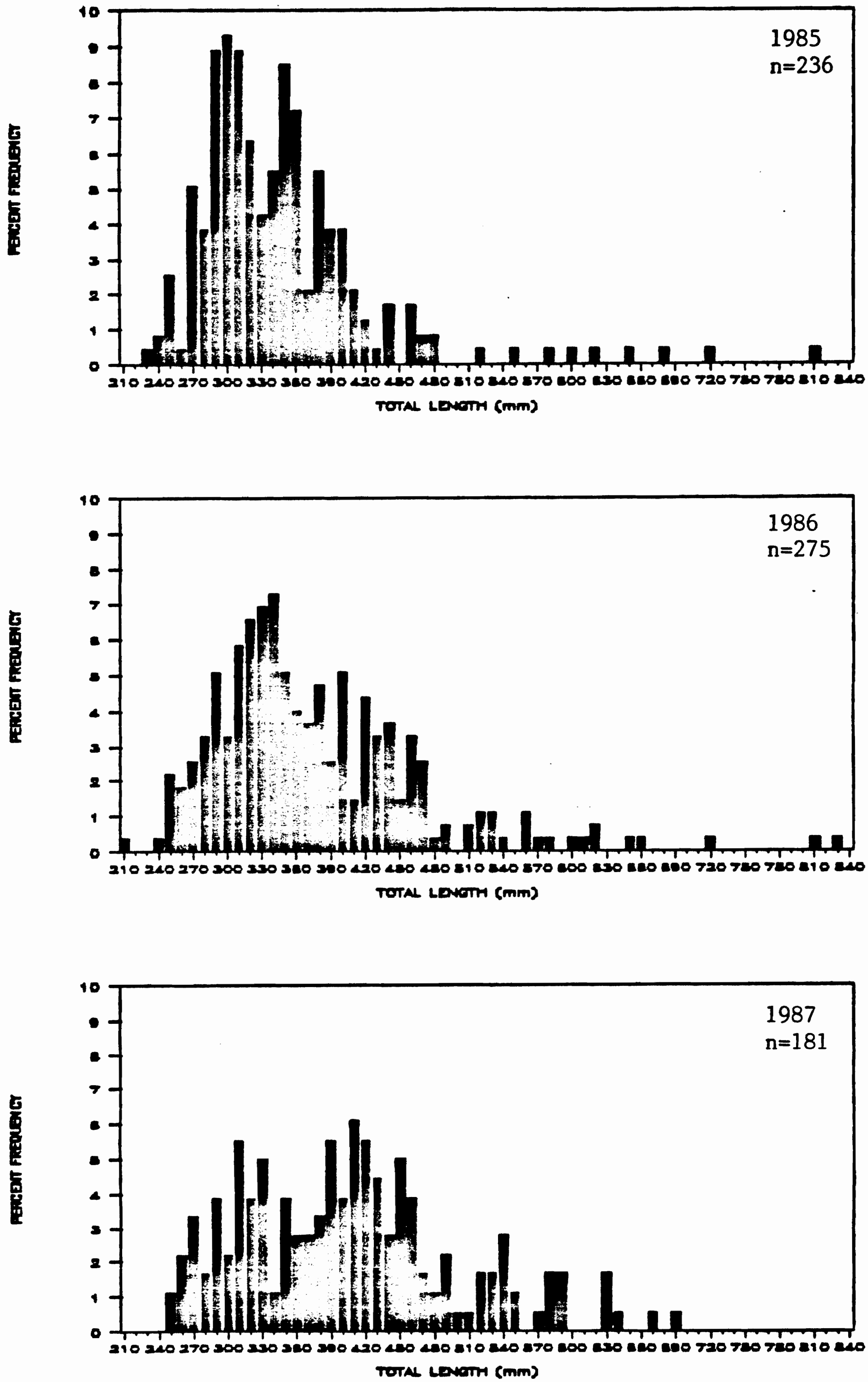



FIGURE 35. Size composition of California sheephead from on-board observations of Los Angeles County commercial passenger fishing vessels.

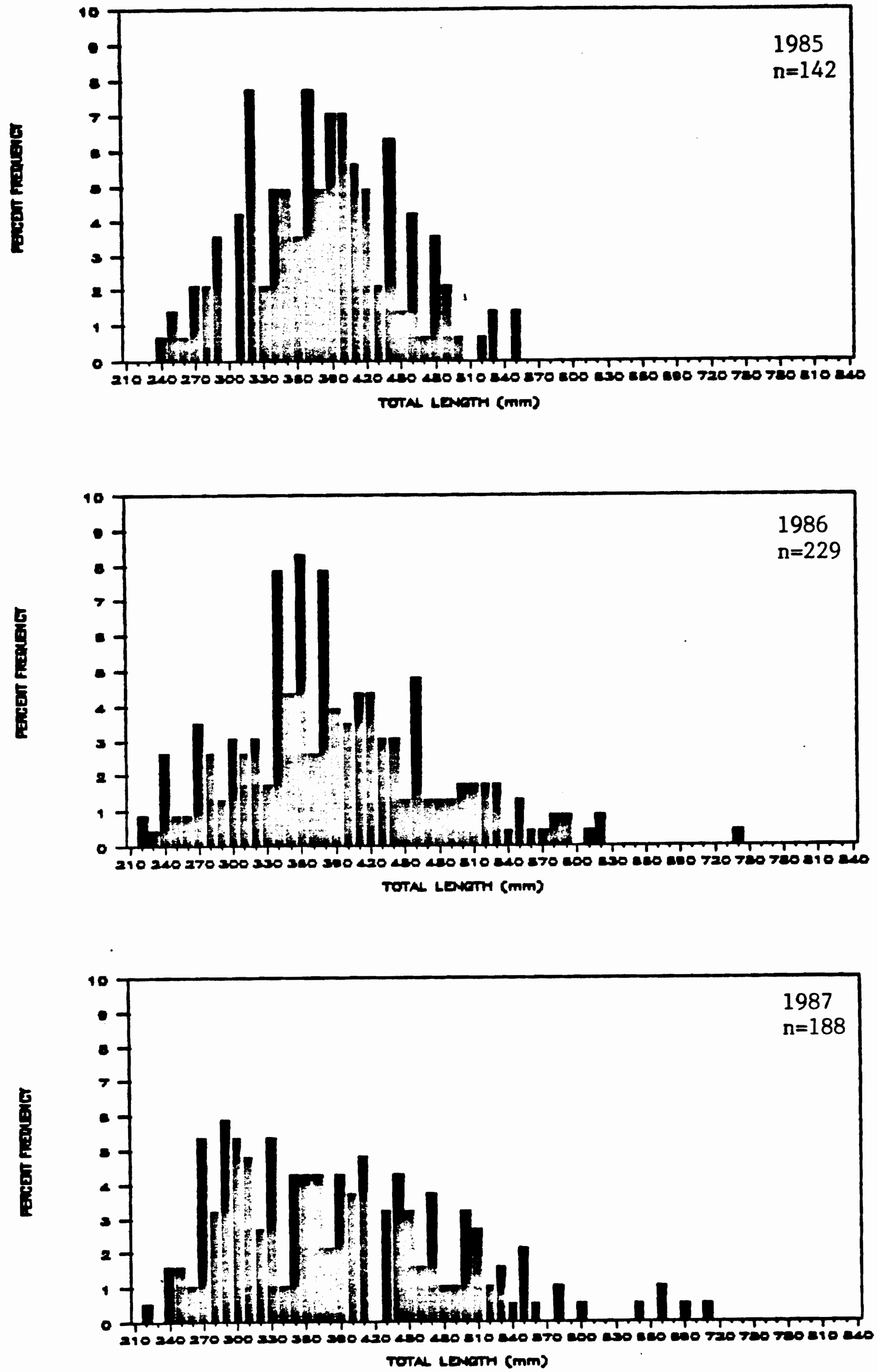



FIGURE 36. Size composition of California sheephead from on-board observations of Ventura County commercial passenger fishing vessels.

## White Croaker (Sciaenidae)

### Catch Estimates

Southern California. Young (1969) stated that CPFV landing operators ranked white croaker as the 20th most important species to the CPFV fleet, and that it was a nuisance to CPFV anglers 90% of the time. More recently, white croaker has gained notoriety due to the high amount of toxins found in its flesh (McCain et al. 1988). According to our IRI, white croaker annually ranked as the 7th to 15th most important species to the CPFV fleet (Table 12). However, because the IRI does not take into account the desirability of the species to CPFV anglers, its actual importance is considerably lower. CPFV anglers expend little effort for white croaker, and most of the catch is probably incidental to that of other fish species.

Estimated total catch of white croaker nearly tripled from 1985 to 1986, and then in 1987, dropped to only 60% of the 1986 catch (Table 24). Estimated landings and catches of released white croaker followed the same trends as total catch (Table 24).

The ratio of kept to released white croaker was 0.7 to 1 in 1985, 0.9 to 1 in 1986, and 0.7 to 1 in 1987. Peak catches of white croaker occurred from June through August, and a smaller peak occurred from February through April (Figure 37). Most of the summer catch of white croaker was probably incidentally caught during trips targeting barred sand bass, while the winter peak was probably an incidental white croaker catch on trips targeting California halibut.

Estimated catches of white croaker have dropped since the time of Collins and Crooke's (unpublished manuscript) survey. The average annual

TABLE 24. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of White Croaker from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| AREA | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 817 | 48 | 8,380 | 28 | 5,651 | 30 | 306 | 51 | 2,125 | 23 | 1,225 | 56 | 1,123 | 47 | 10,506 | 25 | 6,875 | 31 |
| Orange County | 5,546 | 45 | 9,383 | 31 | 1,255 | 25 | 4,821 | 33 | 20,570 | 41 | 5,688 | 44 | 10,367 | 34 | 29,953 | 33 | 6,943 | 38 |
| Los Angeles County | 5,753 | 35 | 22,622 | 25 | 9,444 | 29 | 11,563 | 24 | 21,417 | 17 | 17,105 | 21 | 17,316 | 23 | 44,039 | 19 | 26,549 | 22 |
| Ventura County | 1,031 | 34 | 1,355 | 64 | 5,296 | 50 | 1,683 | 38 | 1,254 | 42 | 6,880 | 31 | 2,714 | 33 | 2,610 | 50 | 12,176 | 33 |
| Santa Barbara County | 78 | 59 | 939 | 62 | 151 | 43 | 548 | 31 | 997 | 28 | 797 | 49 | 626 | 29 | 1,936 | 38 | 948 | 47 |
| Southern California | 13,226 | 25 | 42,680 | 16 | 21,797 | 19 | 18,920 | 17 | 46,363 | 20 | 31,694 | 16 | 32,146 | 17 | 89,043 | 15 | 53,491 | 15 |

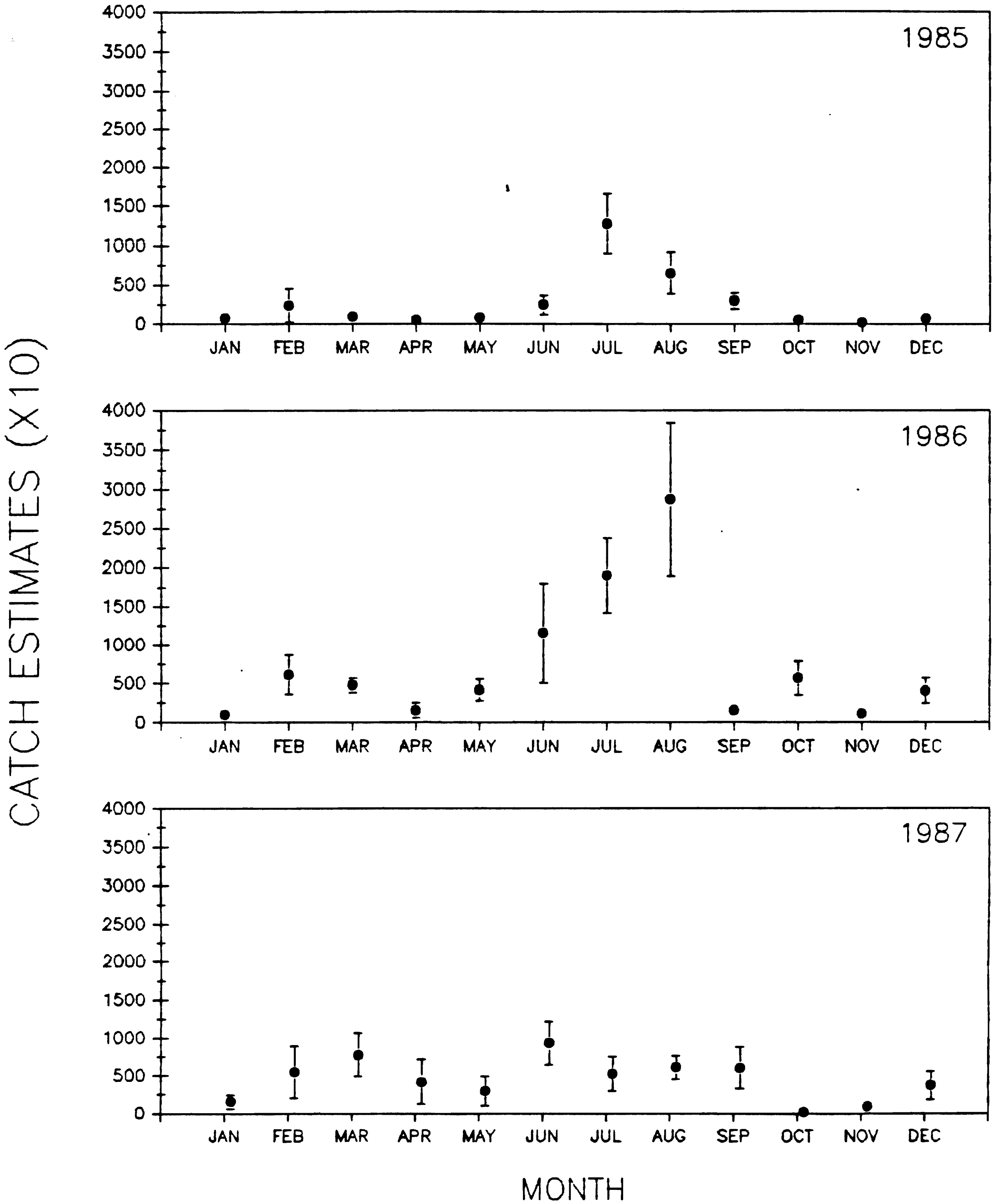



FIGURE 37. Monthly total catch estimates (number of fish) and standard deviations of white croaker from on-board observations of southern California commercial passenger fishing vessels.

total catch decreased from 83,558 fish ± 11,921 during 1976 to 1978 (Collins and Crooke, unpublished manuscript) to 58,227 ± 9,414 during 1985 to 1987. However, reduced catches of white croaker were probably dictated more by lack of angler demand than a reduced white croaker population. Anglers cite poor taste, lack of fighting ability, and concern about the safety of eating white croaker as primary reasons for not targeting white croaker.

Counties. Los Angeles County had the highest annual total catch of white croaker, accounting for 49% to 54% of the white croaker total catch in southern California between 1985 and 1987 (Table 24). Orange County accounted for 32% and 34% of the southern California white croaker total catch in 1985 and 1986, respectively, and Ventura County, 23% in 1987 (Table 24).

Los Angeles County had the highest annual landings of white croaker from 1985 through 1987 (Table 24). Orange County's white croaker contribution to southern California landings showed the largest decrease among southern California counties, dropping from 42% of the landings in 1985, to 22% in 1986, to 6% in 1987 (Table 24). Ventura County's landings' contribution increased from 8% in 1985 to 24% in 1987, and San Diego County's contribution increased from 6% in 1985 to 26% in 1987 (Table 24). San Diego County had the highest kept-to-released ratio with 2.6 to 1 in 1985, 3.9 to 1 in 1986, and 4.6 to 1 in 1987.

## Size Composition

Southern California. Annual mean lengths of white croaker rose slightly in southern California between 1985 and 1987 (Figure 38). Modal lengths for white croaker were 255 to 259 mm (10.0 to 10.2 in.) and 265

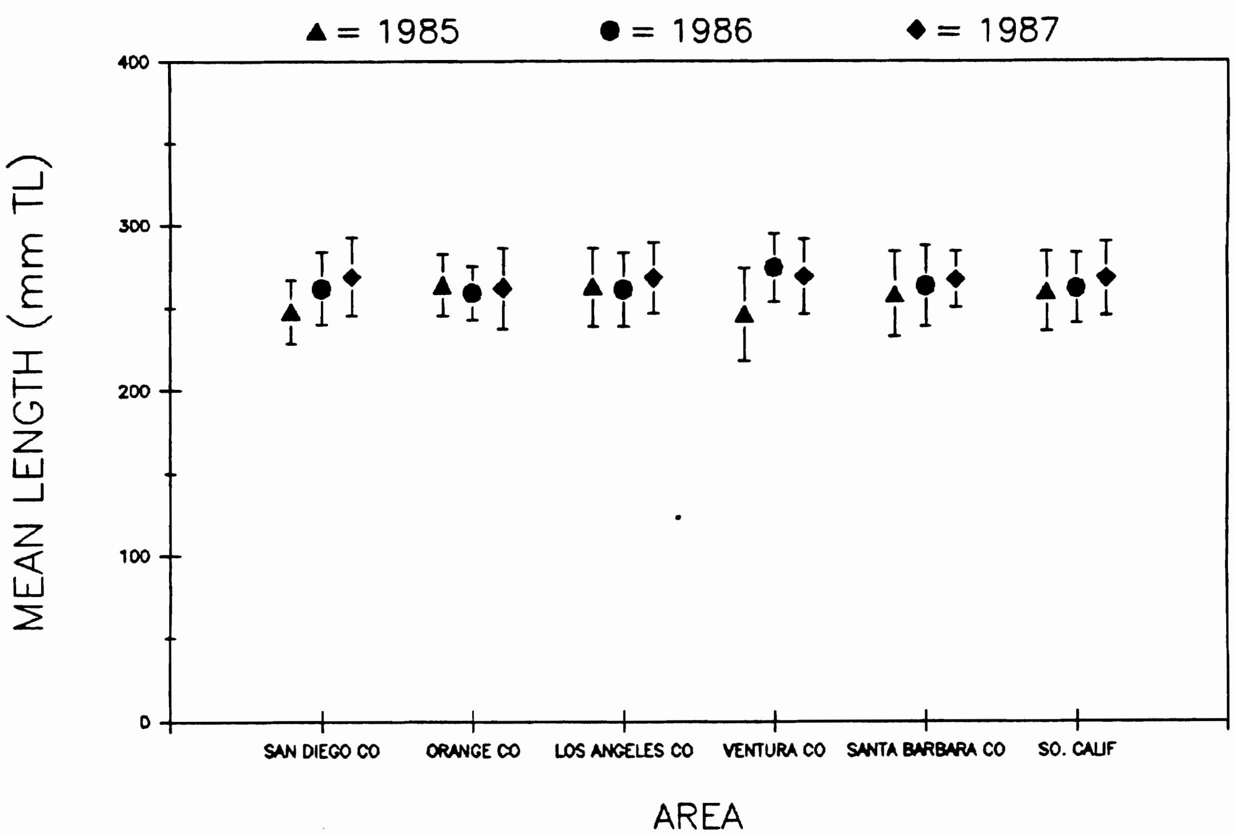



FIGURE 38. Mean lengths and standard deviations of white croaker measured on board southern California commercial passenger fishing vessels.

to 269 mm (10.4 to 10.6 in.) in 1985, 260 to 264 mm (10.2 to 10.4 in.) in 1986, and 265 to 269 mm (10.4 to 10.6 in.) in 1987 (Figure 39). Based on Love's et al. (1984) growth curve, modal size white croaker were probably 7 to 9 years old.

The annual mean length of white croaker in our study was similar to that of Collins and Crooke's (unpublished manuscript). However, it was considerably larger than that of otter trawl-caught white croaker observed by Love et al. (1984). White croaker are probably not fully recruited into the CPFV fishery until they reach approximately 255 mm (10 in.), and, in fact, CPFV mean lengths correspond more closely with private skiff and commercially caught white croaker lengths reported by Love et al. (1984).

Counties. Mean lengths of white croaker varied little during 1985 to 1987 (Figure 38). The mean length of white croaker increased slightly each year in San Diego and Santa Barbara counties (Figure 38). The length frequency analysis for southern California as a whole and by counties exhibited similar patterns (Figures 39 to 44).

Management Recommendations

White croaker are not highly esteemed nor frequently targeted by southern California CPFV anglers. Currently, catches are governed by angler effort rather than resource capabilities. No management policies seem needed at this time. However, CPFV anglers are concerned about the health issues surrounding white croaker and other sport fish species caught off portions of southern California. In addition to the warnings

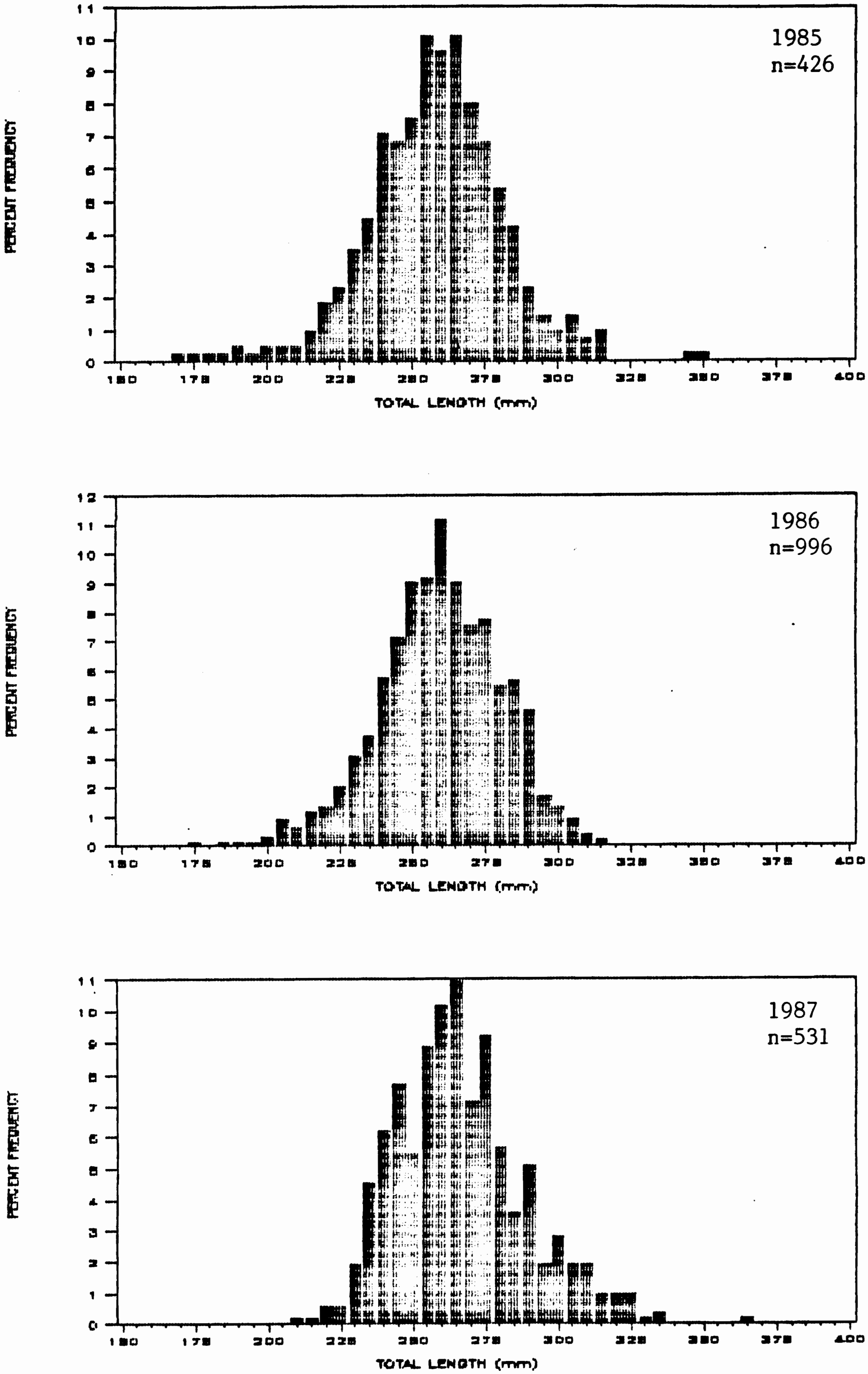



FIGURE 39. Size composition of white croaker from on-board observations of southern California commercial passenger fishing vessels.

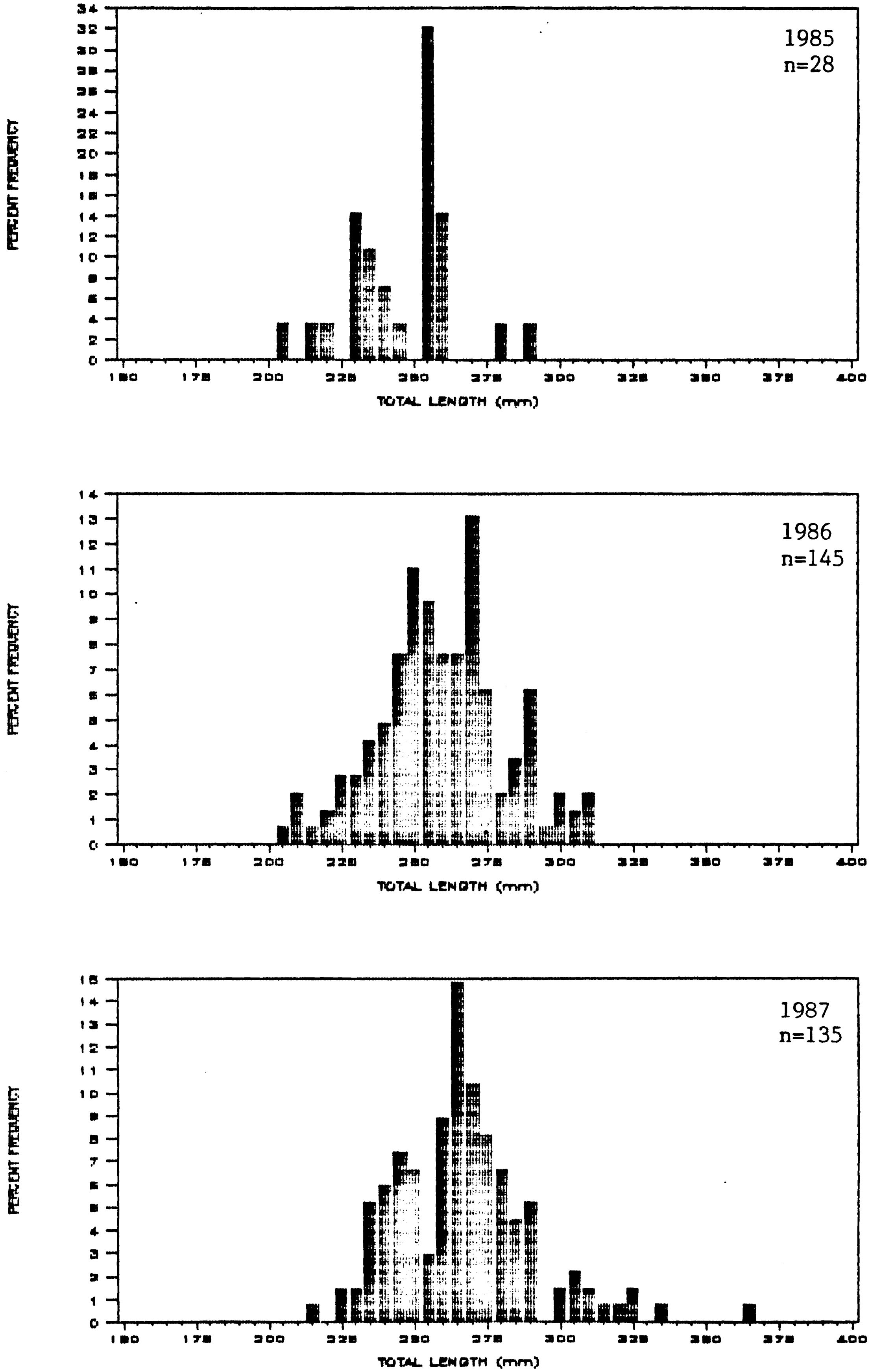



FIGURE 40. Size composition of white croaker from on-board observations of San Diego County commercial passenger fishing vessels.

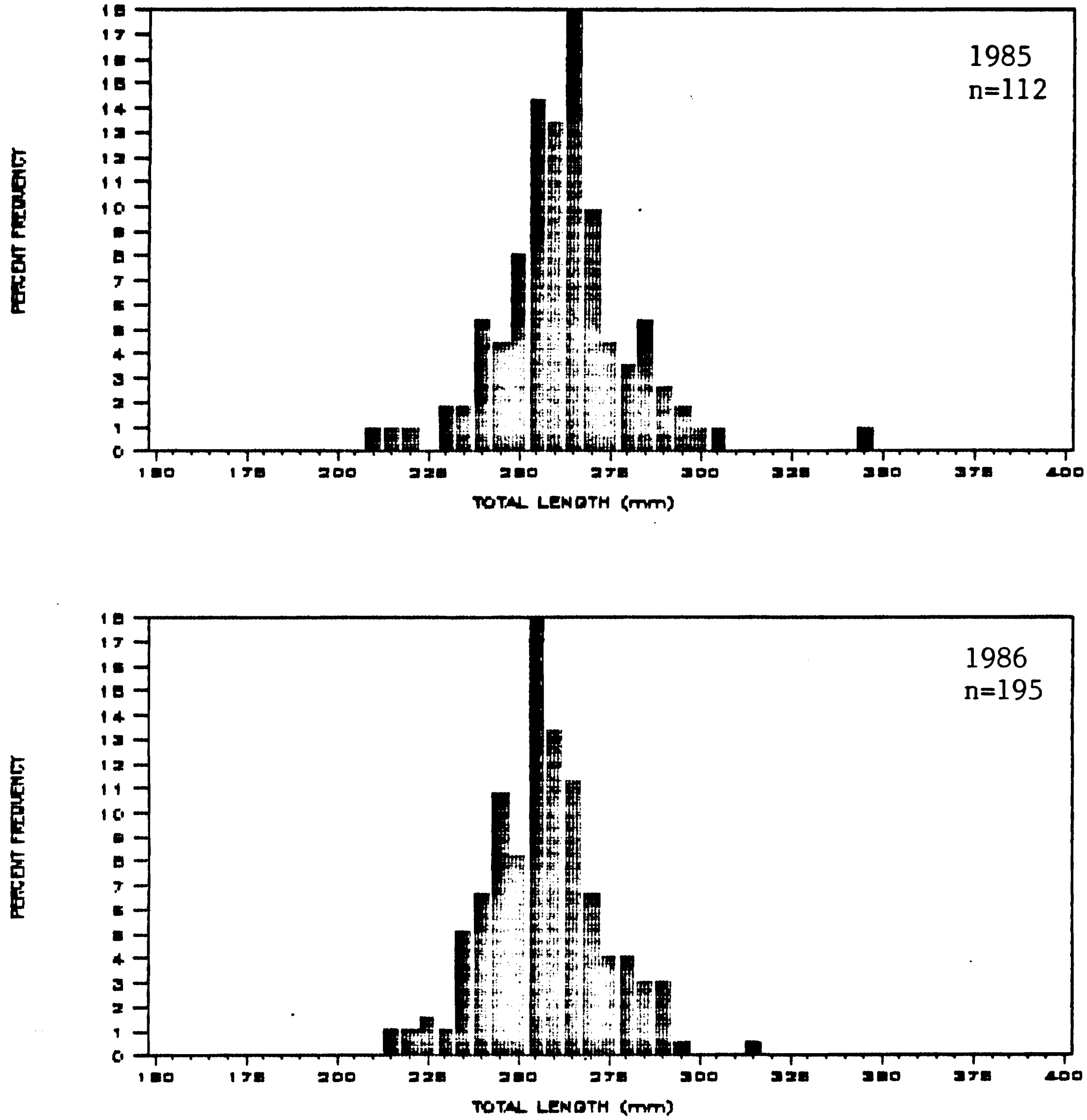



FIGURE 41. Size composition of white croaker from on-board observations of Orange County commercial passenger fishing vessels.

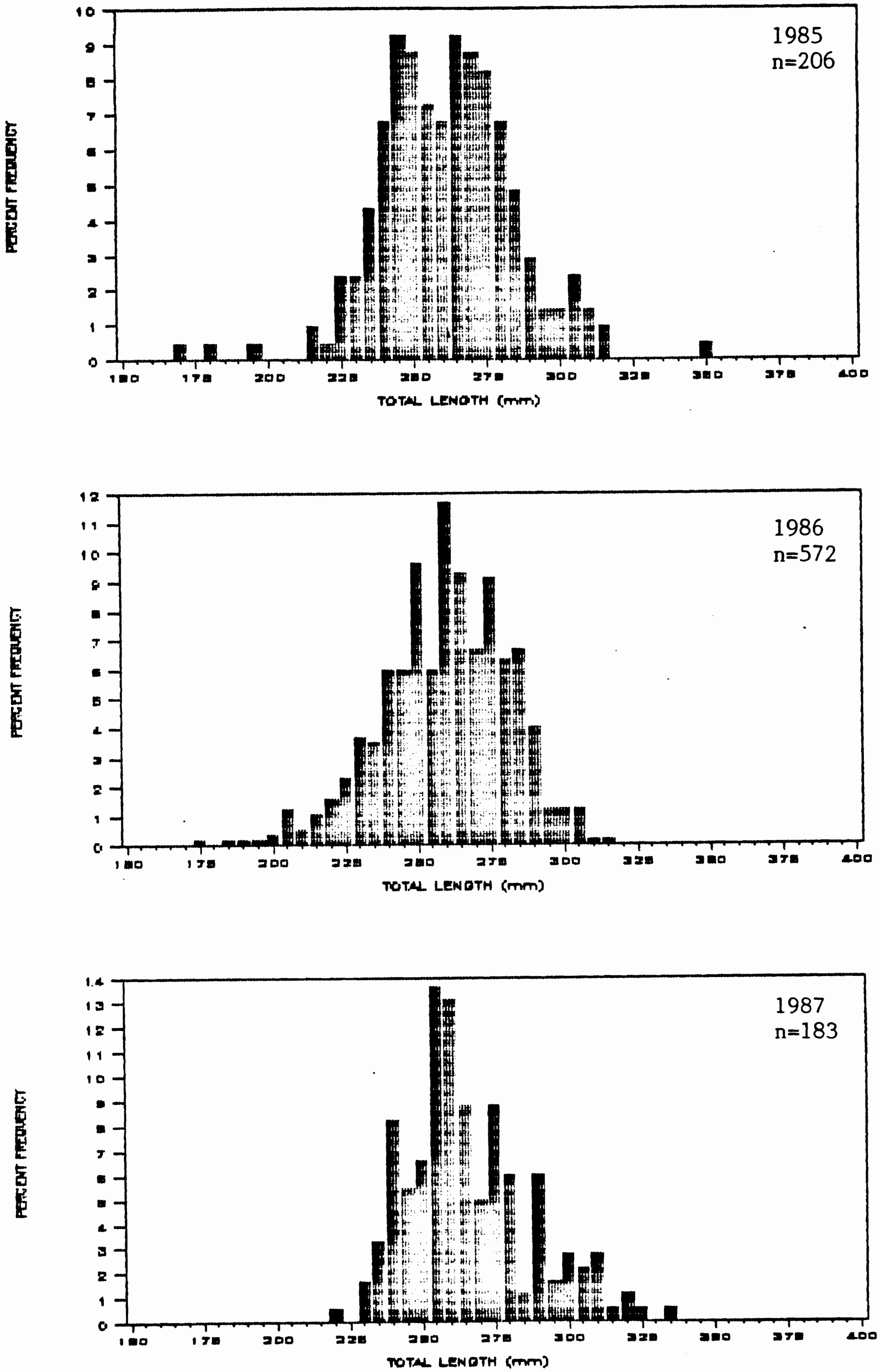



FIGURE 42. Size composition of white croaker from on-board observations of Los Angeles County commercial passenger fishing vessels.

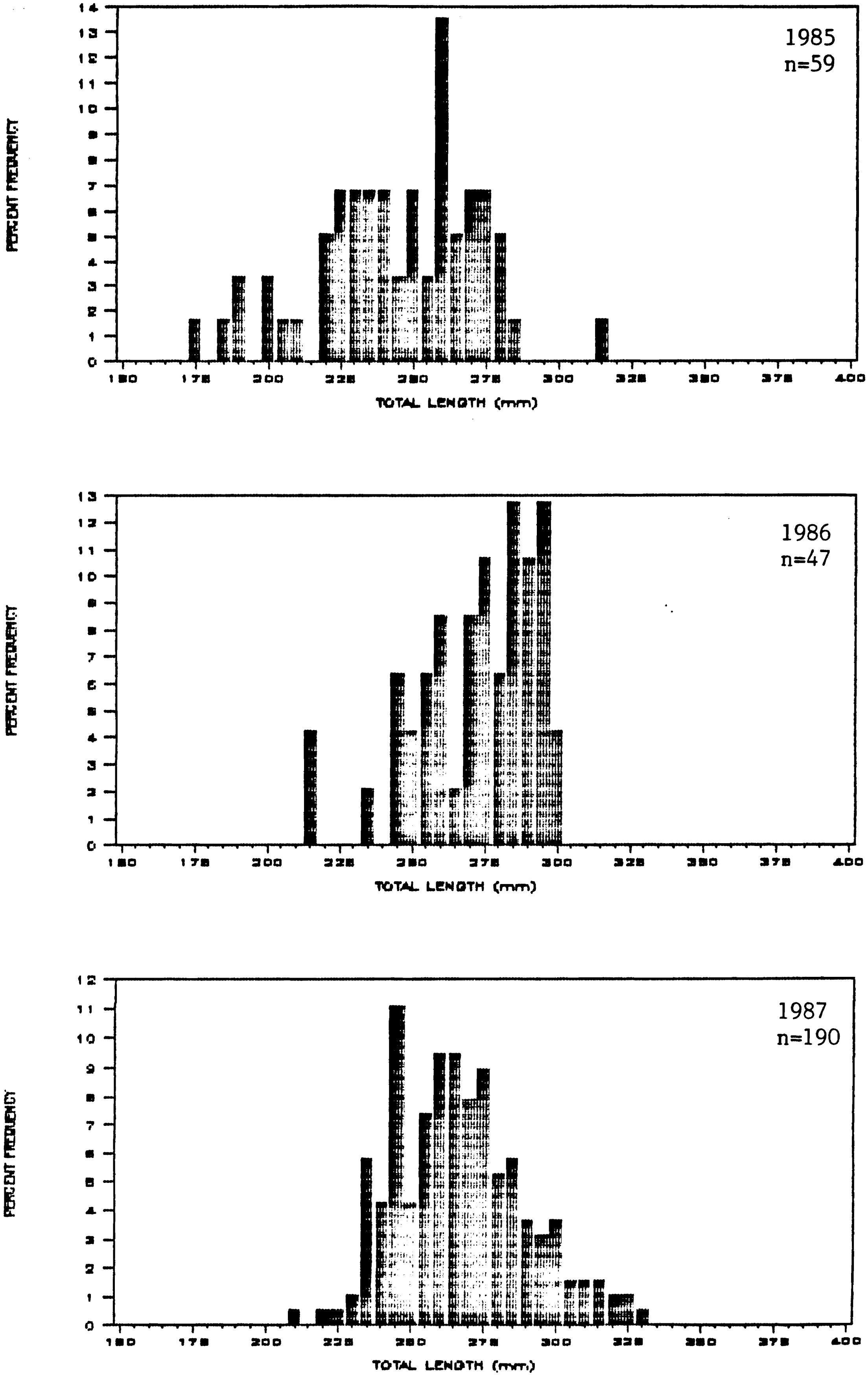
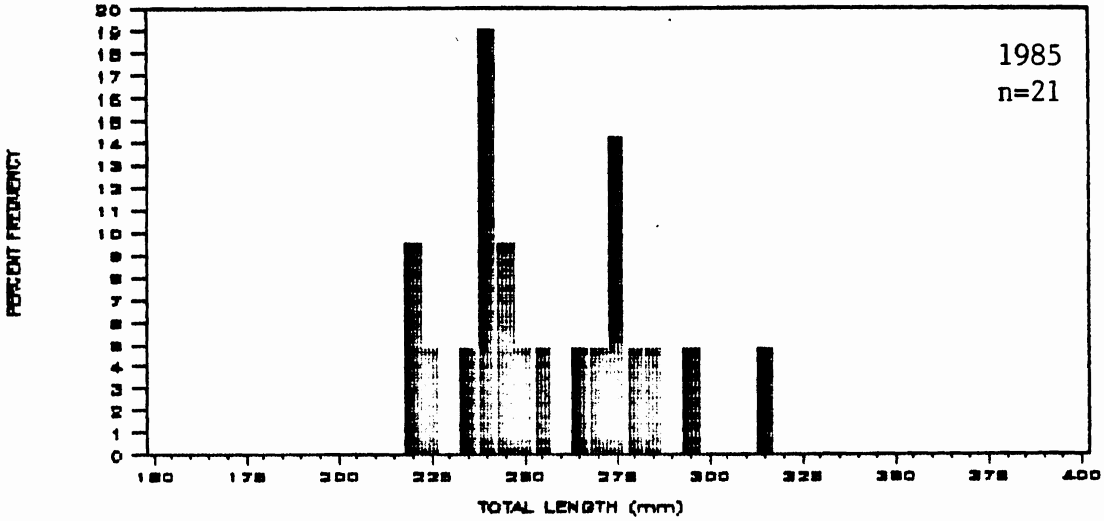



FIGURE 43. Size composition of white croaker from on-board observations of Ventura County commercial passenger fishing vessels.



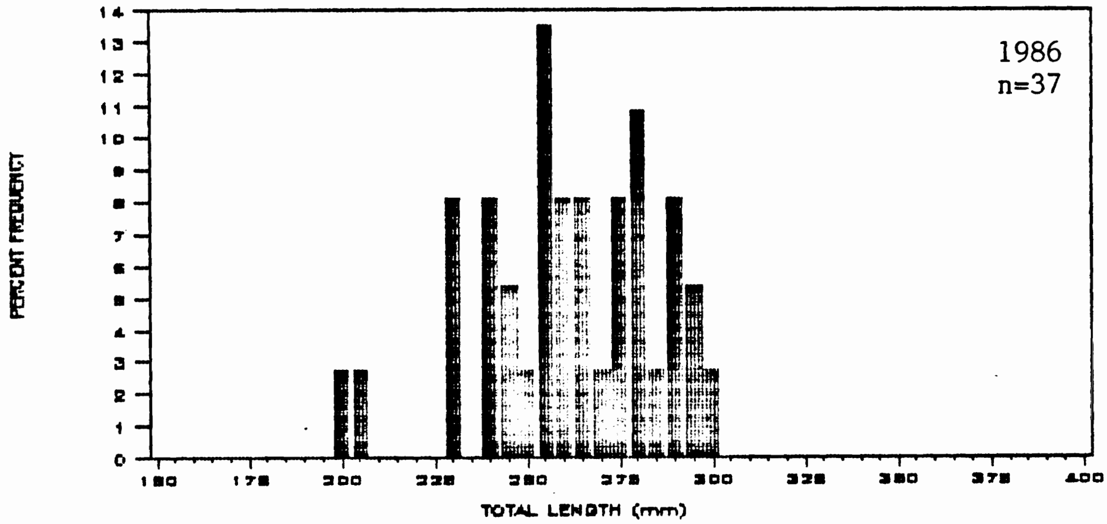




FIGURE 4.4. Size composition of white croaker from on-board observations of Santa Barbara County commercial passenger fishing vessels.

issued in the California sport fishing regulations, DFG and other responsible agencies should make every effort to keep the fishing public informed of all the latest information concerning the safety of consuming sport fish species.

## White Seabass (Sciaenidae)

### Catch Estimates

Southern California. White seabass (henceforth referred to as seabass) is highly esteemed by anglers because of its exceptional good taste and angling challenge (Vojkovich and Reed 1983).

Estimated annual total catches of seabass increased 134% from 1985 to 1986, then declined by 1% in 1987 (Table 25). Most of this increase was in the number of released seabass, which increased 188% from 1985 to 1987 (Table 25). The estimated number of kept seabass was small and extremely variable: 989 in 1985, 3,696 in 1986, and only 547 fish in 1987 (Table 25).

The ratio of kept to released seabass was variable during the survey: 0.3 to 1 in 1985, 0.7 to 1 in 1986, and 0.1 to 1 in 1987. This variability was caused by a general increase in released fish, and a sharp decline in kept fish in 1987.

The peak periods of seabass catches were erratic. In general, the summer and fall months recorded the largest catches during the survey (Figure 45).

The seabass catch during our survey was composed of a greater number of short fish [<711 mm (28 in.)] compared to that reported in Collins and Crooke's (unpublished manuscript) survey. The estimated mean annual catch of legal seabass decreased from 2,565 fish $\pm$ 665 for 1976 through 1978 to 1,646 $\pm$ 771 for 1985 through 1987. Not enough data on short seabass were collected during the 1970's study for comparative purposes. Our survey's legal to short ratios were 0.3 to 1 in 1985, 0.6 to 1 in 1986, and 0.1 to 1 in 1987.

TABLE 25. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of White Seabass from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| AREA | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 247 | 38 | 440 | 56 | 142 | 70 | 907 | 34 | 2,445 | 21 | 1,979 | 30 | 1,153 | 30 | 2,885 | 21 | 2,121 | 28 |
| Orange County | 0 | 0 | 175 | 63 | 73 | 99 | 705 | 30 | 1,740 | 16 | 4,331 | 33 | 705 | 30 | 1,914 | 16 | 4,404 | 32 |
| Los Angeles County | 566 | 29 | 2,917 | 45 | 173 | 61 | 1,259 | 30 | 1,271 | 65 | 567 | 34 | 1,825 | 27 | 4,188 | 37 | 740 | 28 |
| Ventura County | 73 | 98 | 0 | 0 | 102 | 53 | 98 | 98 | 0 | 0 | 1,711 | 53 | 171 | 98 | 0 | 0 | 1813 | 50 |
| Santa Barbara County | 104 | 87 | 163 | 81 | 56 | 98 | 26 | 68 | 151 | 38 | 36 | 99 | 130 | 72 | 314 | 55 | 92 | 71 |
| Southern California | 989 | 22 | 3,696 | 36 | 547 | 33 | 2,994 | 18 | 5,606 | 18 | 8,624 | 21 | 3,983 | 17 | 9,301 | 18 | 9,171 | 20 |

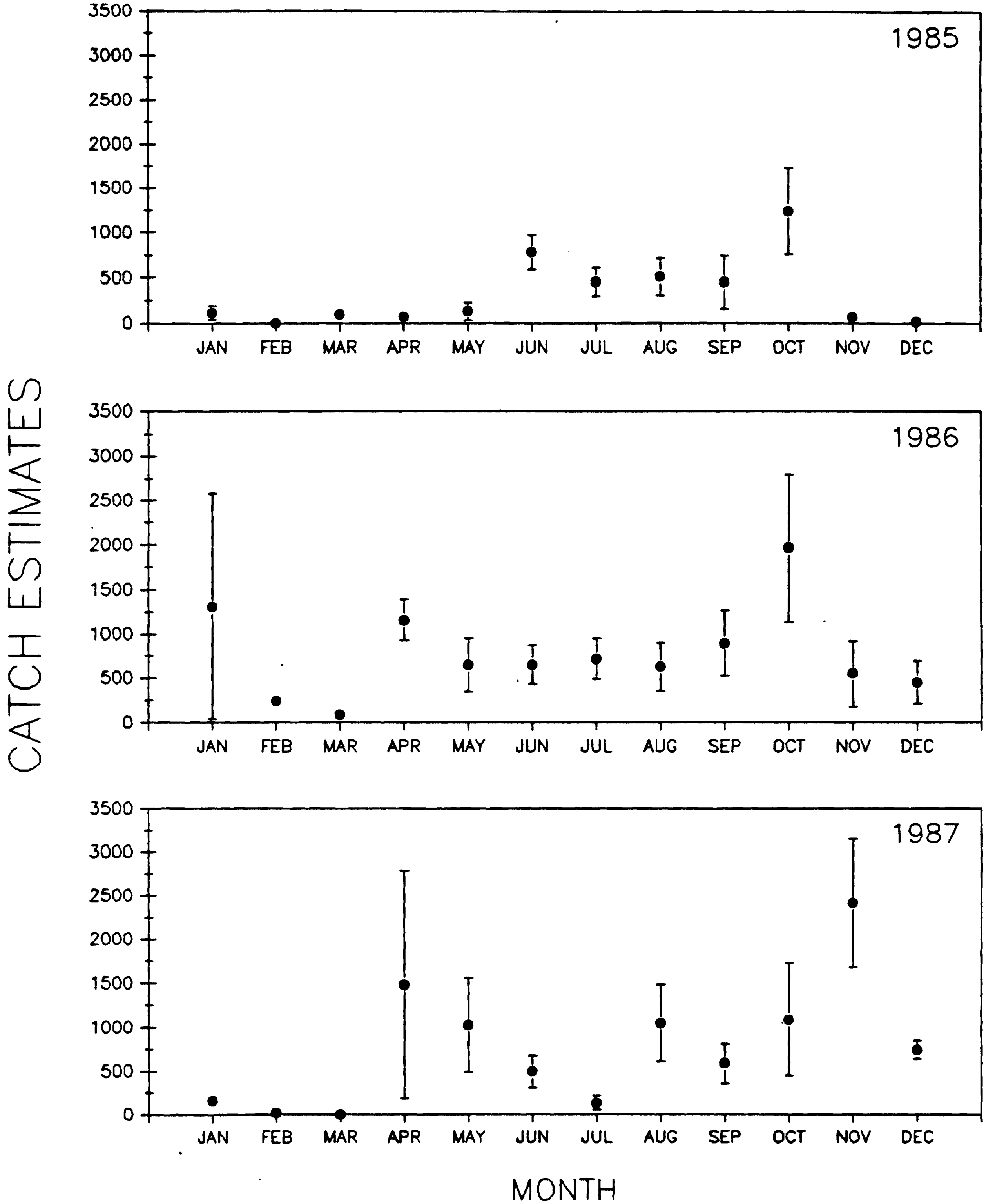



FIGURE 45. Monthly total catch estimates (number of fish) and standard deviations of white seabass from on-board observations of southern California commercial passenger fishing vessels.

Seabass are thought to be migratory, moving northward along the coast in spring, returning southward in the fall, and wintering in Baja California (Young 1973). Moser et al. (1983) found that 85% of seabass larvae occur in Baja California waters, while 15% occur in southern California waters. Thus, spawning would seem to occur mostly in Mexican waters. Thomas (1968) suggested that a single population of seabass occurs off our coast. However, Crooke (1989) indicated that subpopulations may exist. Our data support the migratory theory for seabass, and further suggest the existence of discreet subgroups of legal and short fish. There remains a great deal we do not understand about the early life history, population structure, and migration patterns of this species.

Counties. The highest total catch estimates came from Los Angeles County in both 1985 and 1986, accounting for 46% and 45% of the seabass catches, respectively (Table 25). Orange County led the other counties in 1987 with 48% (Table 25). Santa Barbara County anglers kept a higher proportion of the seabass than those of the other counties during this survey (Table 25), while Orange County anglers returned a higher proportion of the catch than did anglers in the other counties (Table 25).

Size Composition

Southern California. The annual mean lengths of all measured seabass during this survey were 682 mm (26.9 in.) in 1985, 773 mm (30.4 in.) in 1986, and 583 mm (22.9 in.) in 1987 (Figure 46). According to Thomas (1968), these sizes represent to 2- to 5-year-old fish. Greater

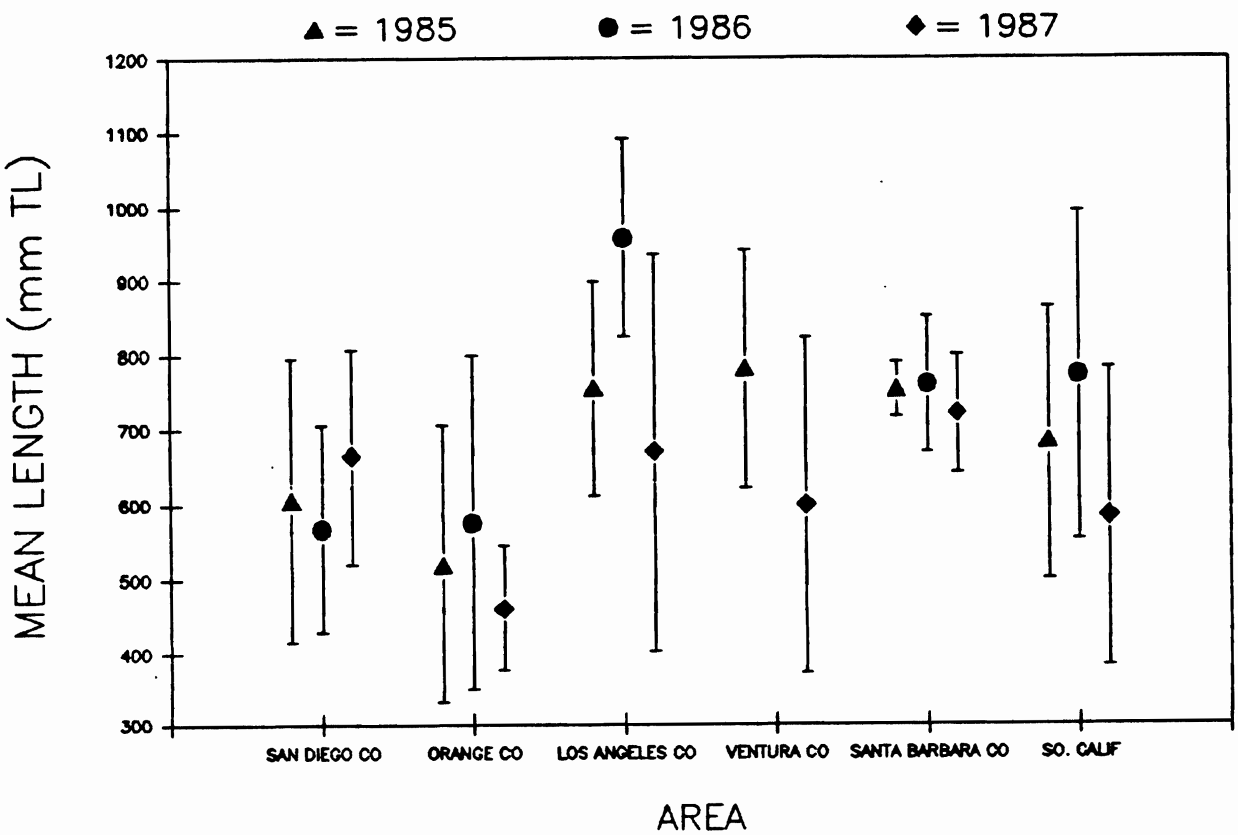



FIGURE 46. Mean lengths and standard deviations of white seabass measured on board southern California commercial passenger fishing vessels. Size limit = 711 mm (28 in.).

numbers of 866 to 1,072 mm (34.1 to 42.2 in.) long fish (6 to 10 years old) were caught in 1986, but in 1987 greater numbers of 467 to 571 mm (18.4 to 22.5 in.) long fish (3 to 4 years old) were caught (Figure 47). The size composition of seabass in our survey indicates an increasing size trend compared to that of earlier DFG surveys. Maxwell (1977) found that the sampled CPFV seabass catch from 1972 through 1974 consisted almost entirely of 2- to 4-year-old fish, with only a few legal size individuals.

The 3-year mean length of seabass in our survey increased by 117 mm (4.6 in.) over that of Collins and Crooke's (unpublished manuscript), because of the larger proportion of older fish sampled in our study.

The annual mean lengths of released seabass during this survey were 526 mm (20.7 in.) in 1985, 506 mm (19.9 in.) in 1986, and 497 mm (19.6 in.) in 1987 (Figure 48). According to Thomas' (1968) criteria, these sizes correspond to 2- to 4-year-old fish. There was a consistent but low percentage of short seabass kept by anglers during this survey: 3.6% in 1985, 4.4% in 1986, and 3.6% in 1987.

Mean lengths of kept seabass during this survey were 811 mm (31.9 in.) in 1985, 882 mm (34.7 in.) in 1986, and 861 mm (33.9 in.) in 1987 (Figure 49). Seabass 723 mm (28.5 in.) long (5 years old) composed most of the kept category in 1985 and 1987, with few larger fish represented (Figure 47). In 1986, however, 723 to 1,072 mm (28.5 to 42.2 in.) long (5 to 10 years old) fish composed most of the kept category (Figure 47).

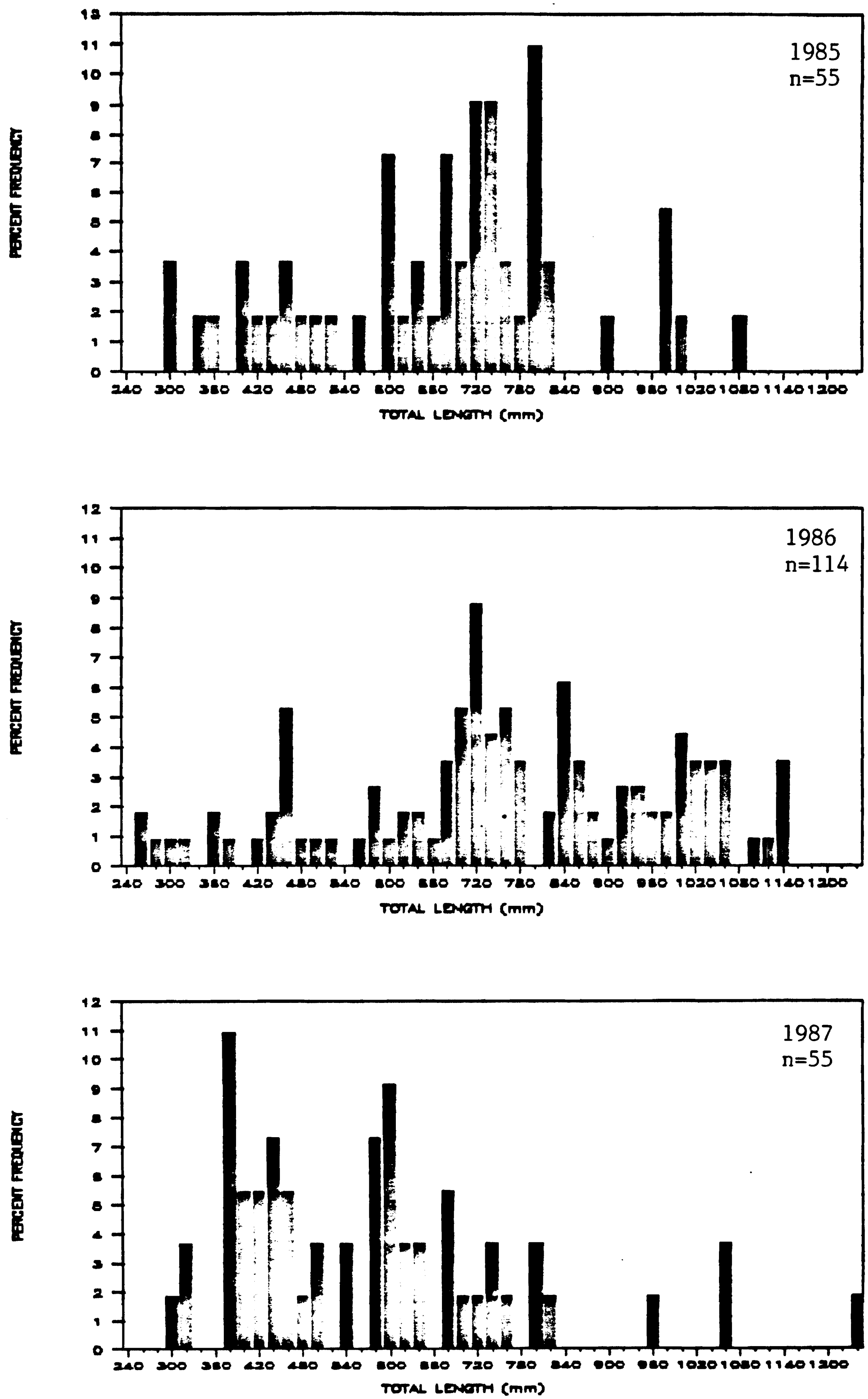



FIGURE 47. Size composition of white seabass from on-board observations of southern California commercial passenger fishing vessels. Size limit = 711 mm (28 in.).

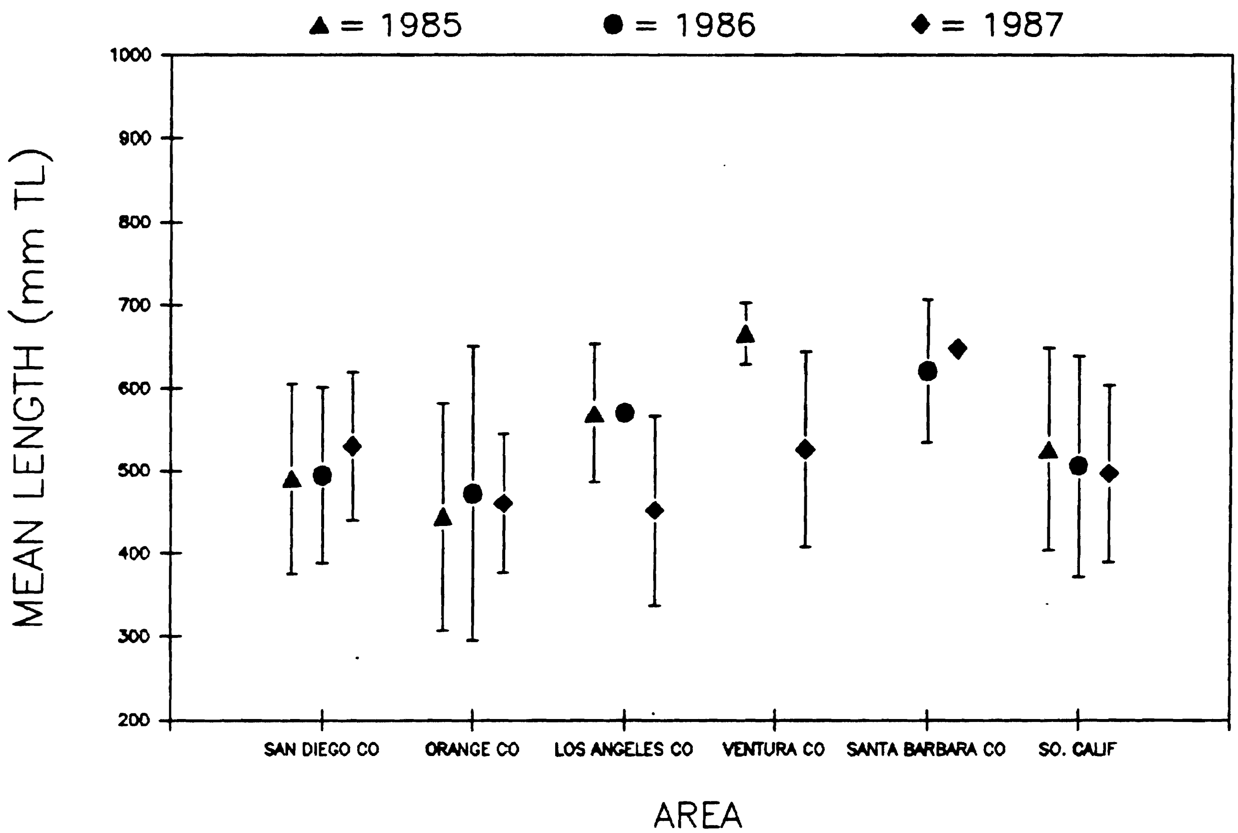



FIGURE 48. Mean lengths and standard deviations of released white seabass measured on board southern California commercial passenger fishing vessels. Size limit = 711 mm (28 in.).

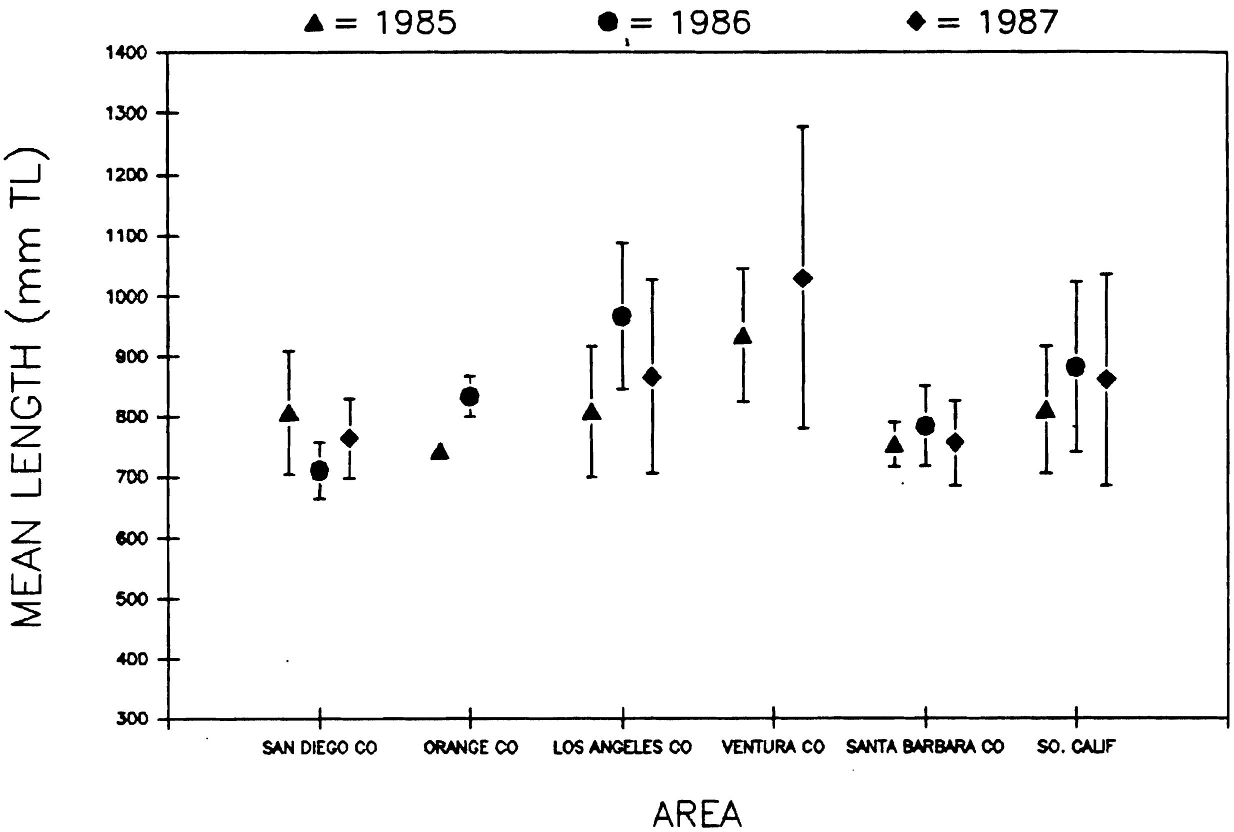



FIGURE 49. Mean lengths and standard deviations of kept white seabass measured on board southern California commercial passenger fishing vessels. Size limit = 711 mm (28 in.).

Counties. The available data were insufficient to perform a size composition analysis by county.

## Management Recommendations

There is a great deal we do not understand about this species. The erratic catch success and continued low numbers of legal-size seabass suggest the population exploited by this fishery is unstable. A continuation of this trend could further depress this fishery if adverse environmental conditions were to combine with fishing mortality.

Monitoring of all fishery segments should be maintained, and a catch moratorium imposed if necessary to prevent further decline of the seabass population. A tag-and-release program on both short and legal-size seabass could further our understanding of its migration patterns and population structure, thereby providing vital parameters necessary for meaningful management.

## Pacific Bonito (Scombridae)

### Catch Estimates

Southern California. According to Collins et al. (1980), Pacific bonito (henceforth referred to as bonito) is a schooling fish with two adjacent stock segments residing principally off Baja California, variable portions of which move northward in late summer and fall, and then return to overwinter in more southerly, warmer waters. They further state that southern California-spawned fish, which are at the northern fringe of the population center, seem to spawn locally for at least their first spawning and may remain in the area for a longer time than those fish from more southerly areas.

The bonito total catches increased by 286% from 1985 to 1987 (Table 26). Bonito's contribution to the southern California catch of combined fishes increased from 3% in 1985 to 11% in 1987 (Tables 26 and 13).

A high percentage of the bonito total catch was kept by anglers: 97% in 1985, 76% in 1986, and 92% in 1987.

Most bonito were caught during the summer and fall months. In each successive year of our survey, they were caught over a broader portion of the year, indicating an increasing availability to the fishery (Figure 50).

On a comparative basis, the bonito total catch in our survey was less variable than that reported during Collins and Crooke's (unpublished manuscript) survey. Their total catch estimates were 168,835 fish ± 18,210 in 1976, 98,764 ± 20,015 in 1977, and 207,105 ± 26,448 in 1978.

TABLE 26. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of Pacific Bonito from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| AREA | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 51,119 | 13 | 186,775 | 10 | 205,942 | 8 | 653 | 35 | 53,359 | 18 | 7,211 | 24 | 51,772 | 13 | 240,135 | 10 | 213,153 | 8 |
| Orange County | 11,207 | 43 | 99,001 | 15 | 72,448 | 29 | 75 | 71 | 31,885 | 23 | 5,693 | 35 | 11,282 | 43 | 130,887 | 15 | 78,141 | 28 |
| Los Angeles County | 53,299 | 19 | 72,074 | 16 | 128,599 | 12 | 3,282 | 35 | 27,324 | 23 | 26,310 | 22 | 56,581 | 19 | 99,398 | 16 | 154,909 | 12 |
| Ventura County | 6,958 | 24 | 5,437 | 49 | 42,555 | 24 | 49 | 69 | 1,356 | 57 | 1,830 | 38 | 9,007 | 24 | 6,793 | 50 | 44,385 | 23 |
| Santa Barbara County | 1,175 | 42 | 3,192 | 61 | 2,832 | 35 | 41 | 69 | 181 | 65 | 212 | 58 | 1,216 | 42 | 3,372 | 60 | 3,044 | 34 |
| Southern California | 123,758 | 10 | 366,479 | 7 | 452,376 | 7 | 4,100 | 29 | 114,106 | 12 | 41,256 | 16 | 127,858 | 11 | 480,585 | 7 | 493,632 | 7 |

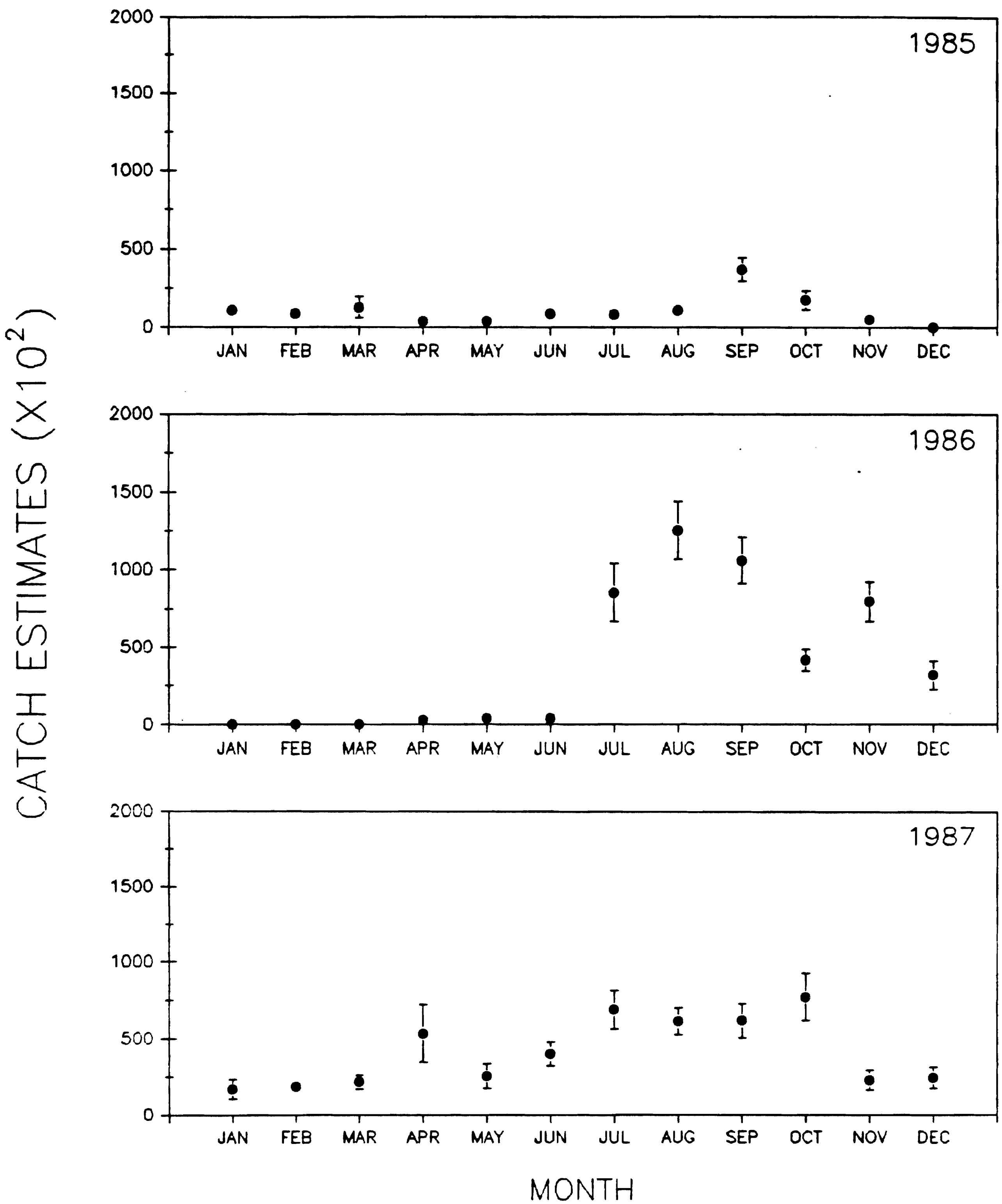



FIGURE 50. Monthly total catch estimates (number of fish) and standard deviations of Pacific bonito from on-board observations of southern California commercial passenger fishing vessels.

Counties. The highest total catch estimates came from San Diego County in both 1986 and 1987, accounting for 50% and 43% of the bonito catches, respectively (Table 26). In 1985, Los Angeles County led the other counties with 44% of the catch (Table 26).

Size Composition

Southern California. Mean lengths of bonito were similar in 1985 and 1987, but substantially lower in 1986: 437 mm (17.2 in.) in 1985, 359 mm (14.1 in.) in 1986, and 446 mm (17.6 in.) in 1987 (Figure 51). Current DFG regulations allow anglers to retain five bonito under the minimum size limit of 610 mm (24 in.). This regulation allows for a high percentage of undersized bonito to be kept, as our survey revealed: 92%, 99%, and 98% in 1985, 1986, and 1987, respectively.

The analysis of length frequencies revealed modal size classes of 400 to 409 mm (15.7 to 16.1 in.), 500 to 509 mm (19.7 to 20.0 in.) and 590 to 640 mm (23.2 to 25.2 in.) in 1985 and 1987; and modal size classes of 330 to 339 mm (12.9 to 13.3 in.) and 490 to 509 mm (19.3 to 20.0 in.) in 1986 (Figure 52). According to Collins et al. (1980), this means that the catch was composed of young-of-the-year and 1-year old fish, with lesser numbers of 2-year-old fish.

The size composition of bonito in our study is similar to that of earlier DFG surveys. In his study, Maxwell (1977) found that the sampled southern California CPFV bonito catch was comprised of fish less than 3 years old, and that a single year class was the major catch component in some years. In their study, Collins and Crooke (unpublished manuscript) found the catch to be dependent on 1-year-old bonito. We found young-of-the-year fish to be more important to the

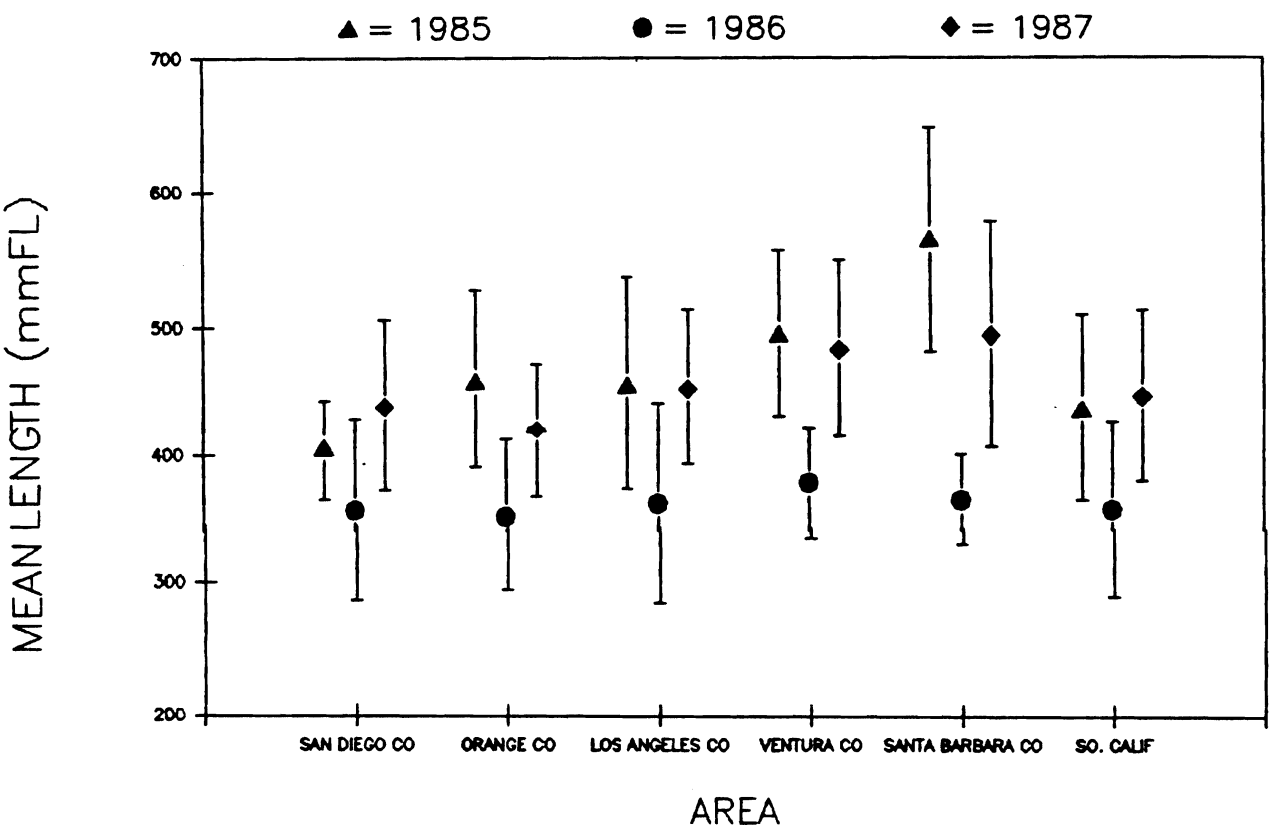



Figure 51. Mean lengths and standard deviations of Pacific bonito measured on board southern California commercial passenger fishing vessels. Size limit = 610 mm (24 in.).

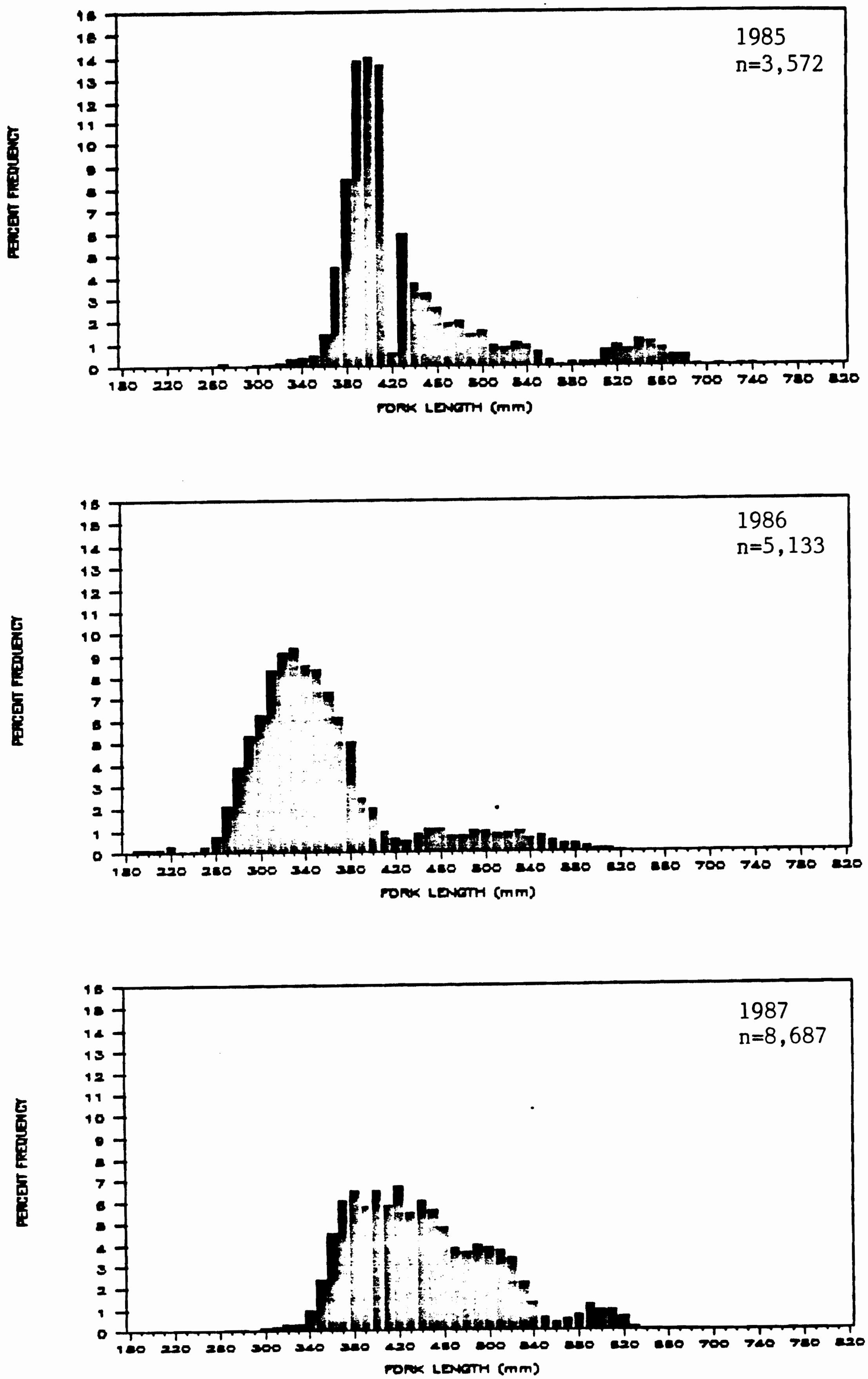



FIGURE 52. Size composition of Pacific bonito from on-board observations of southern California commercial passenger fishing vessels. Size limit = 610 mm (24 in.).

catch than older fish. Based on a 3-year mean, the mean length of bonito declined approximately 36 mm (1.4 in.) between our survey and that of Collins and Crooke (unpublished manuscript), because of the preponderance of younger fish during our survey.

Counties. Our data show a cline of increasing mean length from San Diego County to Santa Barbara County (Figures 51, 53 through 57). In 1985 and 1987, the largest bonito were landed in Ventura and Santa Barbara counties. In 1986, the largest bonito were landed in San Diego, Orange, and Los Angeles counties.

Management Recommendations

The current size regulation with the allowed retention of five fish under the size limit for sport-caught bonito was established in 1982 in conjunction with the bonito commercial regulation, to manage the take of this species equitably between the two industries (Rob Collins, California Department of Fish and Game, Marine Resources Division, pers. comm.). We have no evidence yet that the regulation, as it applies to sport fish, has had an impact on the bonito stock. This is probably due, in large part, to the migratory nature of the species. The catch does fluctuate from year to year.

Adherence to the bonito regulation by CPFV anglers is good in some areas, not quite as good in other areas. Although we have no firm statistical figures, we know from on-board observations that in certain areas of southern California, CPFV anglers will retain over-limits of undersized bonito and give them to anglers who do not have their limits.

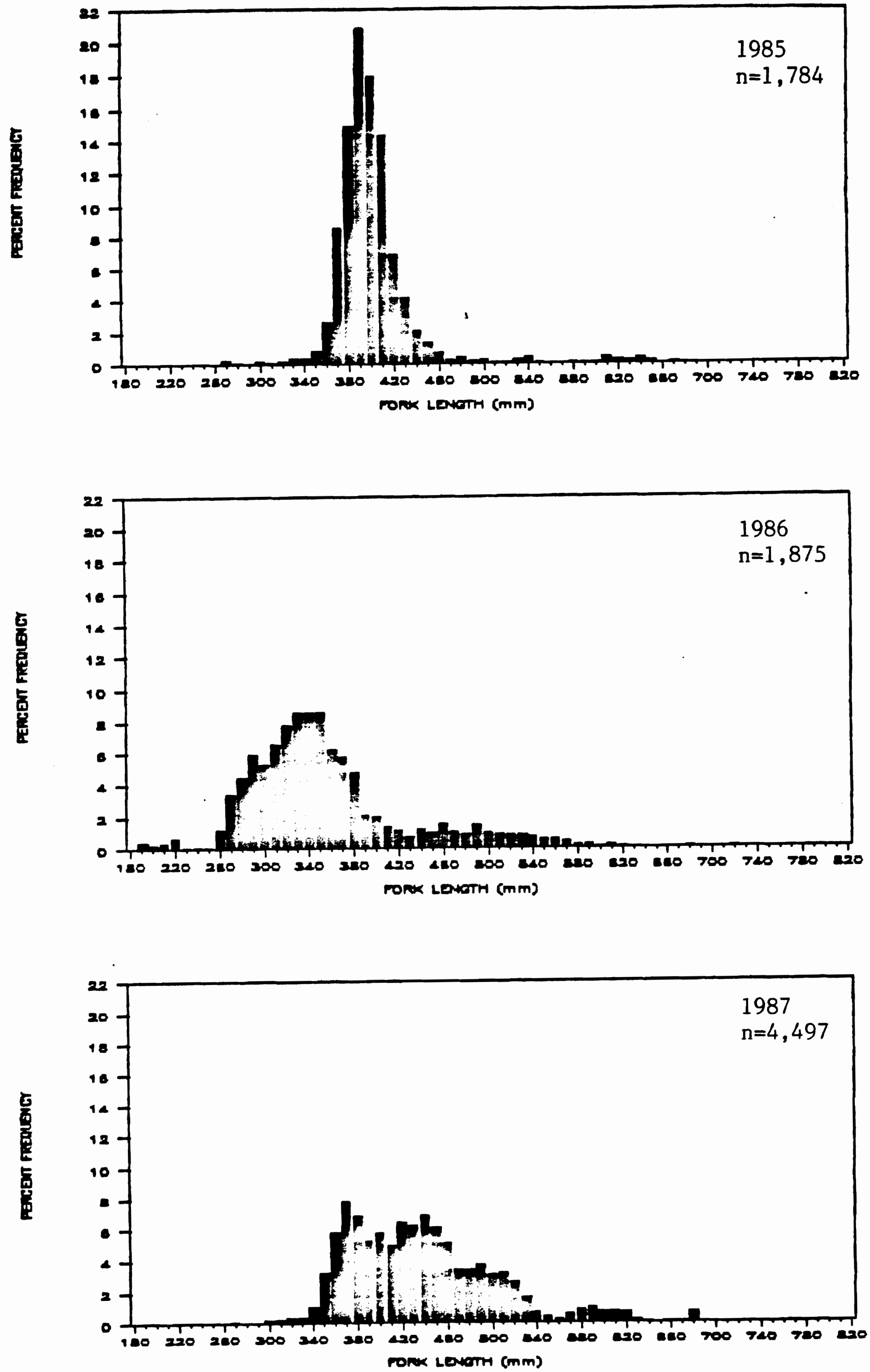



FIGURE 53. Size composition of Pacific bonito from on-board observations of San Diego County commercial passenger fishing vessels. Size limit = 610 mm (24 in.).

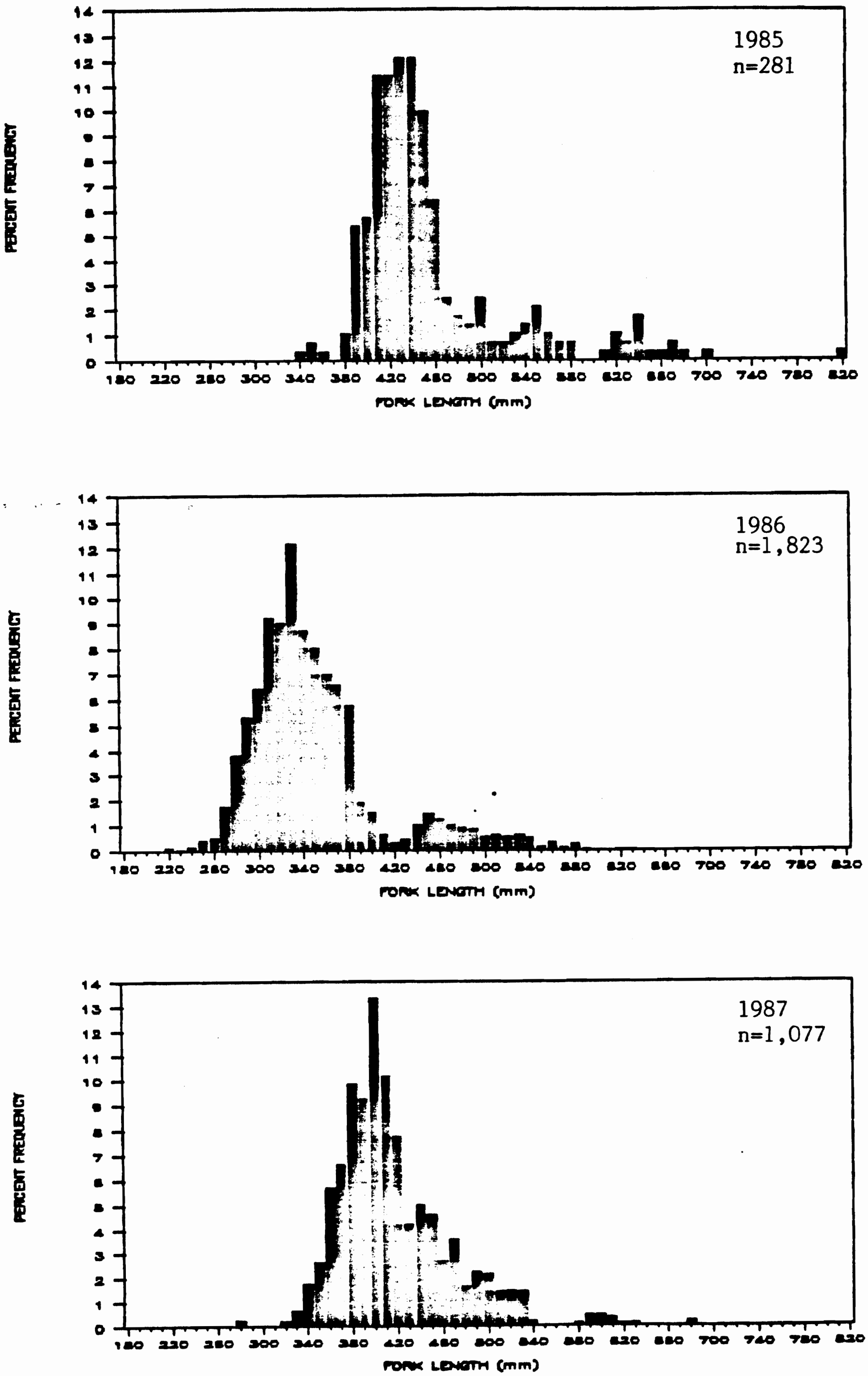



FIGURE 54. Size composition of Pacific bonito from on-board observations of Orange County commercial passenger fishing vessels. Size limit = 610 mm (24 in.).

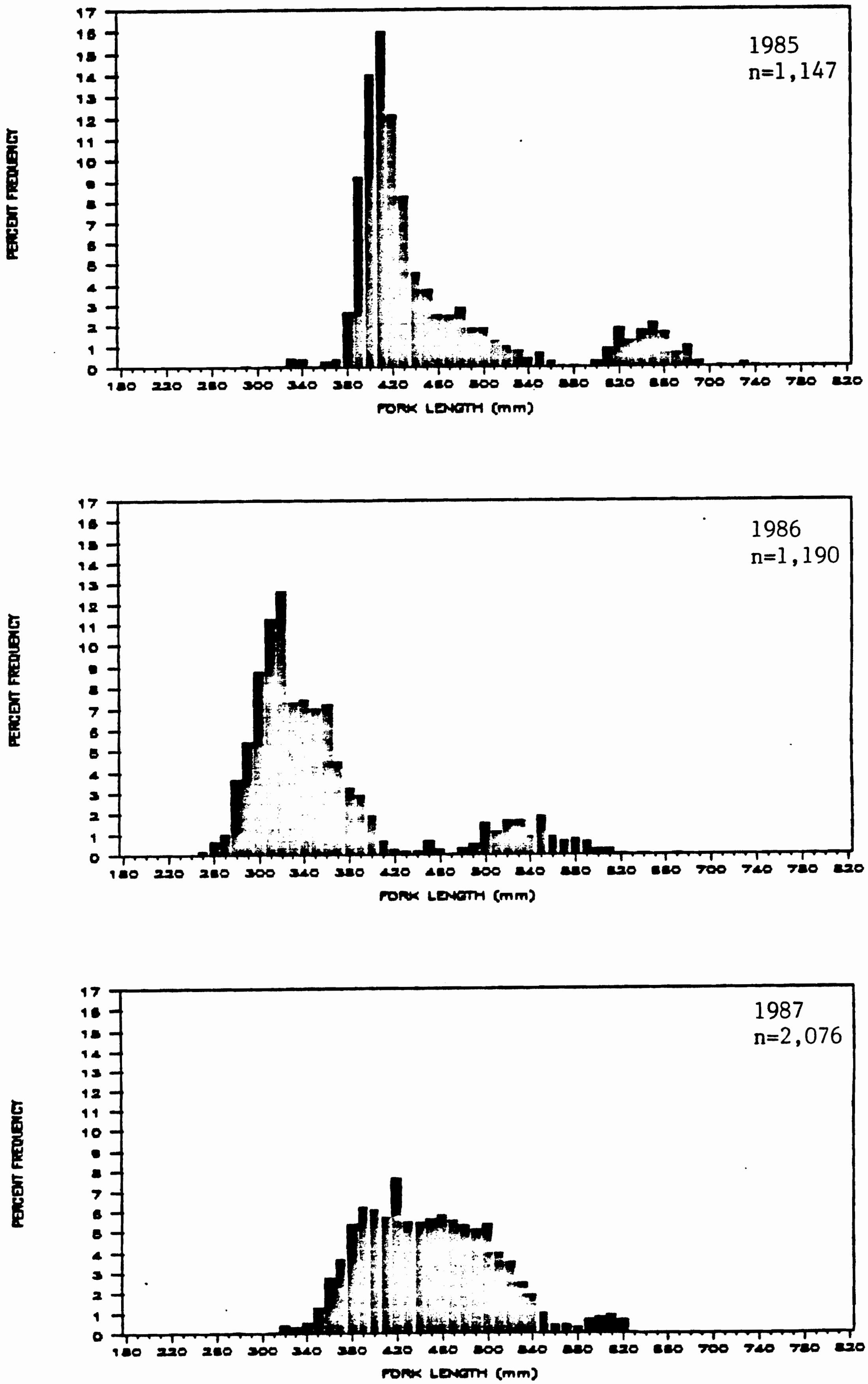



FIGURE 55. Size composition of Pacific bonito from on-board observations of Los Angeles County commercial passenger fishing vessels. Size limit = 610 mm (24 in.).

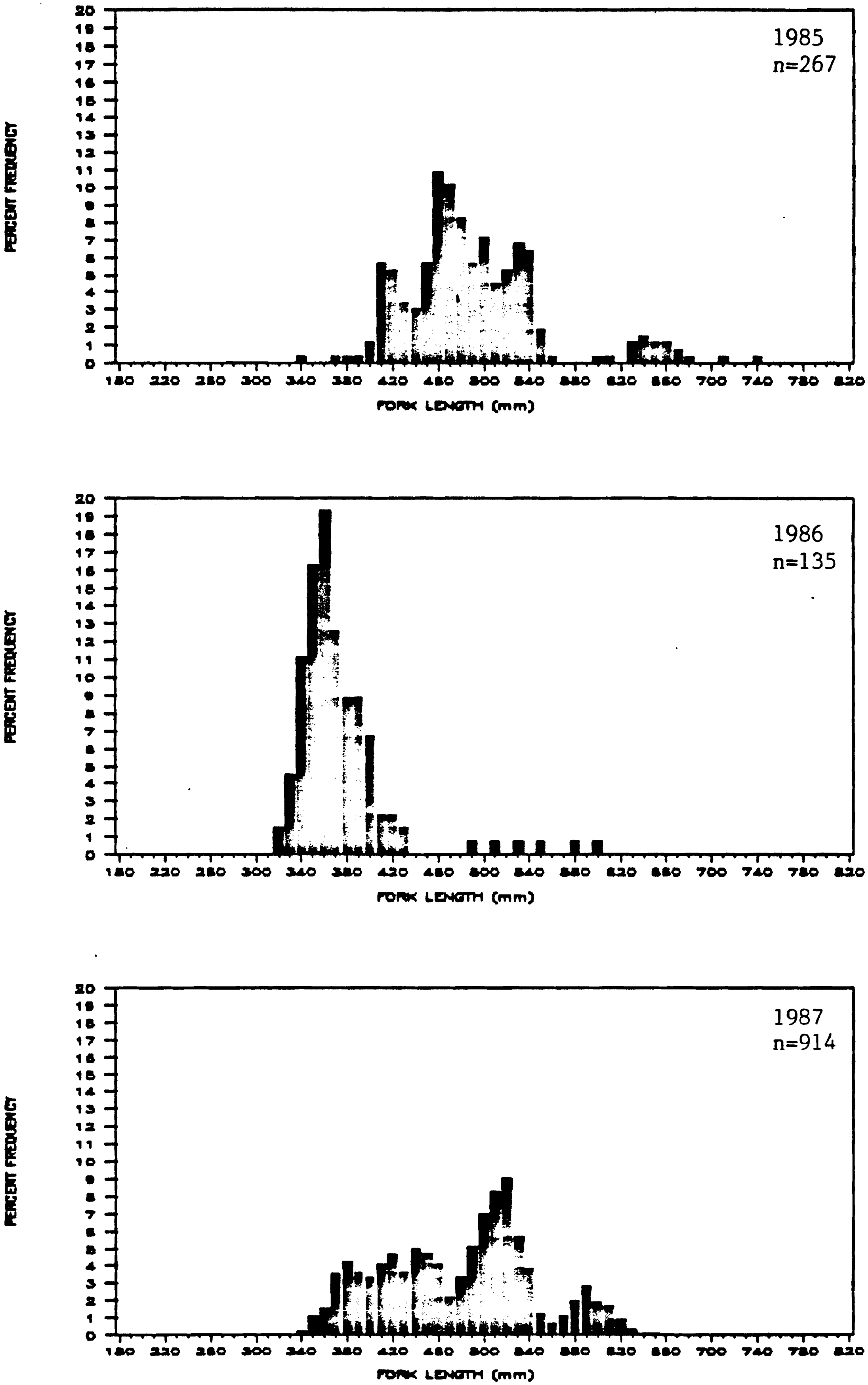



FIGURE 56. Size composition of Pacific bonito from on-board observations of Ventura County commercial passenger fishing vessels. Size limit = 610 mm (24 in.).

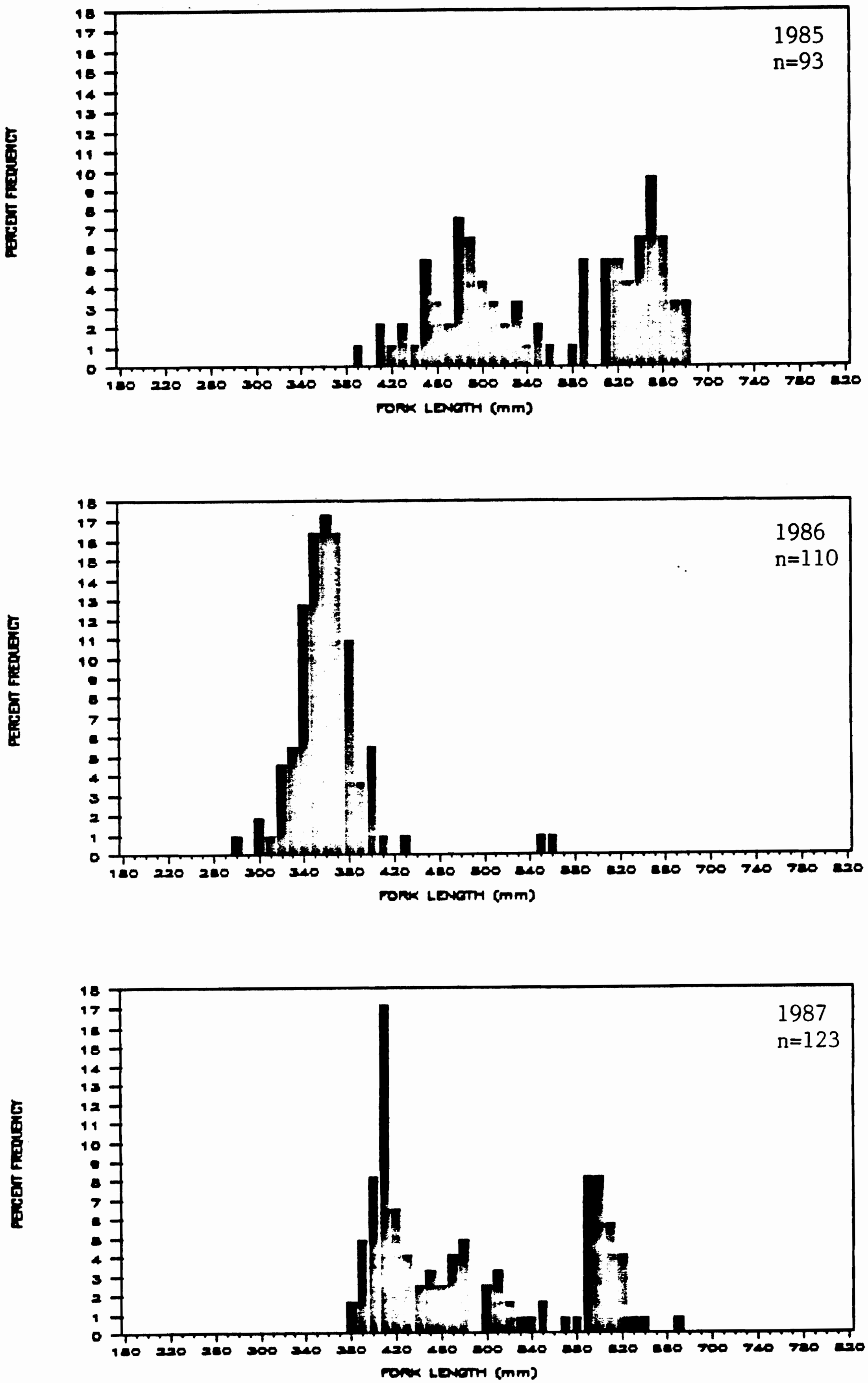



FIGURE 57. Size composition of Pacific bonito from on-board observations of Santa Barbara County commercial passenger fishing vessels. Size limit = 610 mm (24 in.).

Based on historical evidence, other studies, and our findings, we recommend that the current management regime be retained in order to further evaluate the effects of the bonito regulation.

## Pacific Mackerel (Scombridae)

### Catch Estimates

Southern California. Pacific mackerel (henceforth referred to as mackerel) is an often maligned surface-schooling fish, whose only use to the serious sport angler is as bait to attract more desirable species. Nonetheless, based on our IRI, mackerel ranked first in 1985 and 1987, and second in 1986 (Table 12). Mackerel would rank much lower if our IRI took desirability into account. However, there was a declining trend in its total catch estimates of 16% from 1985 to 1987 (Table 27). There was a corresponding decrease in its contribution to the total catch of combined fishes from 25% in 1985 to 19% in 1987 (Tables 13 and 27).

Although mackerel have no minimum size limit, some 40% of the catch is released after capture (Table 27). Most CPFV's avoid areas of known mackerel concentrations, unless small individuals are needed for bait, or more desirable species are not readily available at the time. Mackerel are caught year-round, but peak catches occur from May through September (Figure 58).

On a comparative basis, the mackerel catches from 1985 through 1987 were considerably more stable than those reported by Collins and Crooke (unpublished manuscript). Their total catch estimates were 43,498 fish $\pm$ 7,571 in 1976, 399,814 $\pm$ 39,359 in 1977, and 823,241 $\pm$ 64,330 in 1978. Their reported catch increase also corresponded to an increase in mackerel's contribution to the total catch of combined fishes, from 2% in 1976 to 20% in 1978. This rapid catch growth was

TABLE 27. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of Pacific Mackerel from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| AREA | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 316,170 | 17 | 207,208 | 11 | 267,866 | 8 | 44,411 | 12 | 47,062 | 14 | 89,829 | 10 | 360,581 | 16 | 254,270 | 10 | 357,695 | 8 |
| Orange County | 79,363 | 12 | 97,748 | 13 | 67,680 | 18 | 74,279 | 14 | 100,729 | 18 | 82,595 | 18 | 153,642 | 11 | 198,477 | 14 | 150,274 | 16 |
| Los Angeles County | 140,111 | 9 | 172,823 | 10 | 114,663 | 10 | 222,393 | 21 | 125,593 | 12 | 117,376 | 12 | 362,504 | 15 | 298,416 | 10 | 232,038 | 9 |
| Ventura County | 45,920 | 18 | 34,714 | 15 | 31,720 | 25 | 25,808 | 24 | 37,961 | 16 | 25,858 | 18 | 71,727 | 17 | 72,675 | 14 | 57,578 | 19 |
| Santa Barbara County | 7,109 | 23 | 16,641 | 18 | 4,852 | 26 | 6,925 | 26 | 8,120 | 38 | 7,772 | 17 | 14,034 | 22 | 24,760 | 20 | 12,624 | 18 |
| Southern California | 588,672 | 10 | 529,134 | 6 | 486,780 | 6 | 373,816 | 13 | 319,464 | 8 | 323,429 | 7 | 962,488 | 8 | 848,597 | 6 | 810,209 | 5 |

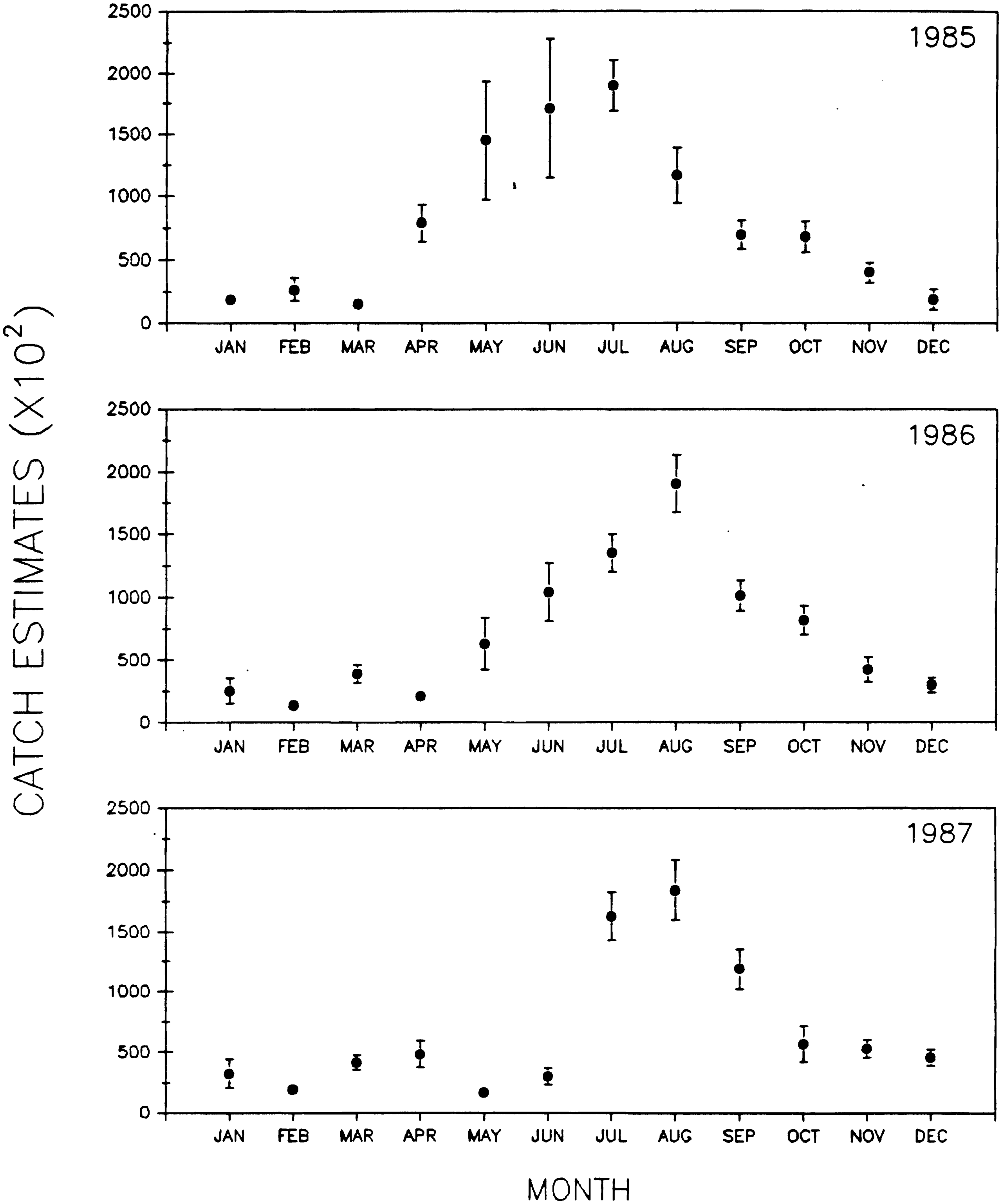



FIGURE 58. Monthly total catch estimates (number of fish) and standard deviations of Pacific mackerel from on-board observations of southern California commercial passenger fishing vessels.

expected because the early 1970's was a resurgent period for the mackerel resource (Klingbeil 1977).

Counties. According to our IRI, mackerel ranked first or second in every county from 1985 through 1987 (Tables 14 through 18). Los Angeles County had the highest estimated catches in both 1985 and 1986, accounting for 38% and 35% of the mackerel catches, respectively (Table 27). San Diego County led the other counties in 1987 with 44% (Table 27). In 1987, there was a substantial mackerel catch decline, ranging from 21% to 49%, in all counties except San Diego (Table 27). San Diego County anglers kept a higher proportion of the mackerel catch than those of the other counties during this survey, while both Orange and Los Angeles county anglers returned a higher proportion of the catch than did anglers in the other counties (Table 27).

Size Composition

Southern California. There was little variation in mean lengths of mackerel during the survey: 329 mm (12.9 in.) in 1985, 332 mm (13.1 in.) in 1986, and 322 mm (12.7 in.) in 1987 (Figure 59). Size composition of kept and released fish were similar, indicating no angler selection by size (Figures 60 and 61).

The length frequency analysis revealed a modal size class of 320-329 mm (12.6-12.9 in.) in 1985, bi-modal size classes of 280-289 mm (11.0-11.4 in.) and 330-339 mm (12.9-13.3 in.) in 1986, and tri-modal size classes of 300-309 mm (11.8-12.2 in.), 330-339 mm (12.9-13.3 in.), and 350-359 mm (13.8-14.1 in.) in 1987 (Figure 62). According to Klingbeil (1977), this would indicate a mackerel catch composed of mainly 2- to 4-year-old fish, with some younger and older fish mixed

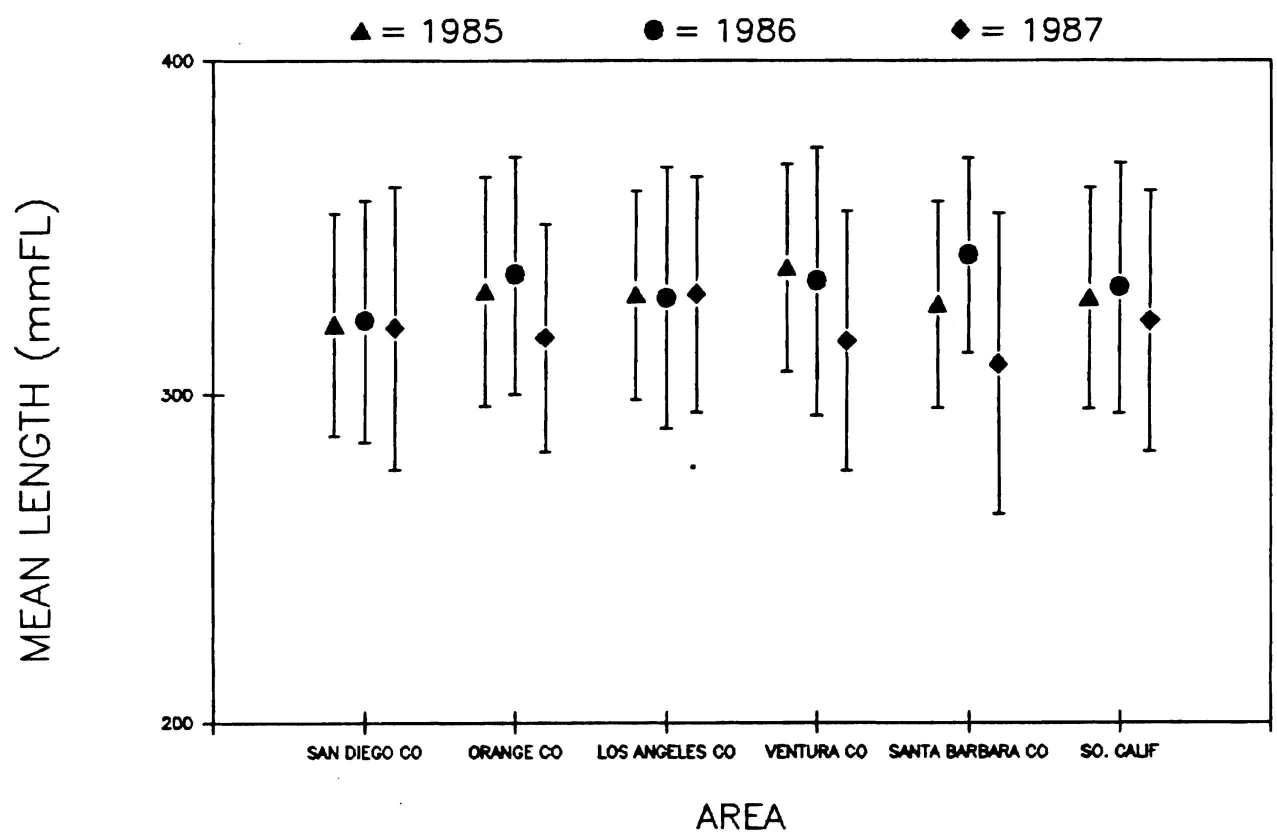
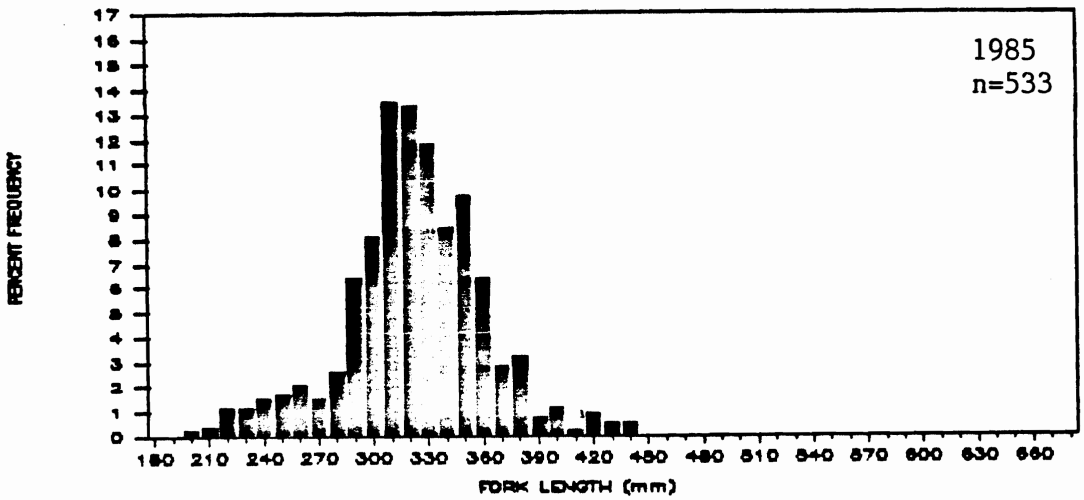
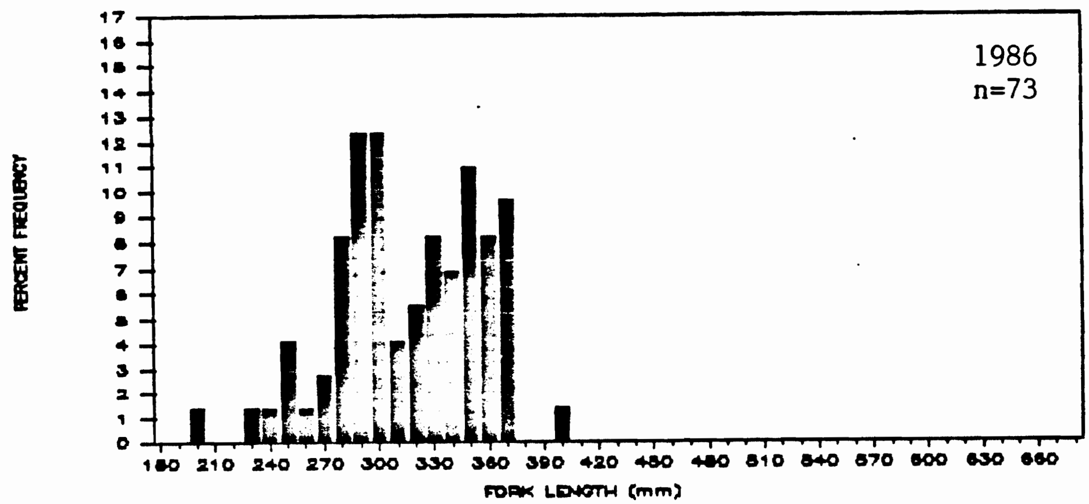



FIGURE 59. Mean lengths and standard deviations of Pacific mackerel measured on board southern California commercial passenger fishing vessels.



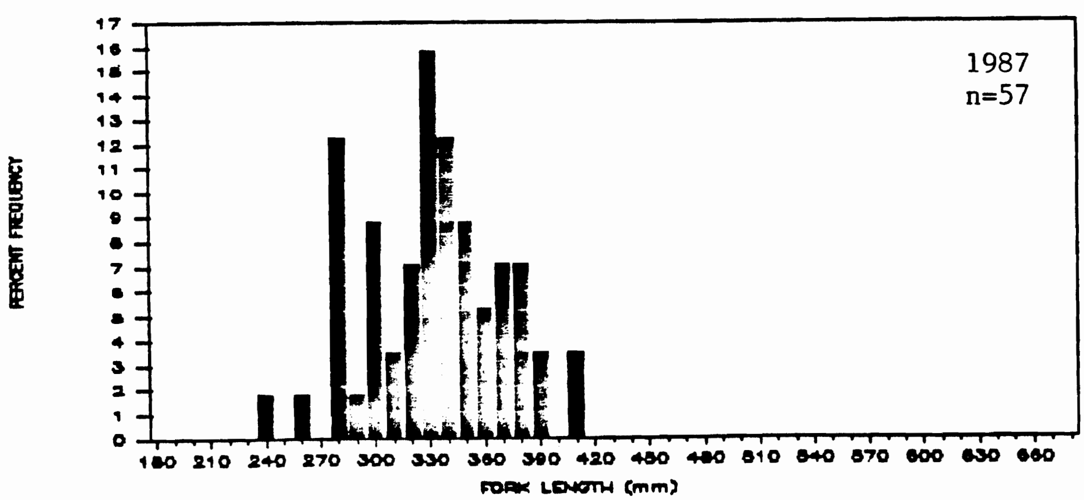




FIGURE 60. Size composition of released Pacific mackerel from on-board observations of southern California commercial passenger fishing vessels.

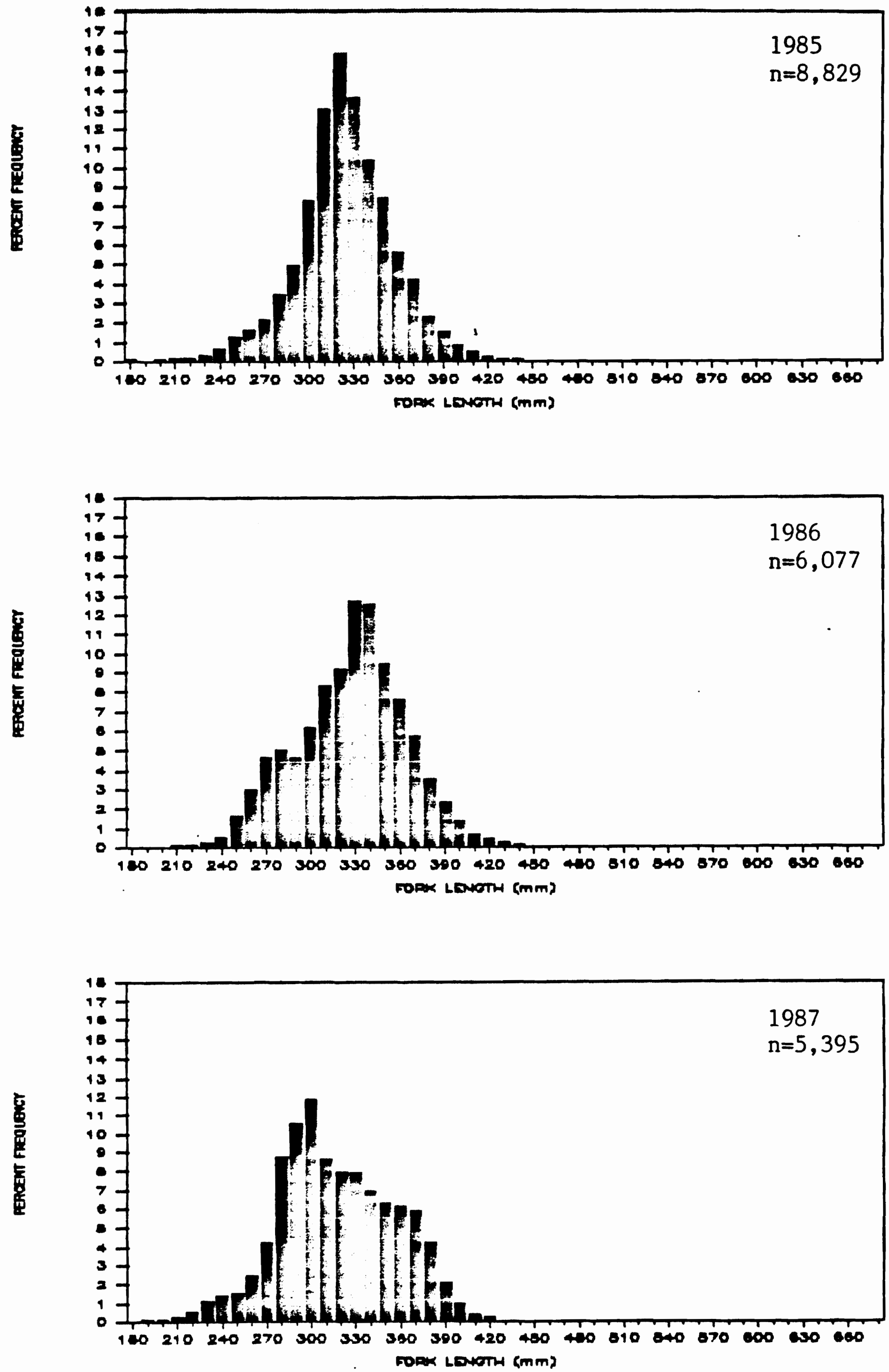



FIGURE 61. Size composition of kept Pacific mackerel from on-board observations of southern California commercial passenger fishing vessels.

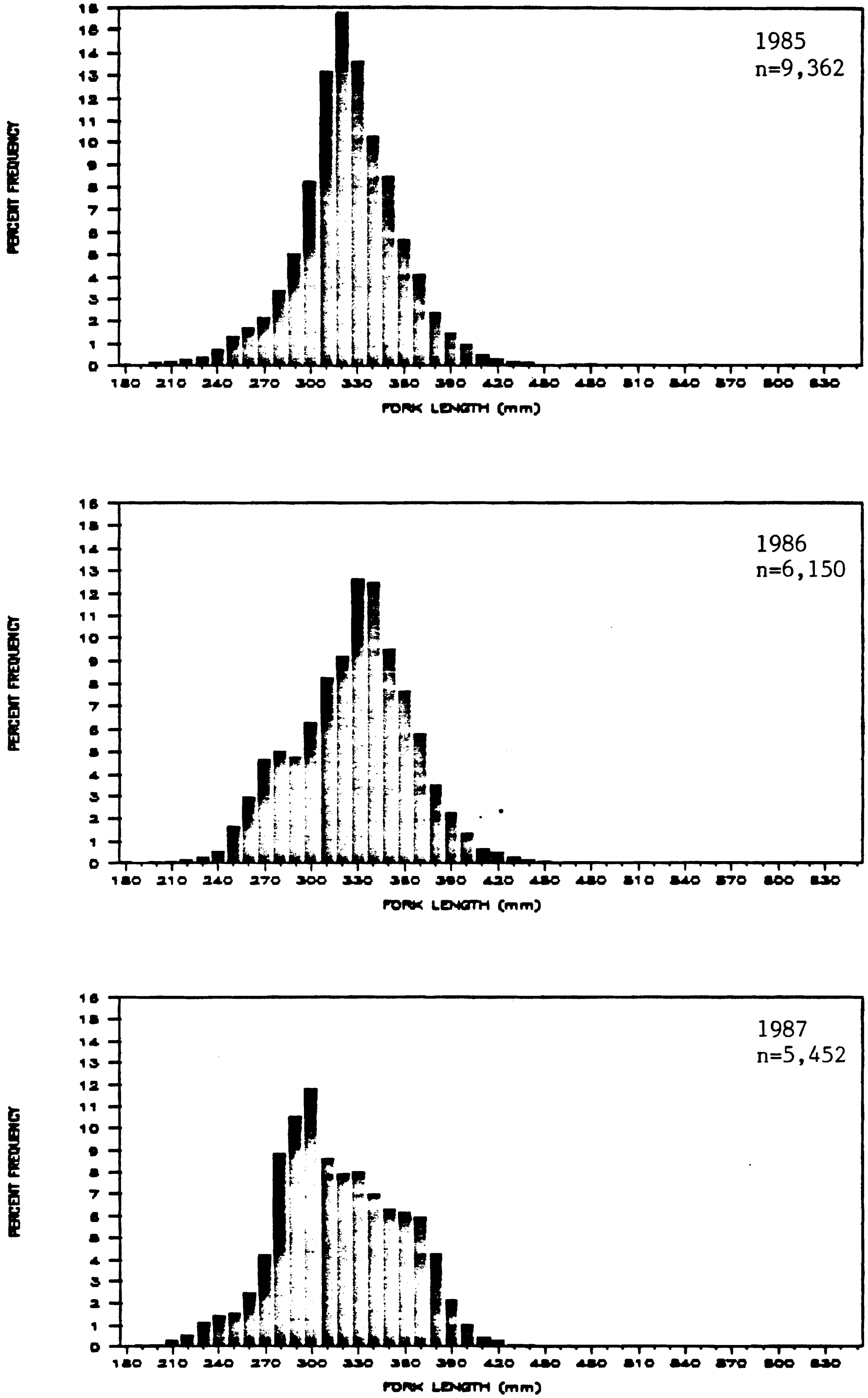



FIGURE 62. Size composition of Pacific mackerel from on-board observations of southern California commercial passenger fishing vessels.

in. From their survey, Collins and Crooke (unpublished manuscript) concluded that catches of mackerel are dependent on the strength of dominant year classes.

Counties. Size composition variability between and within counties was minimal, reflecting the uniform nature of the mackerel population being fished (Figures 63 through 67). San Diego and Los Angeles counties showed the least variability in size composition during this survey. Their annual mean lengths and size composition were nearly identical (Figures 63 and 65). Santa Barbara County showed the most variability in size composition (Figure 67). In 1986 there was a slight cline toward larger fish, from San Diego County to Santa Barbara County, but that was reversed in 1987 (Figures 63 through 67).

Management Recommendations

No change from the present management regime is indicated at this time. Angler utilization of kept mackerel could be enhanced by an education effort aimed at proper shipboard care and preparation of this fish for cooking, to ensure it ends up on the table rather than in the rose garden.

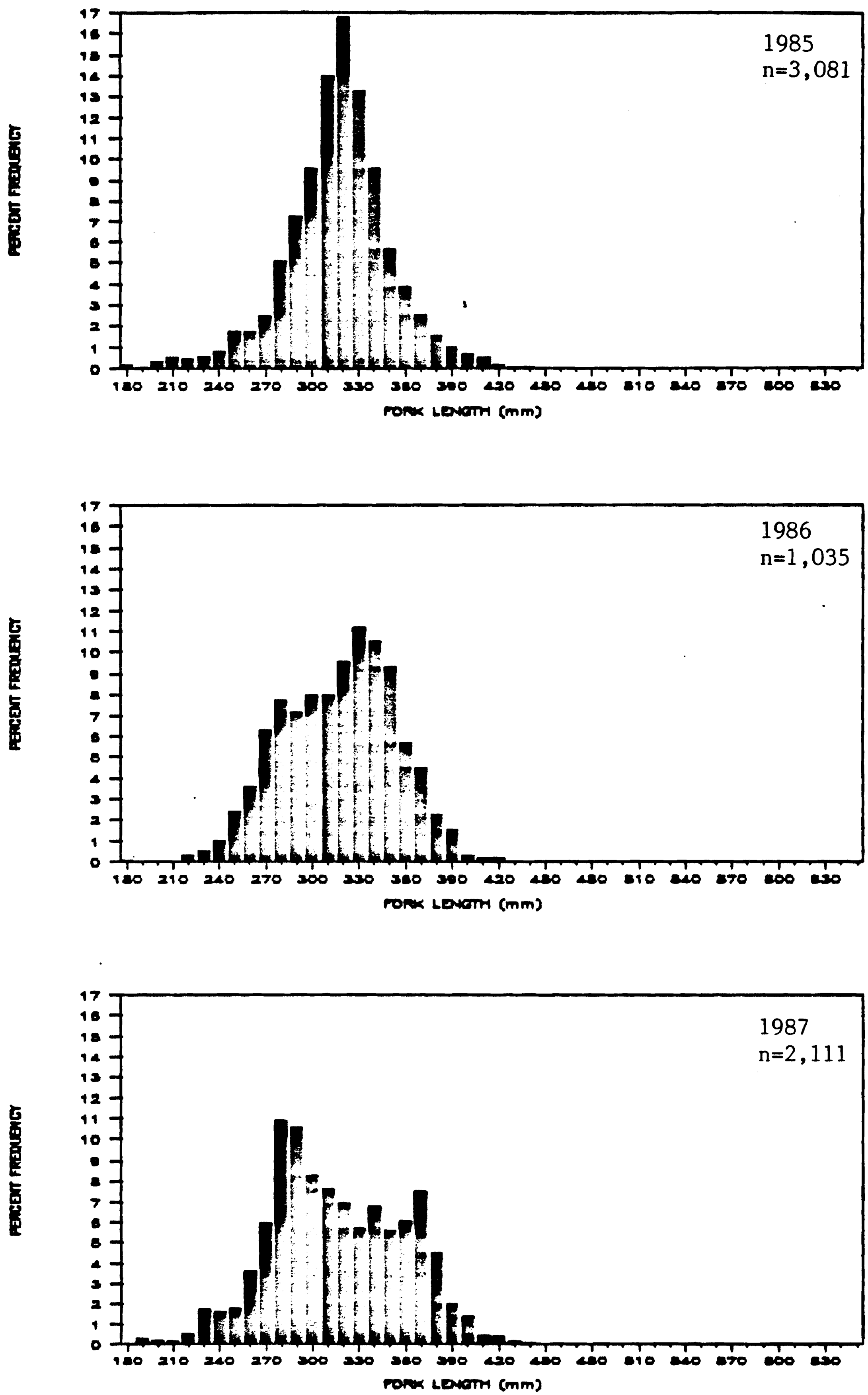



FIGURE 63. Size composition of Pacific mackerel from on-board observations of San Diego County commercial passenger fishing vessels.

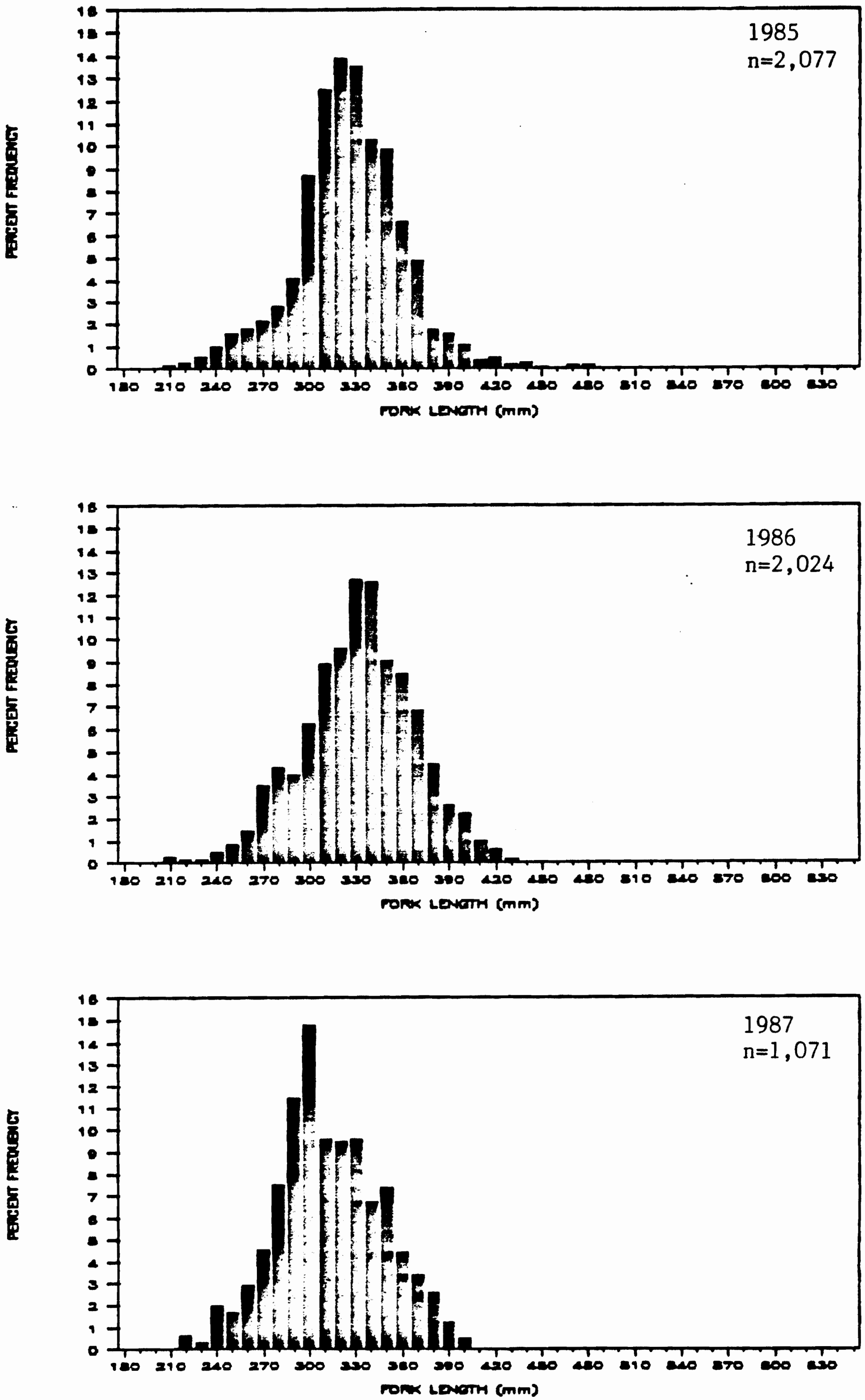



FIGURE 64. Size composition of Pacific mackerel from on-board observations of Orange County commercial passenger fishing vessels.

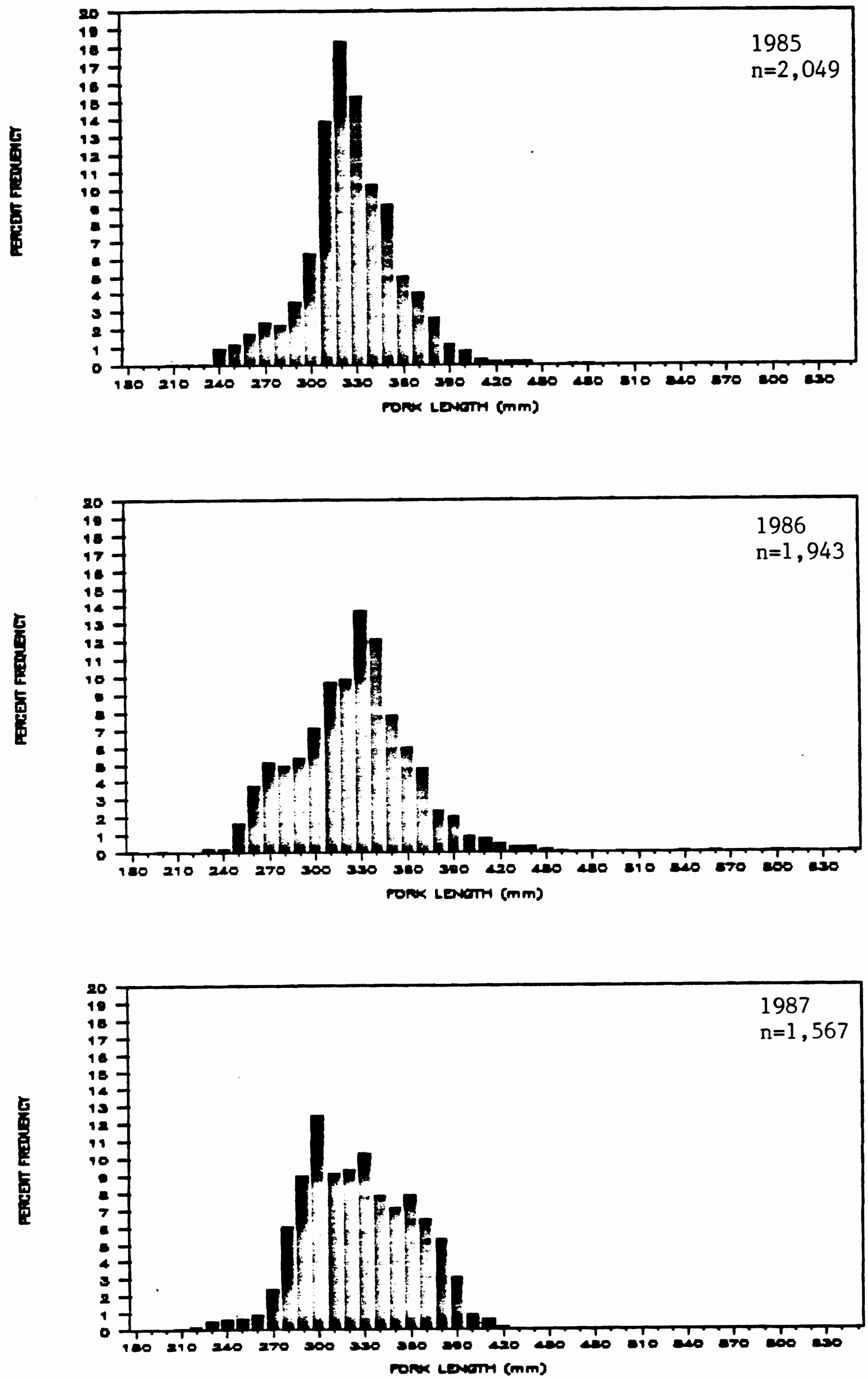



FIGURE 65. Size composition of Pacific mackerel from on-board observations of Los Angeles County commercial passenger fishing vessels.

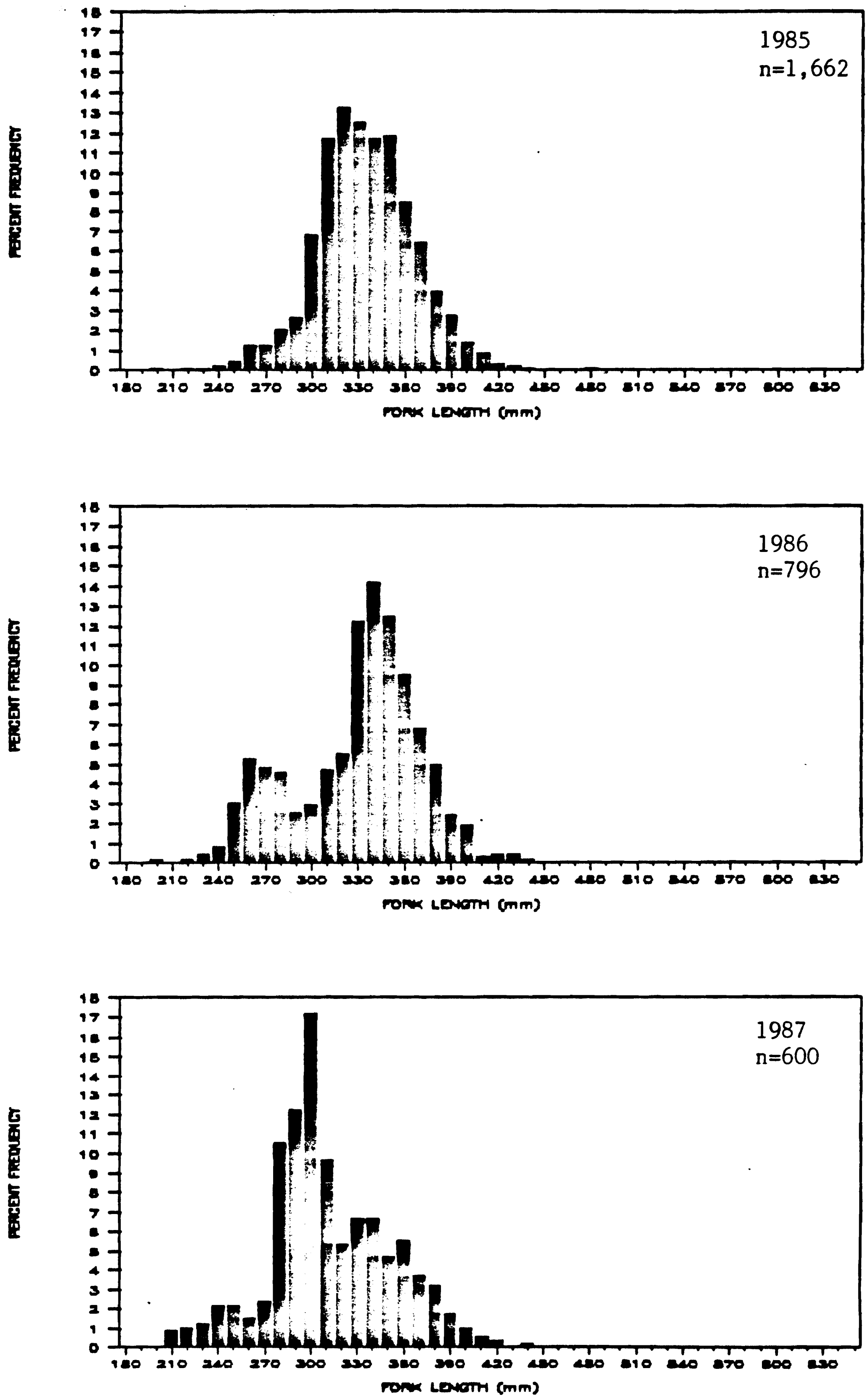



FIGURE 66. Size composition of Pacific mackerel from on-board observations of Ventura County commercial passenger fishing vessels.

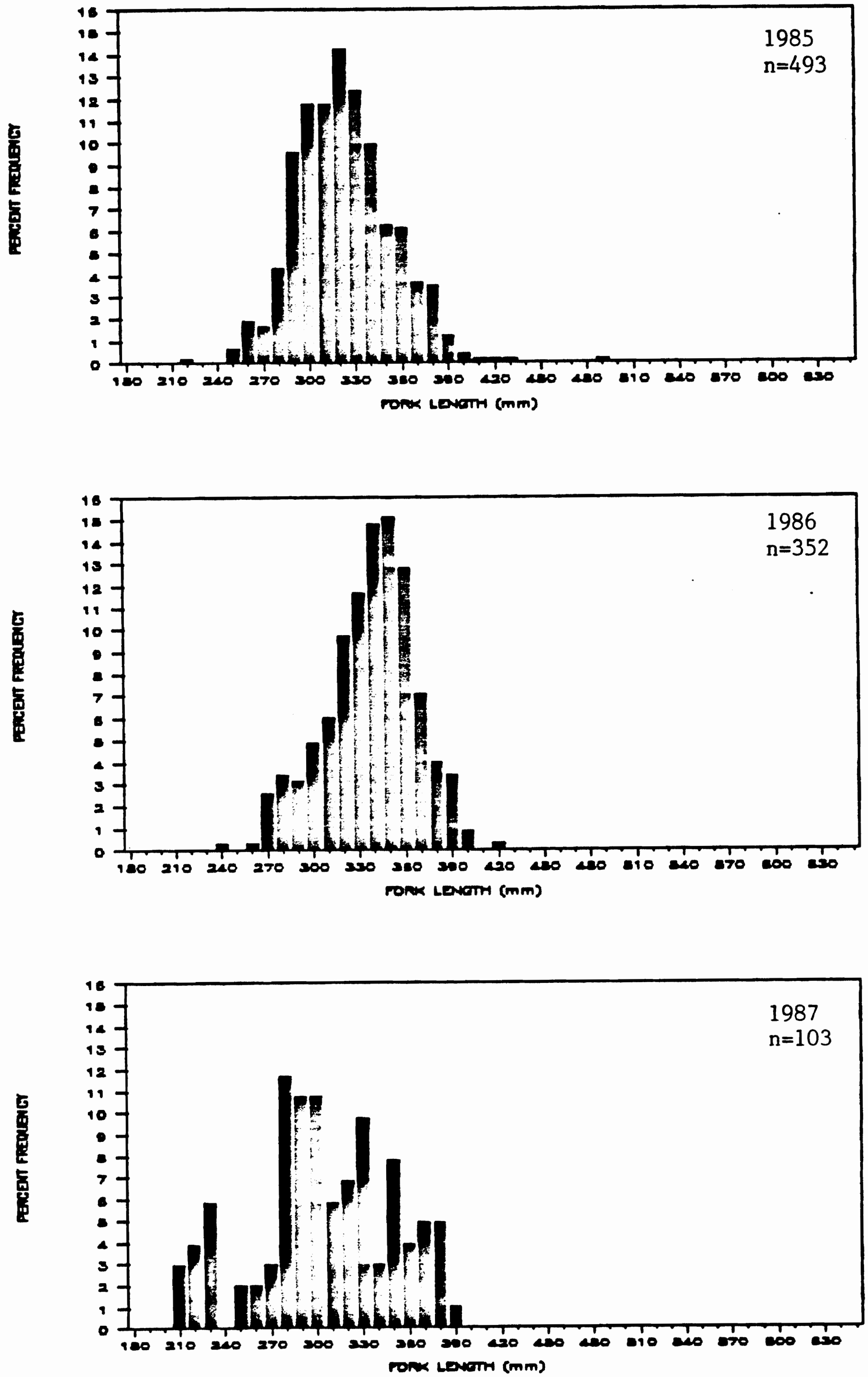



FIGURE 67. Size composition of Pacific mackerel from on-board observations of Santa Barbara County commercial passenger fishing vessels.

## Sculpin (Scorpaenidae)

### Catch Estimates

Southern California. Sculpin or spotted scorpionfish is a shallow-water, bottom-dwelling species, commonly caught in nearshore waters in depths of 30 m (100 ft) or less (Eschmeyer, et al. 1983). Total catch estimates ranged from 58,758 fish ± 5,288 in 1985 to 96,215 ± 14,432 in 1987 (Table 28). Collins and Crooke (unpublished manuscript) had sculpin total catch estimates ranging from 32,583 ± 7,751 in 1976 to 69,966 ± 14,954 in 1978.

The total catch distribution by month showed considerable variation over the 3 years surveyed (Figure 68). In 1985 the total catch did not fluctuate significantly from month to month and a catch peak of 9,200 fish occurred in January. In 1986 the January peak was present, but a much larger catch peak occurred from July through September that reached 12,600 fish. The sculpin total catch pattern in 1987 differed considerable from that of the previous 2 years. A January catch peak of 11,499 was again present, accompanied by major peaks in March (15,407), June (15,027), and November (10,634). Based on the April through August spawning period reported by Frey (1971), we expected to see an increase in the CPFV sculpin total catch during that time period. The fact that it did not occur in 1985 indicates that additional factors, such as CPFV targeting of other species and fishing sites, or environmental conditions, may influence the sculpin catch.

Counties. The three southernmost counties of San Diego, Orange and Los Angeles contributed the major part of the estimated sculpin

TABLE 28. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of Sculpin from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| AREA | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 13,579 | 14 | 20,354 | 30 | 19,143 | 16 | 2,664 | 15 | 5,004 | 27 | 4,972 | 15 | 16,243 | 12 | 25,359 | 26 | 24,115 | 14 |
| Orange County | 7,442 | 23 | 6,645 | 13 | 2,101 | 16 | 4,087 | 25 | 9,297 | 16 | 5,804 | 21 | 11,529 | 19 | 15,941 | 12 | 7,905 | 17 |
| Los Angeles County | 25,093 | 16 | 16,679 | 13 | 44,483 | 32 | 3,184 | 17 | 16,220 | 10 | 11,862 | 11 | 28,278 | 14 | 32,899 | 9 | 56,345 | 25 |
| Ventura County | 1,825 | 43 | 3,688 | 21 | 5,473 | 25 | 664 | 24 | 2,886 | 19 | 1,527 | 28 | 2,489 | 34 | 6,573 | 16 | 7,000 | 23 |
| Santa Barbara County | 170 | 52 | 206 | 36 | 209 | 47 | 50 | 76 | 542 | 46 | 642 | 24 | 220 | 46 | 748 | 35 | 851 | 21 |
| Southern California | 48,108 | 10 | 47,572 | 14 | 71,408 | 20 | 10,650 | 12 | 33,948 | 8 | 24,807 | 8 | 58,758 | 9 | 81,520 | 9 | 96,215 | 15 |

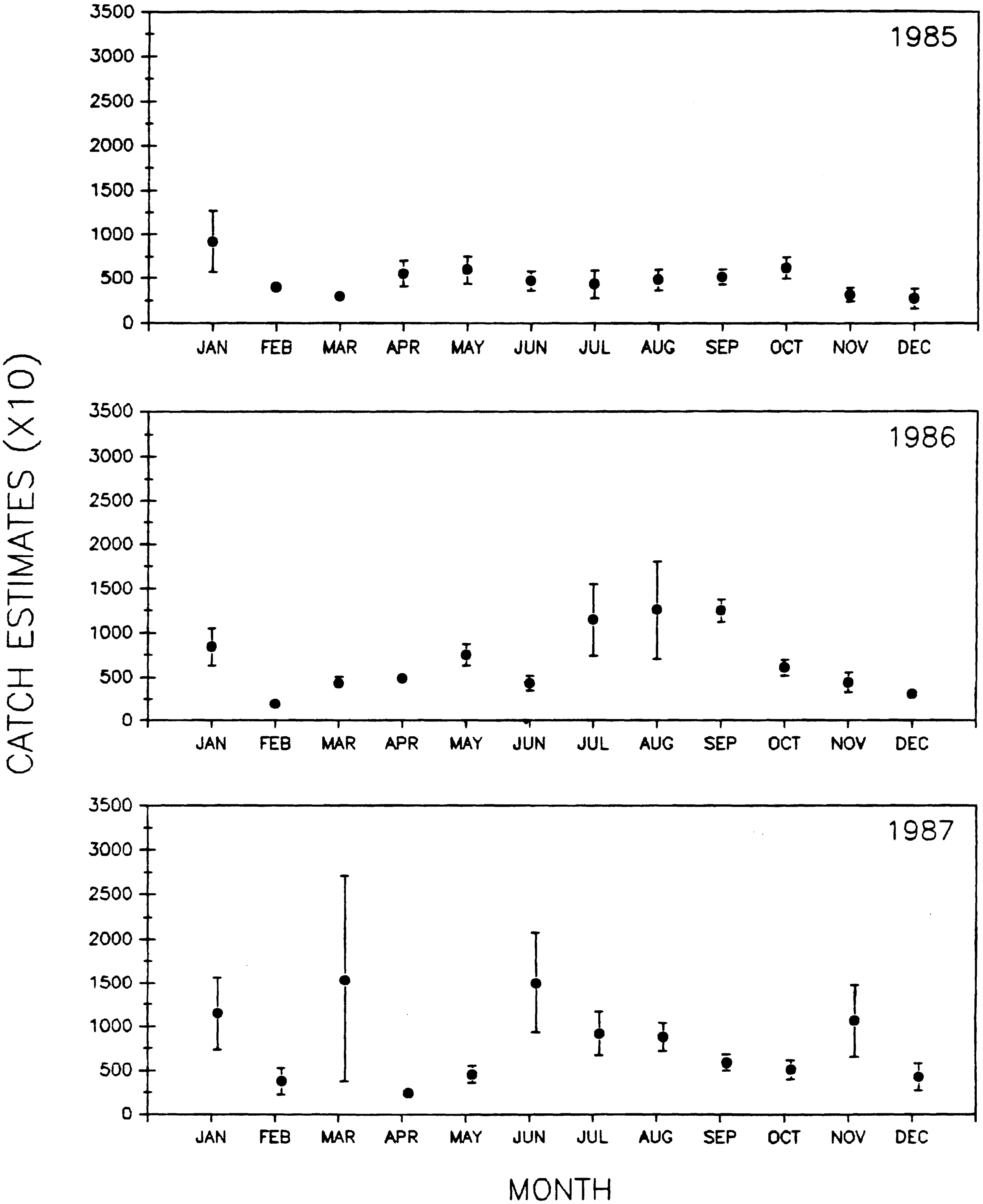



FIGURE 68. Monthly total catch estimates (number of fish) and standard deviations of sculpin from on-board observations of southern California commercial passenger fishing vessels.

total catch. At least 90% of the sculpin total catch came from those counties in each of the 3 years. Los Angeles County led all counties with sculpin total catches ranging from 40% in 1986 to 58% in 1987. The geographic distribution of sculpin in the catch may have been related to the presence of large, nearshore sculpin spawning areas within close proximity to Los Angeles and San Diego CPFV landings. The Coronado Island site, fished by San Diego CPFV's, and Dago Bank, fished by Los Angeles County CPFV's, are two sites which have been identified as important sculpin spawning areas (Love et al. 1987).

Size Composition

Southern California. The sculpin length frequency modes for each year were very close to the distribution mean (Figure 69). The mean lengths (Figure 70), 270 to 284 mm (10.6 to 11.2 in.), were within the size range of 6-year old sculpin (Love, et al. 1987). In each of the 3 years, only a small portion of the distribution consisted of sexually immature sculpin, less than 220 mm (8.7 in.)

Counties. The sculpin length frequency distributions for all counties except Santa Barbara (there was insufficient length data from Santa Barbara County for meaningful analysis) were similar in several respects (Figures 71 through 74). In each case, there was a progressive, year by year shifting of the distribution towards younger age classes. This was reflected, except in San Diego County, by the annual decline in the mean lengths of each county's sculpin length frequency sample (Figure 70).

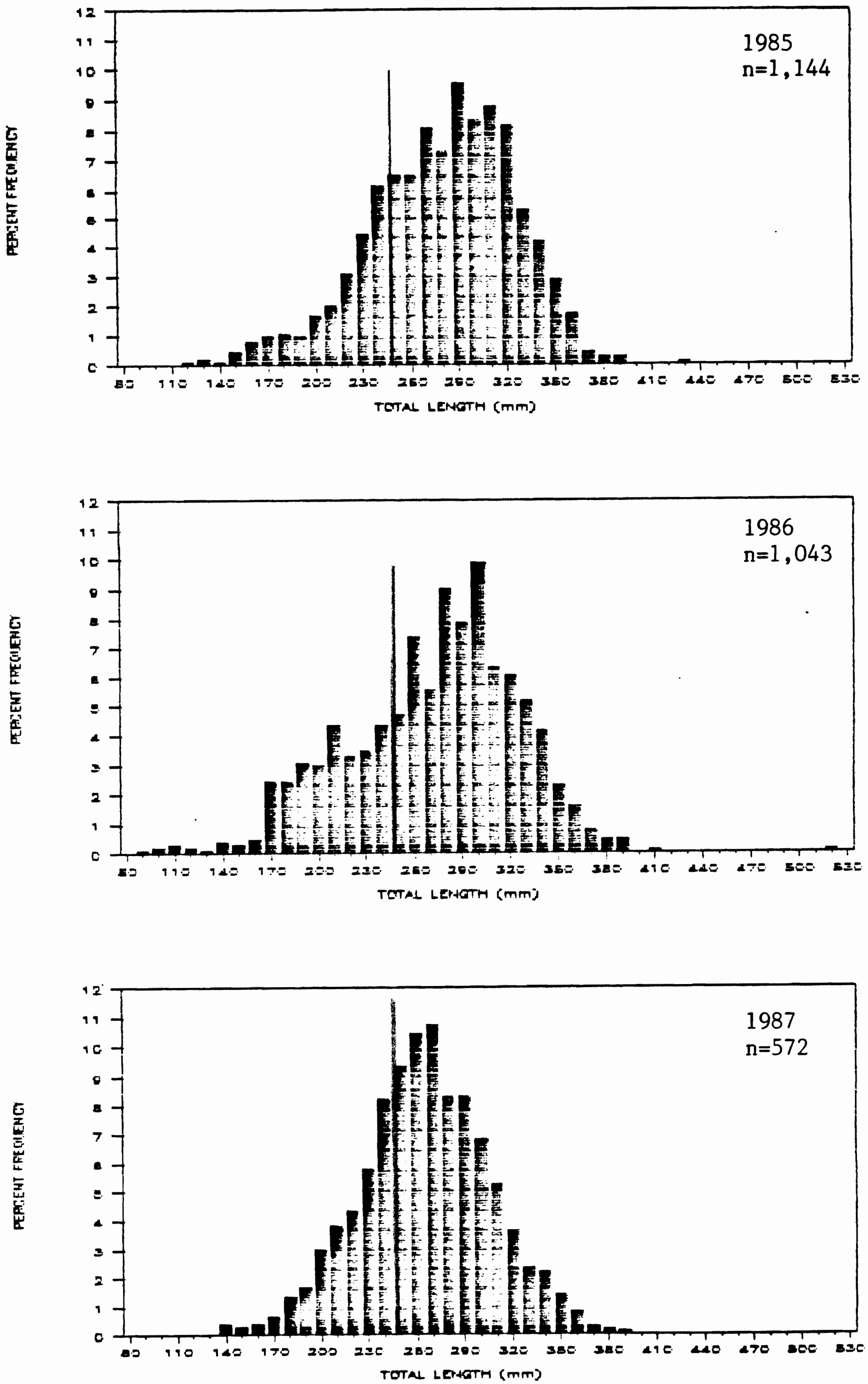



FIGURE 69. Size composition of sculpin from on-board observations of southern California commercial passenger fishing vessels.

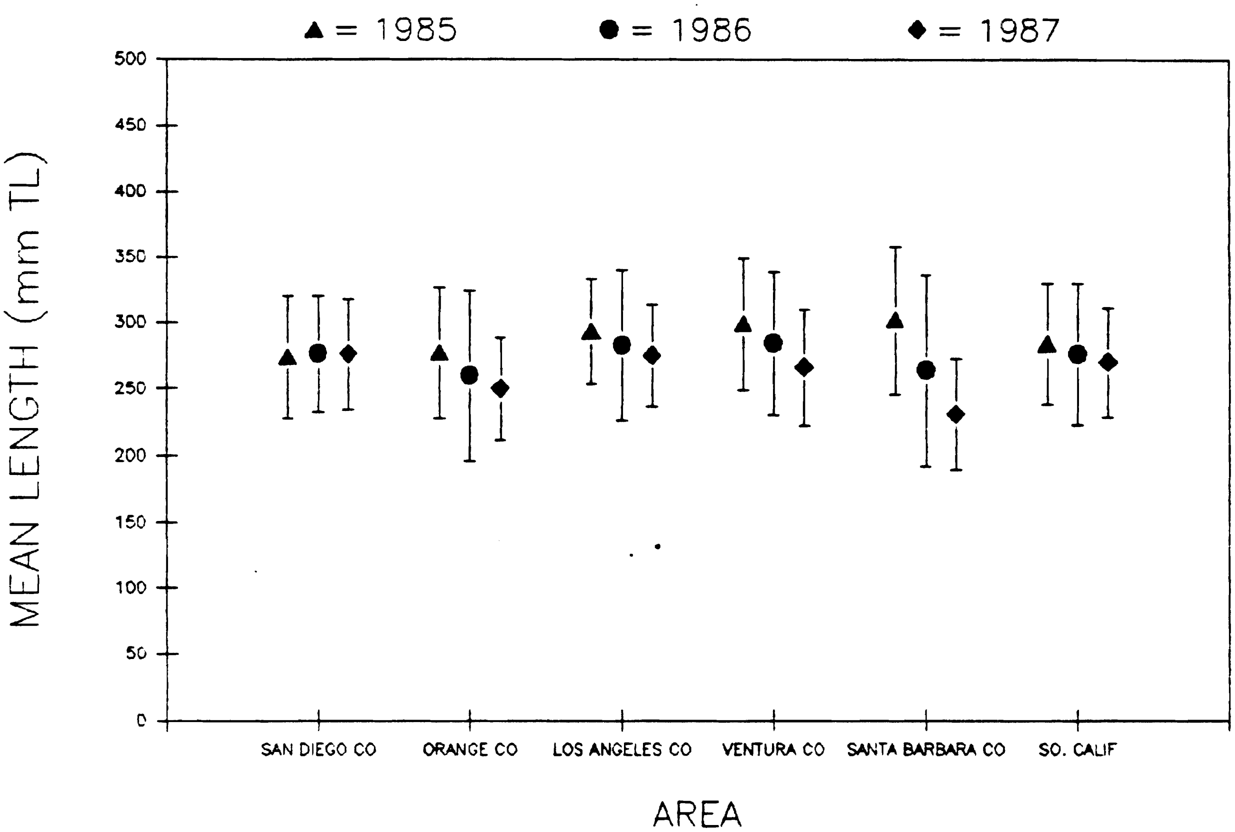



FIGURE 70. Mean lengths and standard deviations of sculpin measured on-board southern California commercial passenger fishing vessels.

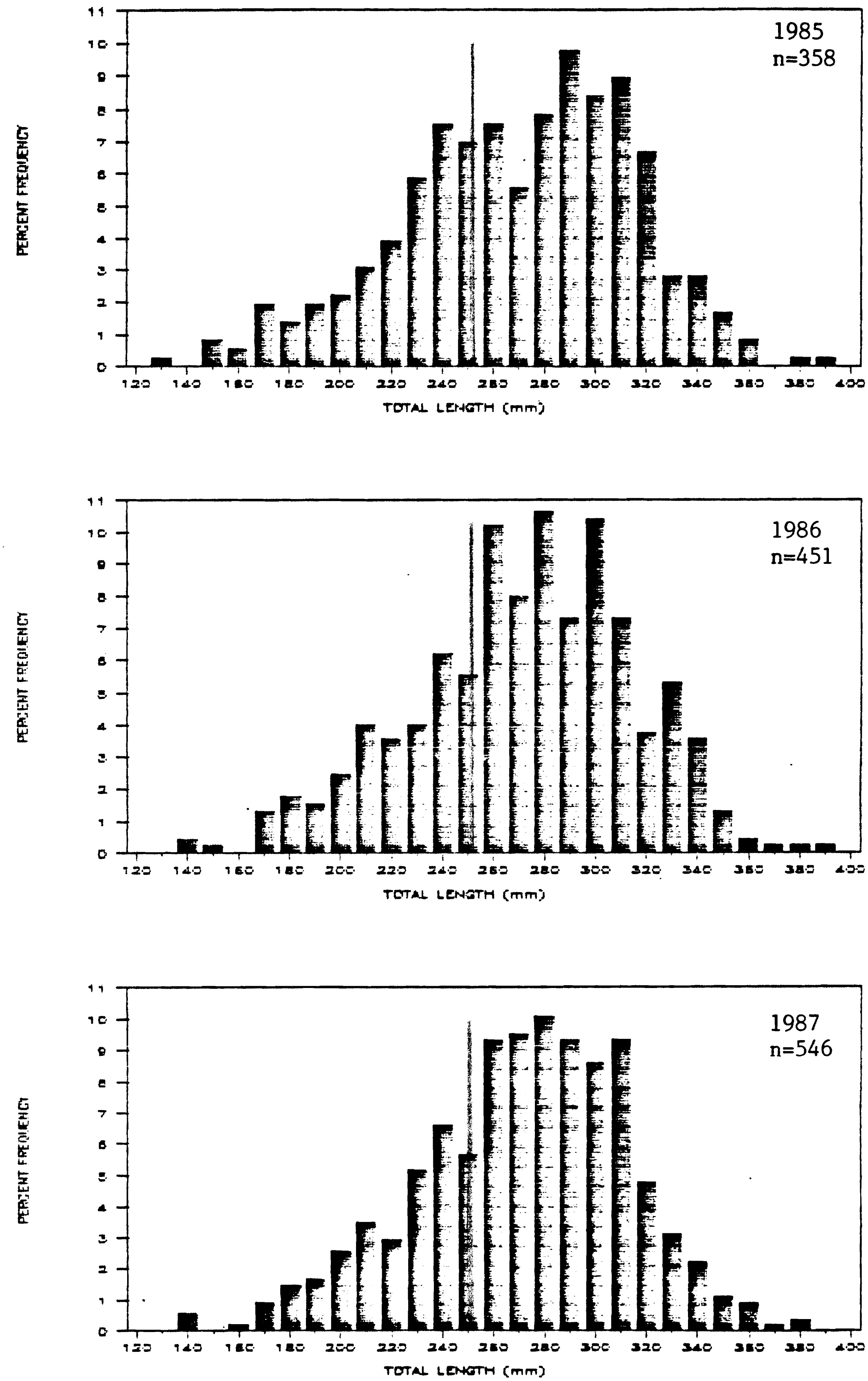



FIGURE 71. Size composition of sculpin from on-board observations of San Diego County commercial passenger fishing vessels.

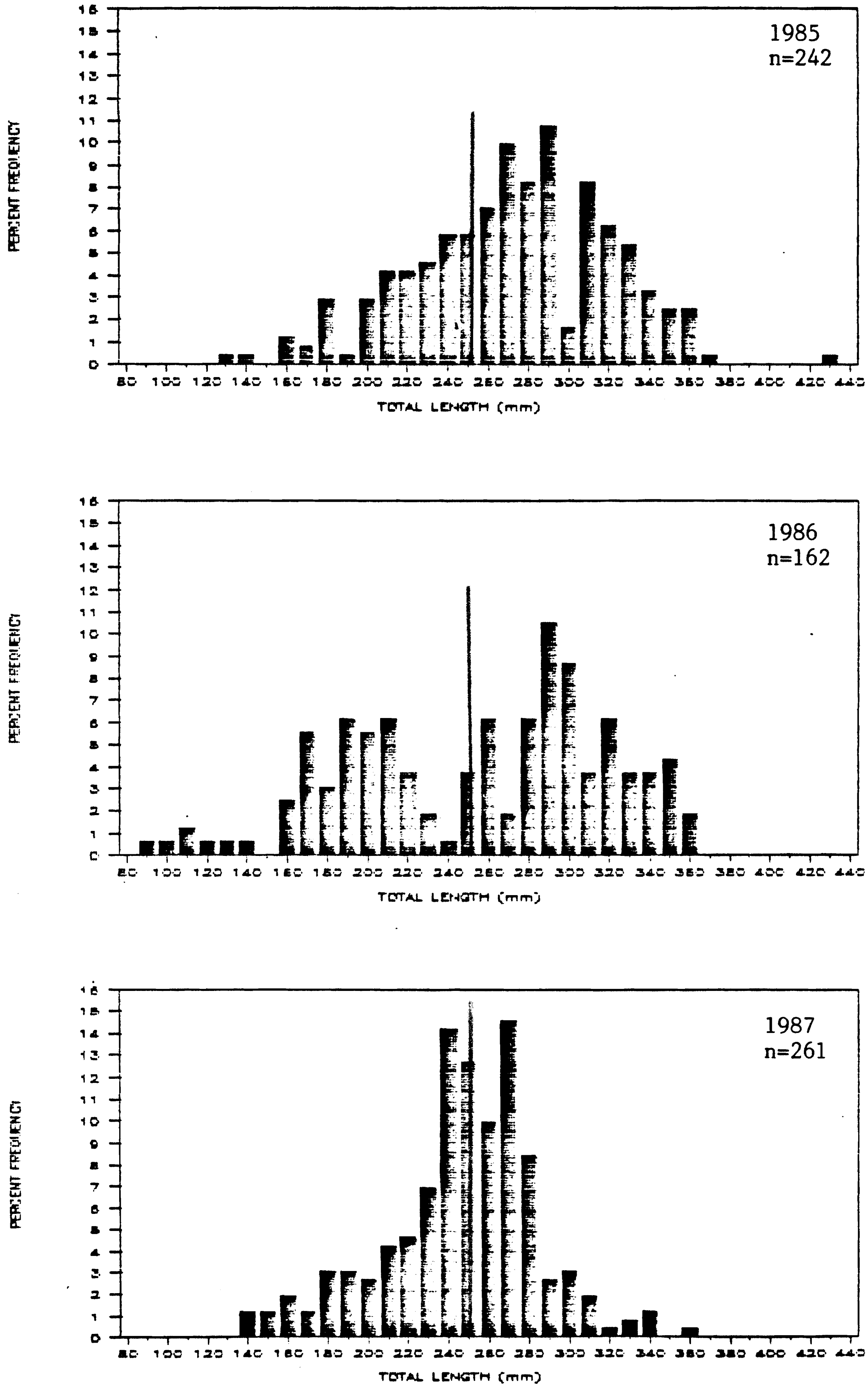



FIGURE 72. Size composition of sculpin from on-board observations of Orange County commercial passenger fishing vessels.

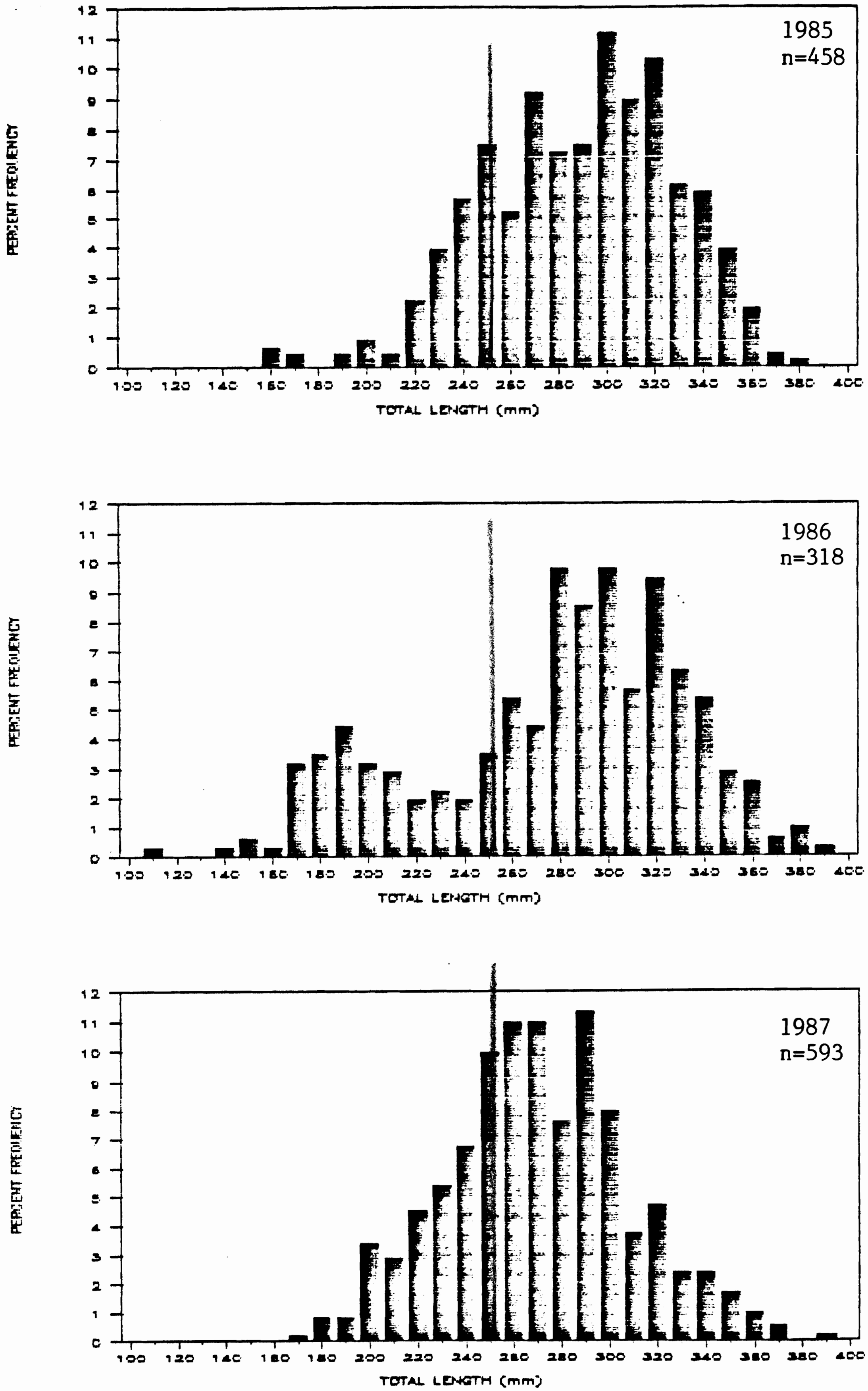



FIGURE 73. Size composition of sculpin from on-board observations of Los Angeles County commercial passenger fishing vessels.

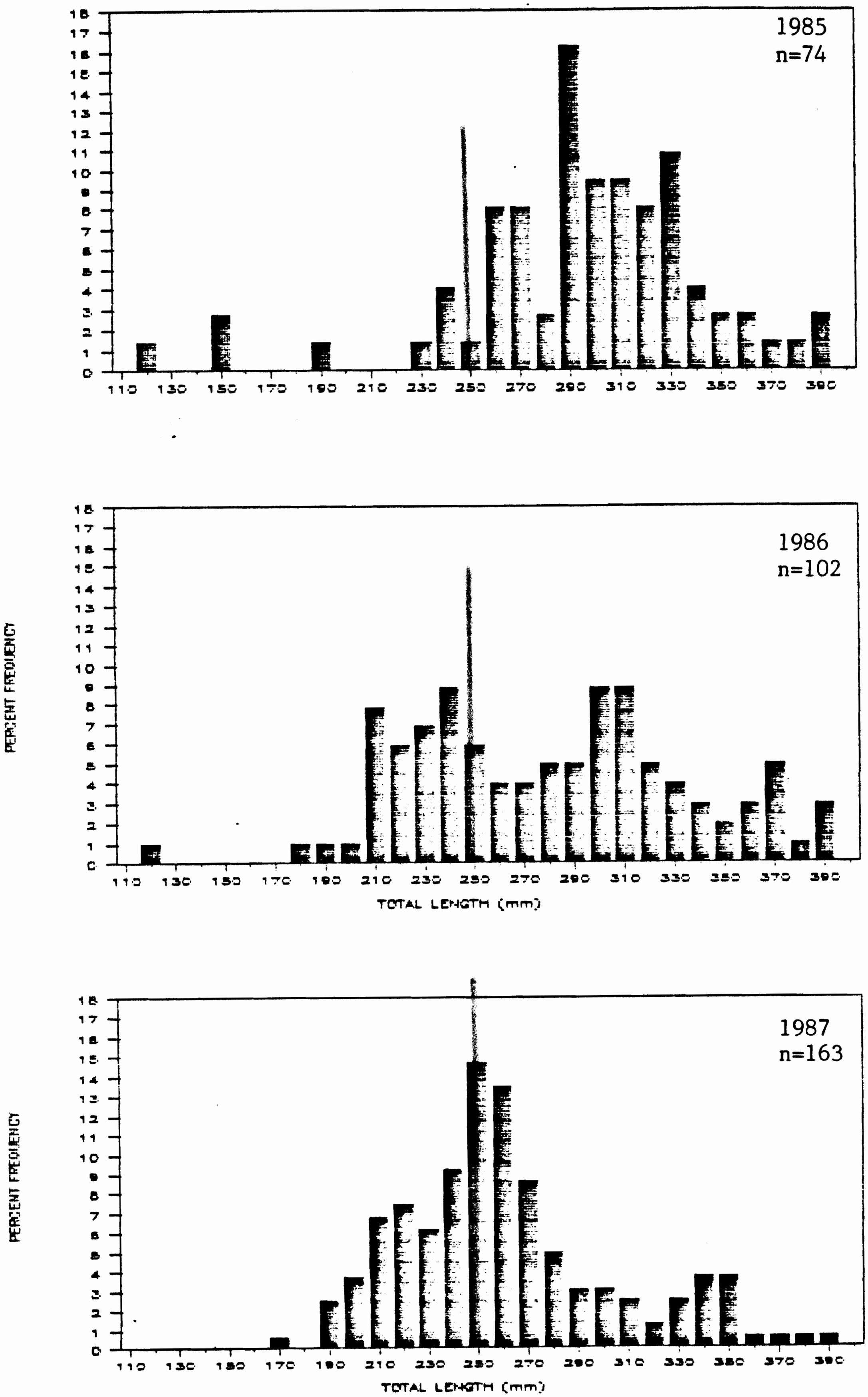



FIGURE 74. Size composition of sculpin from on-board observations of Ventura County commercial passenger fishing vessels.

## Management Recommendations

The CPFV sculpin landings began to rise rapidly in the early 1960's and peaked at over 90,000 fish in 1980, according to CPFV log data. Although sculpin present handling problems for CPFV deckhands and passengers, (because of their venomous fin spines), they are highly esteemed as a food fish and were ranked as the 10th most important species in the CPFV sport fish catch by southern California partyboat operators (Frey 1971). Our survey ranked sculpin among the top ten CPFV species in each of the 3 years surveyed (Table 12).

Though sculpin are caught throughout the year, the greatest catches occur during the spring and summer, a time interval when sculpin migrate to spawning areas. Sculpin are particularly vulnerable to anglers during this time period, and CPFV's will target them specifically, particularly if more desirable gamefish species are unavailable.

Based on our survey results, the conclusions provided by Collins and Crooke (unpublished manuscript), and the long-term CPFV log data trend, it seems that more and more fishing effort is being directed for sculpin, and that much of the increased catch is harvested from traditional spawning areas. It is not yet apparent whether the increasing levels of fishing effort have had an adverse impact on the sculpin stock, although the size structure of fish recruited into the fishery showed a trend toward younger age classes.

The sculpin fishery should be monitored closely, and the catch from the Coronado Islands, Dana Point, Dago Bank, Santa Monica Bay, and Anacapa Island sites, identified as probable or possible sculpin spawning areas (Love et al. 1987), should be given particularly close scrutiny.

## All Rockfishes (Scorpaenidae)

### Catch Estimates

Southern California. Rockfish total catch estimates decreased from 750,531 fish ± 45,030 in 1985 to 695,769 ± 62,620 in 1987 (Table 29). Collins and Crooke (unpublished manuscript) reported rockfish total catches ranging from 1,580,575 ± 63,963 in 1976 to 1,699,899 ± 98,877 in 1978. This indicates that CPFV rockfish catches have declined by more than 50% in 10 years, a trend that is mirrored in the rockfish landings reported in the statewide CPFV log reports (Paul Gregory, California Department of Fish and Game, Marine Resources Division, pers. comm.).

Resolving all the factors behind the drop in southern California rockfish catches over the past decade is beyond the scope of our study. However, we know that the decline in the stocks of key catch species such as bocaccio, chilipepper, and olive rockfish accounted for a large portion of the diminished rockfish catch. These three species composed as much as 71% of the estimated rockfish catch in Collins and Crooke's (unpublished manuscript) study, but only up to 39% of the rockfish total catch during our study. In comparing the average annual total catches of each of these three species, we see that bocaccio catches have dropped by 72%, chilipepper catches, 40%, and olive rockfish catches, 83%. The total catch estimates for other rockfishes, which rank in the top 20 species in our study (Table 30), either did not vary as substantially, or, in a few cases (honeycomb, rosy, and calico rockfishes), were caught in much larger estimated numbers in the

TABLE 29. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of All Rockfishes from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| AREA | FISHES KEPT | | | | | | FISHES RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 92,726 | 14 | 120,745 | 15 | 105,752 | 16 | 14,121 | 17 | 17,443 | 14 | 7,017 | 16 | 106,847 | 13 | 138,188 | 14 | 112,769 | 15 |
| Orange County | 33,208 | 28 | 17,982 | 28 | 9,758 | 39 | 1,405 | 21 | 2,822 | 18 | 1,480 | 33 | 34,613 | 27 | 20,804 | 24 | 11,238 | 35 |
| Los Angeles County | 266,610 | 13 | 257,127 | 16 | 201,536 | 21 | 20,180 | 12 | 12,963 | 25 | 6,819 | 20 | 286,790 | 12 | 270,090 | 16 | 208,356 | 21 |
| Ventura County | 273,296 | 9 | 275,748 | 12 | 297,276 | 12 | 1,798 | 23 | 3,169 | 20 | 4,961 | 28 | 275,094 | 9 | 278,918 | 12 | 302,237 | 12 |
| Santa Barbara County | 45,089 | 23 | 23,071 | 29 | 59,600 | 27 | 2,098 | 21 | 1,425 | 47 | 1,569 | 25 | 47,188 | 21 | 24,497 | 28 | 61,169 | 26 |
| Southern California | 710,930 | 7 | 694,674 | 8 | 673,923 | 9 | 39,602 | 9 | 37,822 | 11 | 21,845 | 11 | 750,531 | 6 | 732,496 | 8 | 695,769 | 9 |

TABLE 30. Ranking of Rockfish Species Observed On Board Southern California Based Commercial Passenger Fishing Vessels. Based on the Mean of the 1985 Through 1987 Catch Estimates.

| SPECIES | 1985 | 1986 | 1987 | 3-Year Mean | % of 3-Year Catch Mean |
|---|---|---|---|---|---|
| Bocaccio | 193,609 | 151,031 | 107,344 | 150,661 | 20.74 |
| Chilipepper | 42,690 | 70,396 | 149,673 | 87,586 | 12.06 |
| Vermilion rockfish | 47,241 | 56,466 | 72,389 | 58,699 | 8.08 |
| Greenspotted rockfish | 61,797 | 38,278 | 36,366 | 45,480 | 6,26 |
| Starry rockfish | 42,752 | 35,259 | 24,721 | 34,244 | 4.72 |
| Olive rockfish | 16,857 | 25,271 | 44,485 | 28,871 | 3.98 |
| Blue rockfish | 34,673 | 19,862 | 31,984 | 28,840 | 3.97 |
| Honeycomb rockfish | 31,279 | 34,602 | 20,629 | 28,837 | 3.97 |
| Bank rockfish | 21,452 | 48,034 | 12,435 | 27,307 | 3.76 |
| Squarespot rockfish | 39,113 | 33,225 | 7,679 | 26,672 | 3.67 |
| Rosy rockfish | 32,884 | 26,146 | 14,925 | 24,652 | 3.39 |
| Calico rockfish | 23,964 | 34,070 | 11,338 | 23,124 | 3.18 |
| Flag rockfish | 22,534 | 15,278 | 12,643 | 16,818 | 2.32 |
| Copper rockfish | 11,409 | 11,538 | 26,296 | 16,414 | 2.26 |
| Greenstriped rockfish | 14,140 | 16,741 | 17,560 | 16,147 | 2.22 |
| Speckled rockfish | 16,483 | 9,766 | 19,683 | 15,311 | 2.11 |
| Gopher rockfish | 17,016 | 11,890 | 14,176 | 14,361 | 1.98 |
| Treefish | 12,392 | 15,391 | 10,957 | 12,913 | 1.78 |
| Halfbanded rockfish | 11,506 | 12,653 | 3,228 | 9,129 | 1.26 |
| Kelp rockfish | 6,294 | 10,291 | 9,200 | 8,595 | 1.18 |
| Widow rockfish | 2,235 | 5,979 | 14,421 | 7,545 | 1.04 |

current study than they were during Collins and Crooke's (unpublished manuscript) study.

A breakdown of the estimated total catch by month shows a pattern in which rockfish catches peak in the late fall and winter, and experience a low point during the summer months (Figure 75). This pattern is mostly a result of targeting, in that the CPFV fleet tends to target surface fishes during the summer, to the exclusion of rockfishes. The opposite situation occurs during the late fall and winter, when bottom fishing trips for rockfishes are dominant, and surface fishing is generally unproductive.

The catch-by-month breakdown for 1987 reveals an anomalous pattern in which the peak rockfish total catches occurred in April instead of the months of January, November, or December. Also, the December rockfish total catch, at 19,000, was the lowest monthly estimate for 1987. The April peak, at 118,900 was the result of large rockfish total catches at Los Angeles County landings, where 46% of the April southern California rockfish total catches occurred. The very low rockfish total catches in December were probably due to adverse weather conditions which limited the number of CPFV trips scheduled. Seventeen percent fewer CPFV trips were run in December 1987 than in December 1986.

Counties. Los Angeles and Ventura counties had the largest rockfish total catch estimates during our study. In 1985, Los Angeles County contributed 38% to the southern California rockfish total catch, and Ventura County, 37% (Table 29).

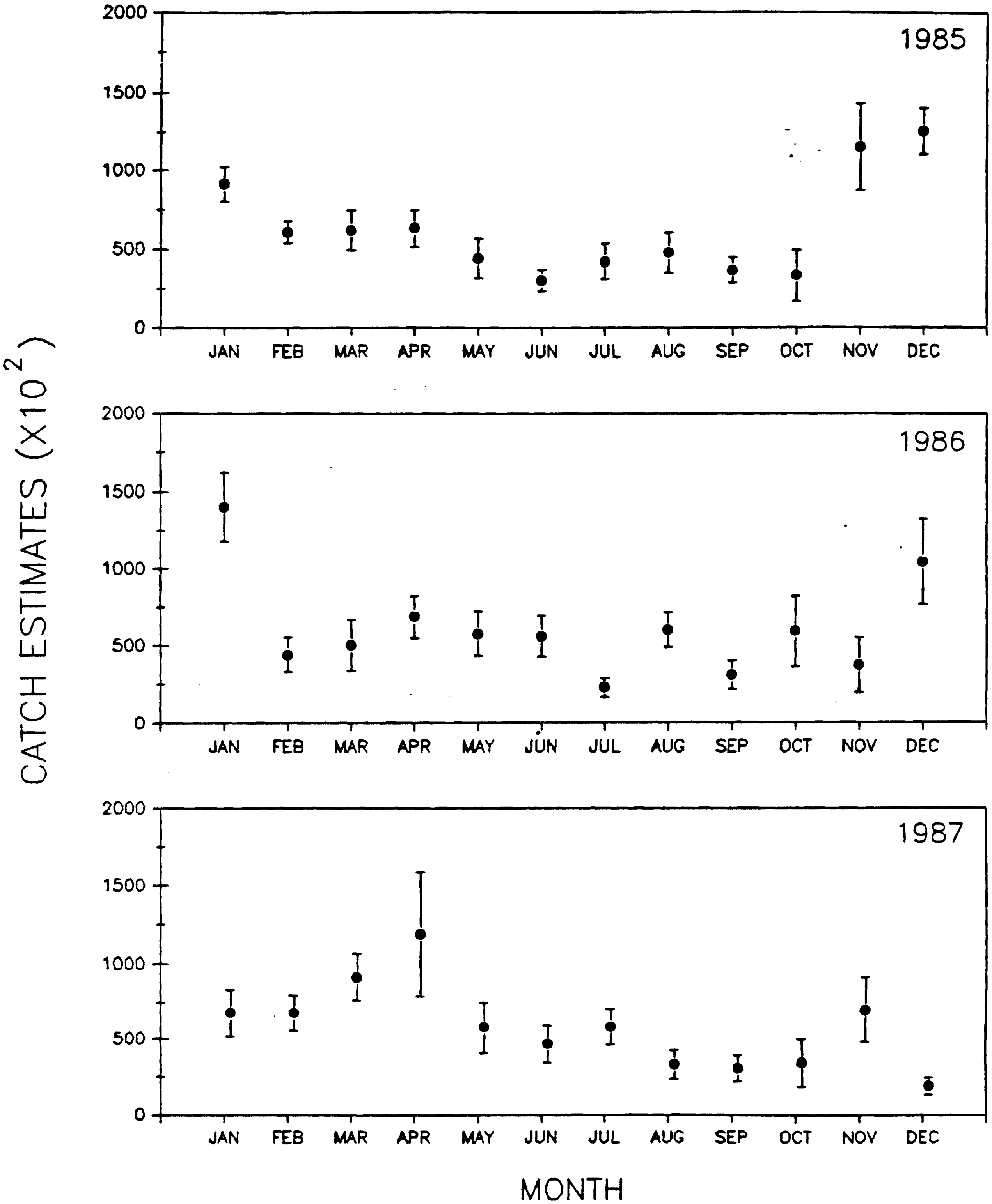



FIGURE 75. Monthly total catch estimates (number of fish) and standard deviations of all rockfishes from on-board observations of southern California commercial passenger fishing vessels.

The species composition of the catch exhibited some county-by-county variation, based on our computed IRI rockfish rankings. In San Diego County various shallow-depth species, including honeycomb, calico, and olive rockfishes dominated the top 20 ranked species (Table 31). In Orange County the higher ranking species were mostly offshore bottom and mid-water species, such as bocaccio, chilipepper, bank, and vermilion rockfish (Table 32). The ranking and composition of the top five species showed considerable annual variation in Orange County from 1985 to 1987. Los Angeles County rockfish IRI rankings showed some stability in the species composition of its first few ranks, with bocaccio, vermilion, squarespot, and starry rockfish representing the top two ranks over the 3 years (Table 33). Ventura County IRI rankings were led by bocaccio in each year, indicating the importance of this offshore species to the Ventura complex CPFV's (Table 34). The other top-ranking rockfishes (with the exception of olive rockfish) were offshore, deep-water species. The IRI ranking of rockfishes for Santa Barbara County reflected a mixture of shallow-depth and deep-water species among the top 10 ranks (Table 35). The shallow depth-dwelling olive and blue rockfishes were the most important species in 1985 and 1986, while in 1987, vermilion and copper rockfishes, two mid- to deep-water species occupied the top ranks. The admixture of rockfish species in the Santa Barbara County catch may have been a reflection of the CPFV trip types run; a high percentage of trips from this complex were shorter, half-day runs that fished nearshore, coastal reefs. This could have accounted for the importance of shallow-water species in the county's IRI rankings.

TABLE 31. Top 20 Ranks, Based on an Index of Relative Importance, of Rockfish Species Observed On Board San Diego County Based Commercial Passenger Fishing Vessels in 1985, 1986, and 1987.

| RANK | 1985 | 1986 | 1987 |
|---|---|---|---|
| 1 | Honeycomb rockfish | Honeycomb rockfish | Olive rockfish |
| 1 | | Calico rockfish | |
| 2 | Starry rockfish | Vermilion rockfish | Honeycomb rockfish |
| 2 | | Olive rockfish | |
| 3 | Calico rockfish | Starry rockfish | Vermilion rockfish |
| 4 | Flag rockfish | Treefish | Calico rockfish |
| 5 | Gopher rockfish | Gopher rockfish | Treefish |
| 6 | Squarespot rockfish | Squarespot rockfish | Starry rockfish |
| 6 | Bocaccio | | |
| 6 | Treefish | | |
| 7 | Blue rockfish | Bank rockfish | Chilipepper |
| 7 | | Bocaccio | |
| 8 | Bank rockfish | Flag rockfish | Greenstriped rockfish |
| 8 | Vermilion rockfish | | Gopher rockfish |
| 9 | Brown rockfish | Brown rockfish | Flag rockfish |
| 10 | Greenspotted rockfish | Greenspotted rockfish | Greenspotted rockfish |
| 11 | Rosy rockfish | Rosy rockfish | Brown rockfish |
| 12 | Olive rockfish | Speckled rockfish | Bocaccio |
| 12 | | Blue rockfish | Rosy rockfish |
| 13 | Halfbanded rockfish | Kelp rockfish | Squarespot rockfish |
| 14 | Chilipepper | Halfbanded rockfish | Blue rockfish |
| 14 | Kelp rockfish | | Kelp rockfish |
| 15 | Blackgill rockfish | Copper rockfish | Copper rockfish |
| 15 | Rosethorn rockfish | | |
| 16 | Greenstriped rockfish | Blackgill rockfish | Mexican rockfish |
| 17 | Grass rockfish | Greenstriped rockfish | Greenblotched rockfish |
| 18 | Chameleon rockfish | Chilipepper | Grass rockfish |
| 18 | Speckled rockfish | Grass rockfish | |
| 19 | Copper rockfish | Greenblotched rockfish | Halfbanded rockfish |
| 19 | | | Speckled rockfish |
| 20 | Canary rockfish | Swordspine rockfish | Pink rockfish |

TABLE 32. Top 20 Ranks, Based on an Index of Relative Importance, of Rockfish Species Observed On Board Orange County Based Commercial Passenger Fishing Vessels in 1985, 1986, and 1987.

| RANK | 1985 | 1986 | 1987 |
|---|---|---|---|
| 1 | Bocaccio | Bank rockfish | Vermilion rockfish |
| 2 | Greenspotted rockfish | Chilipepper | Chilipepper |
| 3 | Starry rockfish | Bocaccio | Bocaccio |
| 4 | Flag rockfish | Vermilion rockfish | Olive rockfish |
| 5 | Honeycomb rockfish | Greenblotched rockfish | Flag rockfish |
| 5 | Vermilion rockfish | Greenspotted rockfish | |
| 6 | Bank rockfish | Greenstriped rockfish | Calico rockfish |
| 6 | Rosy rockfish | | |
| 7 | Squarespot rockfish | Calico rockfish | Bank rockfish |
| 7 | | | Greenstriped rockfish |
| 7 | | | Squarespot rockfish |
| 8 | Calico rockfish | Olive rockfish | Greenspotted rockfish |
| 9 | Chilipepper | Rosy rockfish | Treefish |
| 9 | Halfbanded rockfish | | |
| 10 | Brown rockfish | Treefish | Rosy rockfish |
| 11 | Treefish | Splitnose rockfish | Cowcod |
| 12 | Greenstriped rockfish | Swordspine rockfish | Honeycomb rockfish |
| 13 | Splitnose rockfish | Brown rockfish | Greenblotched rockfish |
| 13 | Mexican rockfish | | |
| 14 | Greenblotched rockfish | Halfbanded rockfish | Halfbanded rockfish |
| 14 | | Squarespot rockfish | |
| 15 | Chameleon rockfish | Starry rockfish | Starry rockfish |
| 16 | Grass rockfish | Mexican rockfish | Shortbelly rockfish |
| 17 | Cowcod | Pinkrose rockfish | Gopher rockfish |
| 18 | Gopher rockfish | Stripetail rockfish | Yellowtail rockfish |
| 18 | | Honeycomb rockfish | |
| 19 | Swordspine rockfish | Kelp rockfish | Speckled rockfish |
| 19 | | Flag rockfish | Copper rockfish |
| 20 | Blackgill rockfish | Cowcod | Swordspine rockfish |

TABLE 33. Top 20 Ranks, Based on an Index of Relative Importance, of Rockfish Species Observed On Board Los Angeles County Based Commercial Passenger Fishing Vessels in 1985, 1986, and 1987.

| RANK | 1985 | 1986 | 1987 |
|---|---|---|---|
| 1 | Bocaccio | Bocaccio | Vermilion rockfish |
| 2 | Squarespot rockfish | Starry rockfish | Bocaccio |
| 2 | Starry rockfish | | |
| 3 | Vermilion rockfish | Vermilion rockfish | Starry rockfish |
| 3 | Rosy rockfish | | |
| 4 | Greenspotted rockfish | Squarespot rockfish | Olive rockfish |
| 4 | Calico rockfish | | |
| 5 | Honeycomb rockfish | Flag rockfish | Calico rockfish |
| 5 | | Calico rockfish | |
| 6 | Flag rockfish | Rosy rockfish | Greenspotted rockfish |
| 7 | Treefish | Honeycomb rockfish | Chilipepper |
| 8 | Halfbanded rockfish | Treefish | Speckled rockfish |
| 8 | | | Rosy rockfish |
| 9 | Blue rockfish | Greenspotted rockfish | Honeycomb rockfish |
| 10 | Speckled rockfish | Halfbanded rockfish | Squarespot rockfish |
| 11 | Olive rockfish | Greenblotched rockfish | Flag rockfish |
| 11 | | Olive rockfish | |
| 12 | Chilipepper | Greenstriped rockfish | Greenblotched rockfish |
| 12 | | Brown rockfish | Copper rockfish |
| 13 | Shortbelly rockfish | Chilipepper | Treefish |
| 14 | Brown rockfish | Copper rockfish | Blue rockfish |
| 15 | Greenstriped rockfish | Bank rockfish | Greenstriped rockfish |
| 15 | | Yellowtail rockfish | Halfbanded rockfish |
| 16 | Copper rockfish | Gopher rockfish | Brown rockfish |
| 16 | Gopher rockfish | | |
| 17 | Bank rockfish | Kelp rockfish | Gopher rockfish |
| 18 | Canary rockfish | Redstripe rockfish | Grass rockfish |
| 18 | | Speckled rockfish | |
| 18 | | Grass rockfish | |
| 19 | Greenblotched rockfish | Blue rockfish | Shortbelly rockfish |
| 19 | | | Kelp rockfish |
| 20 | Cowcod | Widow rockfish | Cowcod |

TABLE 34. Top 20 Ranks, Based on an Index of Relative Importance, of Rockfish Species Observed On Board Ventura County Based Commercial Passenger Fishing Vessels In 1985, 1986, and 1987.

| RANK | 1985 | 1986 | 1987 |
|---|---|---|---|
| 1 | Bocaccio | Bocaccio | Bocaccio |
| 2 | Greenspotted rockfish | Greenspotted rockfish | Chilipepper |
| 3 | Starry rockfish | Chilipepper | Olive rockfish |
| 3 | | Starry rockfish | |
| 4 | Chilipepper | Vermilion rockfish | Greenspotted rockfish |
| 4 | | | Vermilion rockfish |
| 5 | Rosy rockfish | Copper rockfish | Copper rockfish |
| 6 | Vermilion rockfish | Rosy rockfish | Blue rockfish |
| 6 | | Kelp rockfish | |
| 7 | Greenstriped rockfish | Blue rockfish | Gopher rockfish |
| 8 | Blue rockfish | Greenstriped rockfish | Greenstriped rockfish |
| 9 | Speckled rockfish | Olive rockfish | Starry rockfish |
| 9 | Flag rockfish | | Kelp rockfish |
| 10 | Gopher rockfish | Gopher rockfish | Rosy rockfish |
| 10 | Copper rockfish | | |
| 11 | Olive rockfish | Speckled rockfish | Widow rockfish |
| 11 | | | Treefish |
| 12 | Kelp rockfish | Flag rockfish | Flag rockfish |
| 12 | Swordspine rockfish | | |
| 13 | Squarespot rockfish | Widow rockfish | Black-and-yellow rockfish |
| 13 | | Treefish | |
| 14 | Treefish | Bank rockfish | Grass rockfish |
| 14 | | | Brown rockfish |
| 15 | Bank rockfish | Swordspine rockfish | Cowcod |
| 16 | Widow rockfish | Squarespot rockfish | Speckled rockfish |
| 17 | Brown rockfish | Cowcod | Bank rockfish |
| 18 | Greenblotched rockfish | Greenblotched rockfish | Swordspine rockfish |
| 18 | Cowcod | | Greenblotched rockfish |
| 18 | | | Squarespot rockfish |
| 19 | Black-and-yellow rockfish | Black-and-yellow rockfish | Halfbanded rockfish |
| 20 | Yellowtail rockfish | Grass rockfish | Stripetail rockfish |

TABLE 35. Top 20 Ranks, Based on an Index of Relative Importance, of Rockfish Species Observed On Board Santa Barbara County Based Commercial Passenger Fishing Vessels in 1985, 1986, and 1987.

| RANK | 1985 | 1986 | 1987 |
|---|---|---|---|
| 1 | Olive rockfish | Blue rockfish | Vermilion rockfish |
| 1 | | Olive rockfish | |
| 2 | Bocaccio | Copper rockfish | Copper rockfish |
| 3 | Blue rockfish | Vermilion rockfish | Olive rockfish |
| 4 | Vermilion rockfish | Greenspotted rockfish | Blue rockfish |
| 5 | Copper rockfish | Bocaccio | Bocaccio |
| 5 | | | Kelp rockfish |
| 6 | Starry rockfish | Yellowtail rockfish | Widow rockfish |
| 7 | Greenspotted rockfish | Brown rockfish | Gopher rockfish |
| 8 | Calico rockfish | Starry rockfish | Greenspotted rockfish |
| 8 | | | Starry rockfish |
| 9 | Yellowtail rockfish | Widow rockfish | Brown rockfish |
| 9 | Rosy rockfish | | |
| 10 | Widow rockfish | Kelp rockfish | Rosy rockfish |
| 11 | Speckled rockfish | Rosy rockfish | Canary rockfish |
| 11 | Squarespot rockfish | | |
| 12 | Gopher rockfish | Halfbanded rockfish | Yellowtail rockfish |
| 13 | Brown rockfish | Gopher rockfish | Chilipepper |
| 14 | Flag rockfish | Greenstriped rockfish | Squarespot rockfish |
| 15 | Yelloweye rockfish | Squarespot rockfish | Calico rockfish |
| 16 | Honeycomb rockfish | Flag rockfish | Black-and-yellow rockfish |
| 16 | | Grass rockfish | |
| 16 | | Black-and-yellow rockfish | |
| 17 | Black-and-yellow rockfish | Chilipepper | Speckled rockfish |
| 17 | | | Flag rockfish |
| 18 | Canary rockfish | Canary rockfish | Greenstriped rockfish |
| 19 | Greenstriped rockfish | Treefish | Treefish |
| 20 | Halfbanded rockfish | Yelloweye rockfish | Greenblotched rockfish |
| 20 | Kelp rockfish | | Grass rockfish |

## Management Recommendations

The southern California CPFV rockfish fishery is a multi-species fishery, which, though dominated by a dozen or so species (Table 30), encompasses at least 49 out of the 62 rockfish species known to inhabit California waters. These rockfishes inhabit a wide range of habitats, have varying food habits, growth rates, etc. Managing such a diverse group as a single entity is not an ideal practice, but given the lack of available data on the individual rockfish species, it is the only workable management scheme currently available. As a result, the principal management implementation consists only of an aggregate 15-fish bag limit for all rockfish species.

Miller and Hardwick (1973) discussed the sport and commercial fisheries for rockfish, and listed the development of an aggregate species population dynamics model as one of the prerequisites necessary for management.

Based on evidence of declining rockfish catches in our study and in the CPFV logbook data (Oliphant 1979), we offer several management recommendations that would reduce the sport-caused portion of fishing mortality, and might stabilize or reverse declining rockfish catch trends. The options are:

1. Reducing the bag limit for rockfishes from 15 to 10.
2. Imposing area fishing closures. This would provide nursery areas, allowing rockfish to mature and spawn, and eventually replenish depleted areas outside of the closures.

3. Imposing a limit on the number of hooks per gangion in order to lower the efficiency or fishing power of each angler.

4. Imposing a single size limit or series of size limits. A minimum size limit would allow more rockfish to reach sexual maturity and reproduce before being taken by anglers.

Of the four options listed, a reduction of the bag limit would probably be the easiest to implement. If a 10-rockfish bag limit proved to be ineffective, then smaller bag limits could be considered. The option regulating gangions might have a comparable effect to a lower bag limit. However, we feel this option would engender greater opposition from anglers, the CPFV industry, and the fishing tackle industry. The area closure option for rockfishes would be difficult to enforce, and would tend to redirect fishing pressure to the remaining, open rockfishing areas. Finally, the size limit option for rockfishes would be the most difficult to implement, and would be ineffective for the smaller rockfish species, unless separate size limits were set for them. Also, most of the rockfish catches occur in 73 m (40 fm) or deeper; rockfishes reeled up rapidly from such depths invariably decompress and have inflated air bladders, making it difficult to return undersized rockfish alive to their original habitat depths.

Attempting to manage the rockfishes on a species-by-species basis would be difficult because each CPFV fishing trip is unable to target a single species, and may catch a dozen or more different rockfishes at one fishing site. Most anglers and many CPFV crew members cannot identify the various rockfishes that occur in the catch.

Without discounting the impact of year-to-year variations of the oceanic environment, such as El Nino, on rockfish stocks, we believe that fishing mortality, both sport and commercial, has been a significant cause of the decline in rockfish catches over the past decade. Based on our findings and analyses, we recommend that the current 15-rockfish bag limit regulation be reduced to a 10-rockfish bag limit, and that additional conservation measures be implemented on the commercial rockfish fishery. The form and scope of such commercial regulations are beyond our purview, but it seems obvious that restricting one component of the rockfish fishery and not the other would not work, nor would it be equitable.

## Bank Rockfish (Scorpaenidae)

### Catch Estimates

Southern California. Bank rockfish is an offshore, bottom-dwelling rockfish species. In our survey, bank rockfish total catch estimates fluctuated between 12,435 fish ± 8,580 and 48,034 ± 15,370 from 1985 to 1987 (Table 36). Bank rockfish was the ninth ranked rockfish catch species, composing 3.8% of the rockfish total catch (Table 30). Collins and Crooke (unpublished manuscript) had bank rockfish total catch estimates ranging from 16,998 ± 3,381 in 1977 to 36,378 ± 11,305 in 1978. It was the 11th ranking rockfish species in their survey, composing 1.3% of the rockfish catch.

The total catch distribution of bank rockfish displayed catch peaks in the winter and spring of 1985 and 1986, and a spring catch peak in 1987 (Figure 76). This pattern was most likely tied to the targeting of the offshore banks by CPFV's during their seasonal offshore rockfish fishery.

Counties. Los Angeles County had the largest total catches of bank rockfish, followed by San Diego County (Table 36). These two counties contributed 55% and 30% of the southern California bank rockfish total catch, respectively.

### Size Composition

Southern California. The length frequency distributions for bank rockfish display several modes in each of the 3 years (Figure 77). We do not have length-at-age data available to assign ages to modal groups, but it appears that the fishery is supported by several cohorts and that new year classes were being recruited into the catch.

TABLE 36. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of Bank Rockfish from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| AREA | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 9,504 | 65 | 14,742 | 74 | 149 | 98 | 0 | 0 | 0 | 0 | 0 | 0 | 9,504 | 65 | 14,742 | 74 | 149 | 98 |
| Orange County | 2,637 | 84 | 180 | 99 | 0 | 0 | 49 | 99 | 0 | 0 | 0 | 0 | 2,685 | 83 | 180 | 99 | 0 | 0 |
| Los Angeles County | 6,079 | 59 | 27,483 | 37 | 11,181 | 76 | 0 | 0 | 0 | 0 | 0 | 0 | 6,079 | 59 | 27,483 | 37 | 11,181 | 76 |
| Ventura County | 3,183 | 78 | 5,630 | 61 | 1,104 | 52 | 0 | 0 | 0 | 0 | 0 | 0 | 3,183 | 78 | 5,630 | 61 | 1,104 | 52 |
| Santa Barbara County | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Southern California | 21,403 | 37 | 48,034 | 32 | 12,435 | 69 | 49 | 99 | 0 | 0 | 0 | 0 | 21,452 | 37 | 48,034 | 32 | 12,435 | 69 |

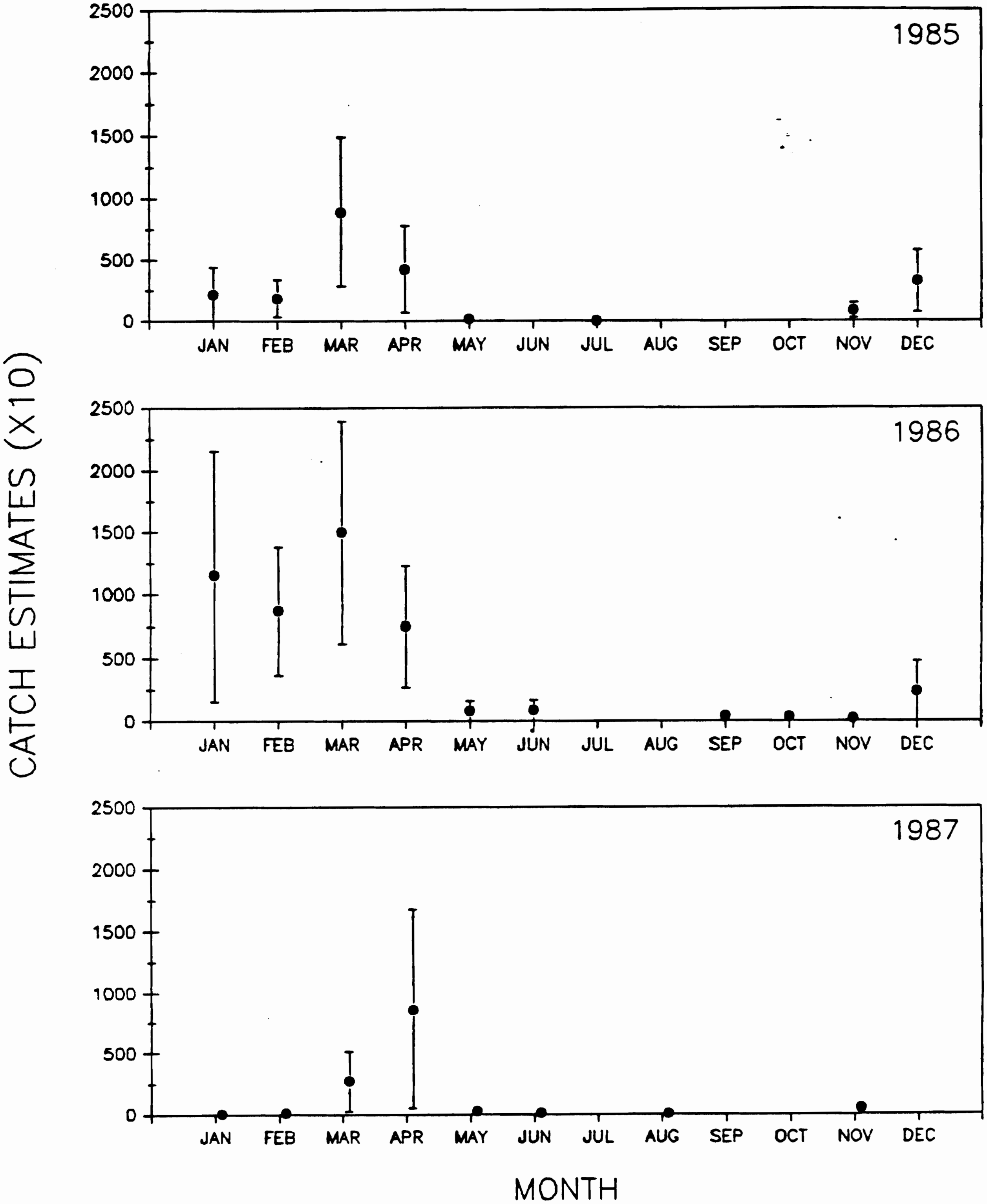



FIGURE 76. Monthly total catch estimates (number of fish) and standard deviations of bank rockfish from on-board observations of southern California commercial passenger fishing vessels.

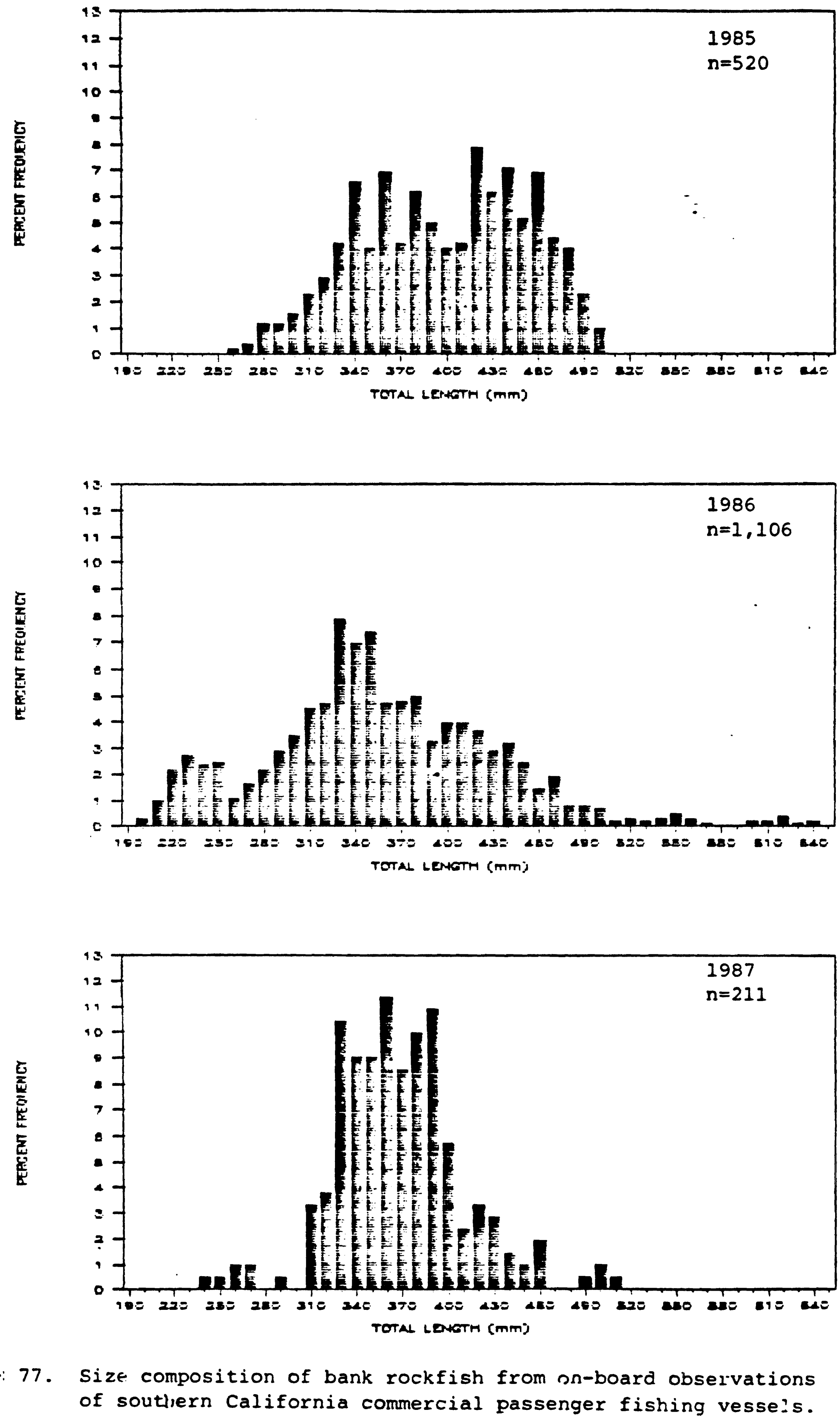



FIGURE 77. Size composition of bank rockfish from on-board observations of southern California commercial passenger fishing vessels.

Counties. The mean length plot displays considerable variation between and within each county over the 3 years (Figure 78). In San Diego, Orange, and Los Angeles counties, bank rockfish mean lengths decreased in varying patterns over the 3 years, while Ventura County bank rockfish mean lengths increased incrementally each year.

In San Diego County the frequency distribution was heavily represented by larger bank rockfish, with modes at 460 to 469 mm (18.1 to 18.5 in.) in 1985 and at 420 to 429 mm (16.5 to 16.9 in.) in 1986 (Figure 79). Most of these fish came from a single San Diego fishing site: Sixty Mile Bank (Ally et al. 1988, 1989). The Orange, Los Angeles, and Ventura counties length data display several length modes in a pattern indicative of recruitment of younger bank rockfish age classes into the CPFV fisheries of those counties (Figures 80 through 82). There were insufficient length frequency data available to analyze the bank rockfish catch from Santa Barbara County.

Management Recommendations

Bank rockfish is an important commercial catch species in southern California, contributing between 8.0% and 32.0% of the sampled rockfish catch between 1983 and 1988 (Sunada, California Department of Fish and Game, Marine Resources Division, pers. comm.). Southern California CPFV's fish bank rockfish seasonally, when they target such offshore banks as Sixty Mile Bank and Southeast Bank. When comparing our bank rockfish total catch estimates with bank rockfish total catch estimates from the 1976 to 1978 survey, there seems to have been very little change in the magnitude of the catch. In both surveys, the range of total catch estimates did tend to fluctuate widely from year to year.

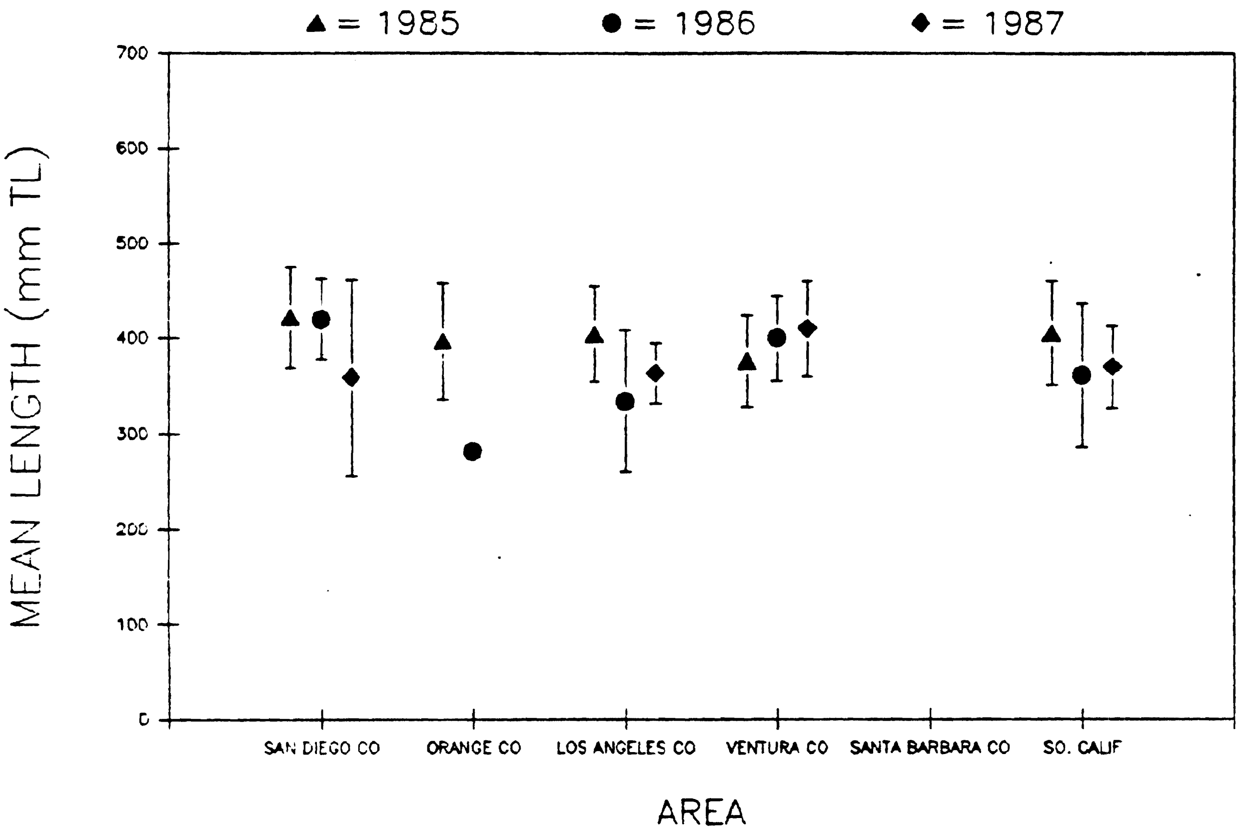
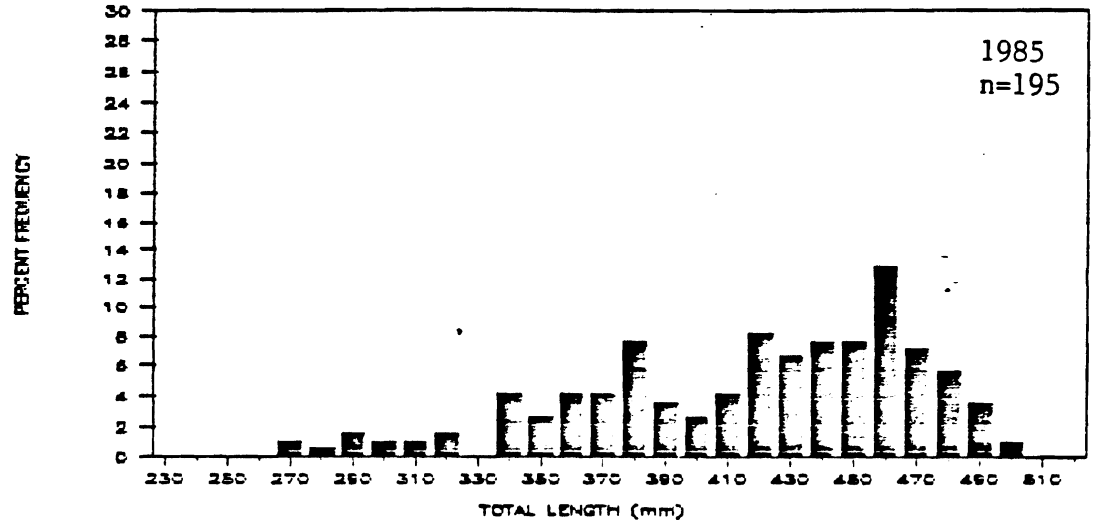



FIGURE 78. Mean lengths and standard deviations of bank rockfish measured on board southern California commercial passenger fishing vessels.



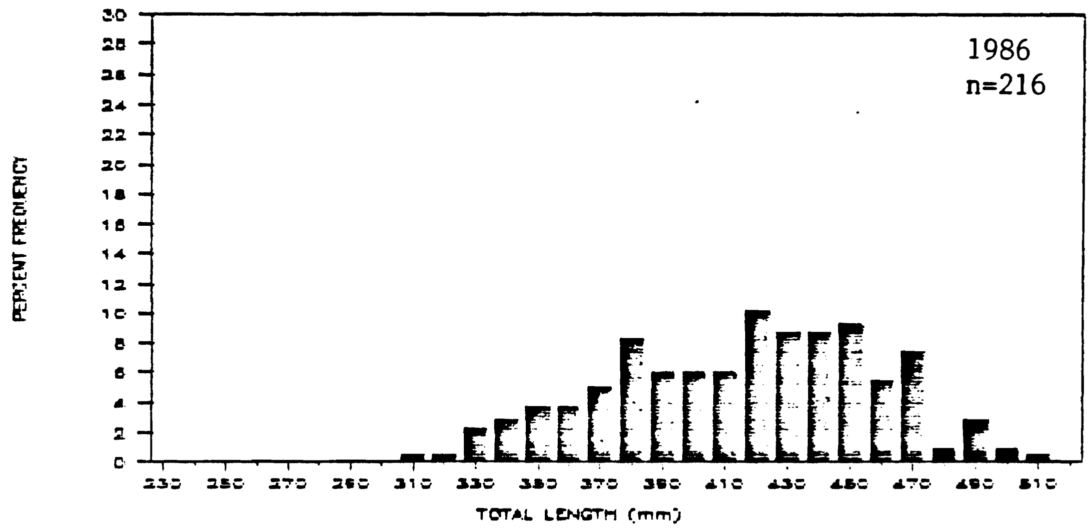




FIGURE 79. Size composition of bank rockfish from on-board observations of San Diego County commercial passenger fishing vessels.

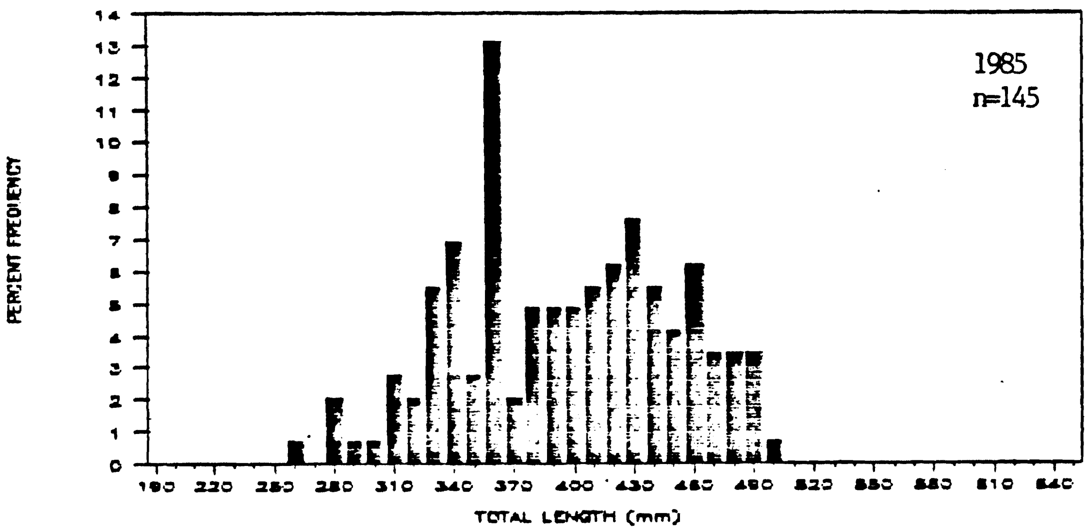



FIGURE 80. Size composition of bank rockfish from on-board observations of Orange County commercial passenger fishing vessels.

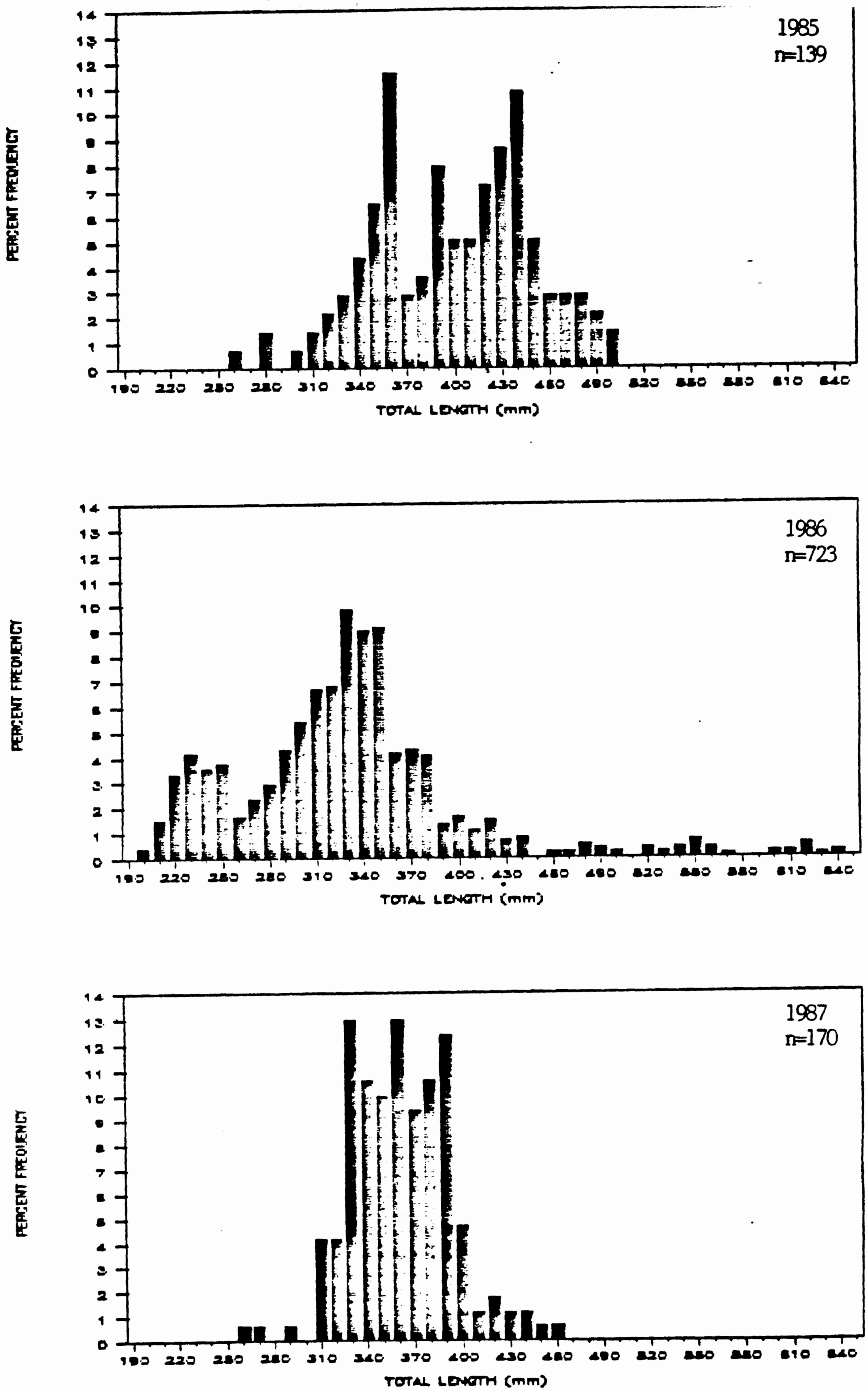



FIGURE 81. Size composition of bank rockfish from on-board observations of Los Angeles County commercial passenger fishing vessels.

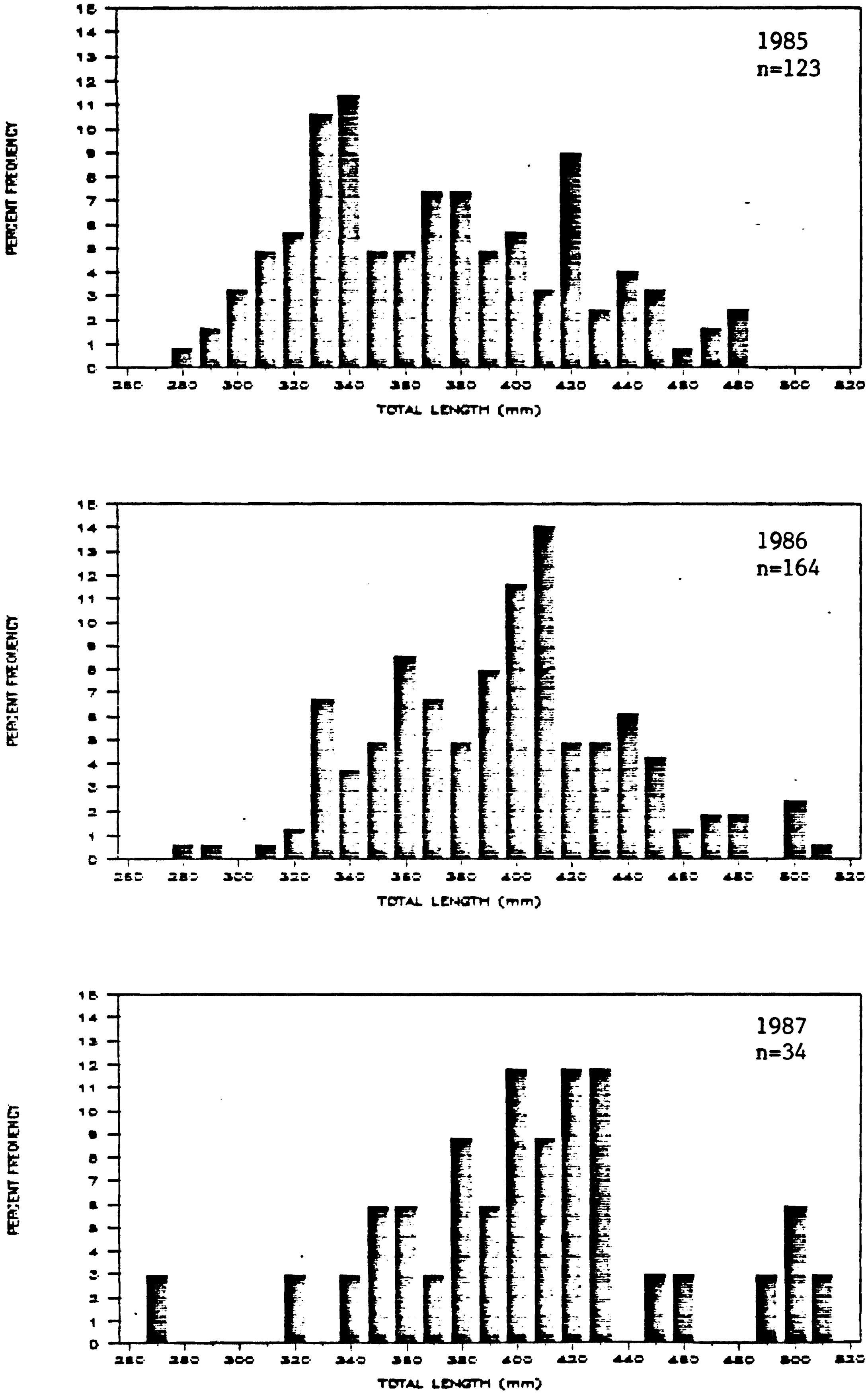



FIGURE 82. Size composition of bank rockfish from on-board observations of Ventura County commercial passenger fishing vessels.

We do not believe that bank rockfish are currently being heavily exploited by southern California CPFV's, and feel that the commercial harvest probably has a greater impact on the stock. Therefore, we do not propose new sport fish regulations to further limit the CPFV take of bank rockfish, except as they apply to the rockfish group.

## Blue Rockfish (Scorpaenidae)

### Catch Estimates

Southern California. Blue rockfish is a shallow-depth, mid-water rockfish species that forms dense schools near the surface to 91 m (50 fm). In our survey the blue rockfish total catch estimates ranged from 19,862 fish ± 5,360 to 34,673 ± 6,935 (Table 37). It was ranked seventh in importance among the rockfishes, based on its 4.0% of the rockfish total catch (Table 30). Collins and Crooke (unpublished manuscript) had blue rockfish total catch estimates ranging from 62,420 ± 7,193 in 1976 to 243,341 ± 91,662 in 1978; it was the fourth ranked rockfish species, composing 9.2% of the *Sebastes* catch.

The blue rockfish total catch distribution was variable, although June, July, and August were the months that consistently displayed the largest estimated catches in each of the 3 years (Figure 83).

Counties. Ventura County had the largest blue rockfish total catches, ranging from 54 to 63% of the estimated southern California blue rockfish totals. Most of the Ventura County blue rockfish were taken at northern Channel Islands sites: San Nicolas Island, Anacapa Island, the west end of Santa Cruz Island, Santa Rosa Island, and the west end of San Miguel Island (Ally et al. 1988). The remaining blue rockfish catches were distributed fairly evenly among San Diego, Los Angeles, and Santa Barbara counties, while the Orange County blue rockfish sampled catch was too small to generate a catch estimate.

TABLE 37. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of Blue Rockfish from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| AREA | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 3,896 | 43 | 2,779 | 38 | 1,355 | 31 | 898 | 99 | 16 | 97 | 52 | 99 | 4,794 | 51 | 2,795 | 38 | 1,407 | 30 |
| Orange County | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Los Angeles County | 6,419 | 44 | 526 | 43 | 3,198 | 70 | 175 | 81 | 39 | 99 | 135 | 70 | 6,594 | 43 | 565 | 41 | 3,333 | 69 |
| Ventura County | 18,767 | 31 | 12,488 | 38 | 18,644 | 34 | 77 | 72 | 0 | 0 | 645 | 47 | 18,843 | 31 | 12,488 | 38 | 19,289 | 33 |
| Santa Barbara County | 4,392 | 32 | 4,014 | 55 | 7,919 | 57 | 50 | 52 | 0 | 0 | 36 | 72 | 4,442 | 31 | 4,014 | 55 | 7,954 | 56 |
| Southern California | 33,473 | 20 | 19,808 | 27 | 31,116 | 26 | 1,199 | 75 | 55 | 76 | 868 | 37 | 34,673 | 20 | 19,862 | 27 | 31,984 | 25 |

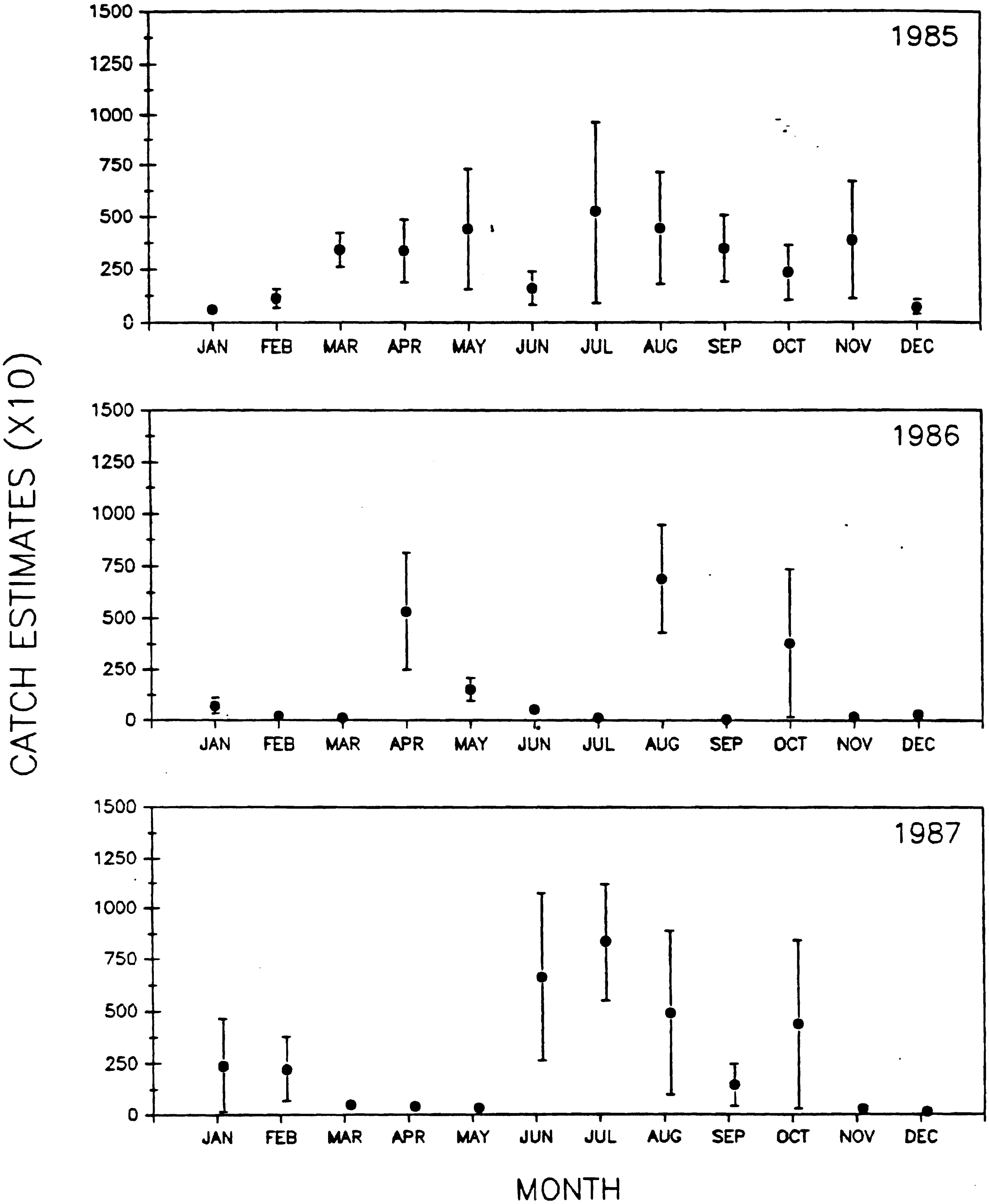



FIGURE 83. Monthly total catch estimates (number of fish) and standard deviations of blue rockfish from on-board observations of southern California commercial passenger fishing vessels.

## Size Composition

Southern California. The blue rockfish length frequency distributions display several modal length groups, one of which represents 1980 year class fish (Figure 84), based on Miller and Geibel's (1973) length at age analyses. These blue rockfish were approximately 230 to 239 mm (9.1 to 9.4 in.) in length and 5 years old in 1985, and represented the major mode in 1987 as 7-year olds, 290 to 299 mm (11.4 to 11.7 in.) fish. The blue rockfish length frequency distributions in Collins and Crooke's study (unpublished manuscript) are also dominated by 5-year-old fish, with smaller modes representing fish up to 12 years old. The presence of these older blue rockfish in the catch is attributed to CPFV's targeting previously unexploited portions of the blue rockfish stock.

Counties. The county length frequency distributions reflect the recruitment and progression of 1980 year class blue rockfish into the CPFV fishery (Figures 85 through 88). The mean lengths for Los Angeles, Ventura, and Santa Barbara counties show a 30 mm (1.2 in.) and greater increase between 1985 and 1986, an indication of the incremental growth in the strong 1980 year class (Figure 89).

## Management Recommendations

In California, blue rockfish population densities reach their peak north of Point Conception (Fitch 1974). In central and northern California, blue rockfish composed 31.4% of the CPFV rockfish catch from 1958 to 1961, making it the top rockfish species (Miller and Gotshall 1965). More recent studies have indicated that the central California blue rockfish stock had the potential of being overfished by

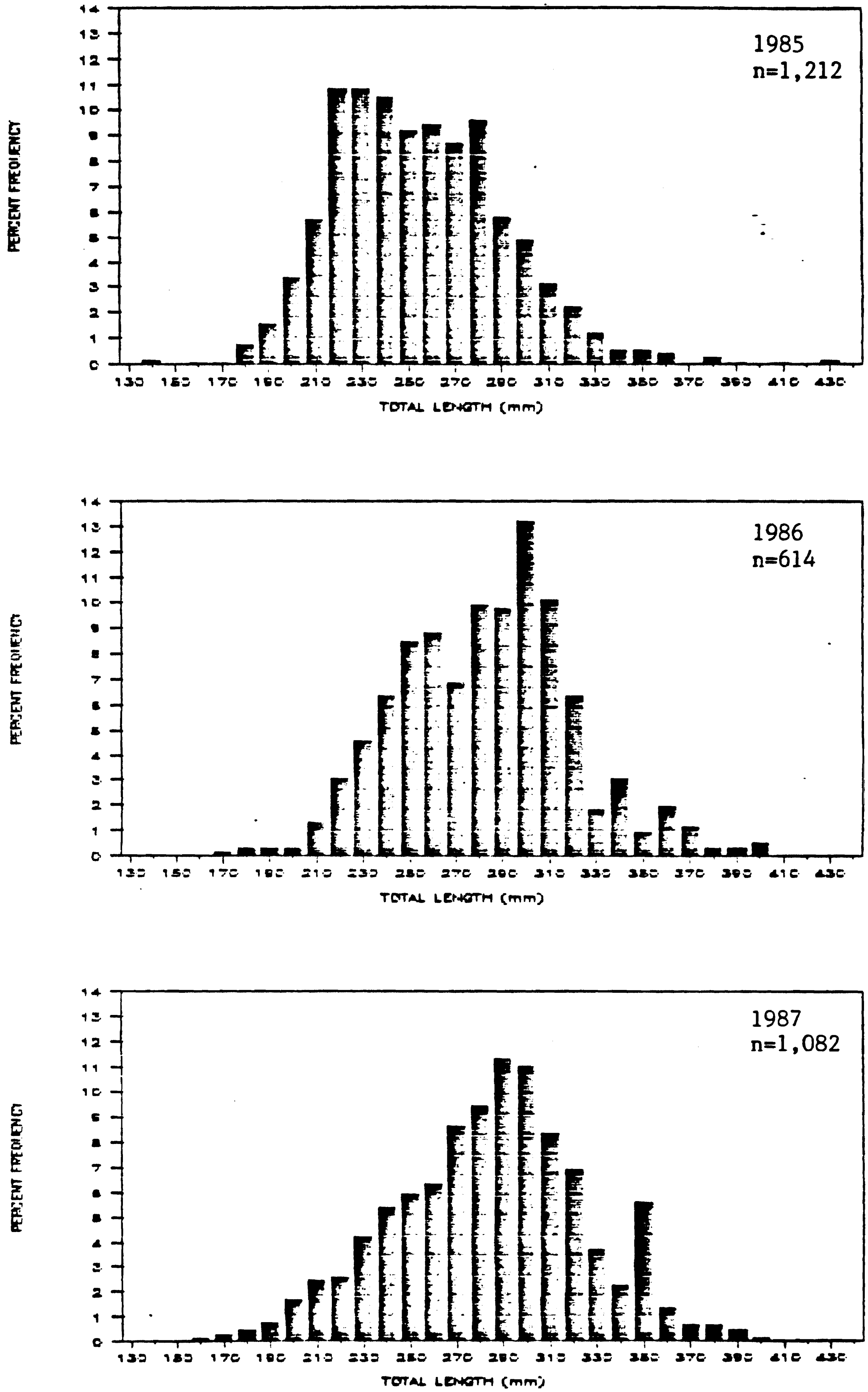



FIGURE 84. Size composition of blue rockfish from on-board observations of southern California commercial passenger fishing vessels.

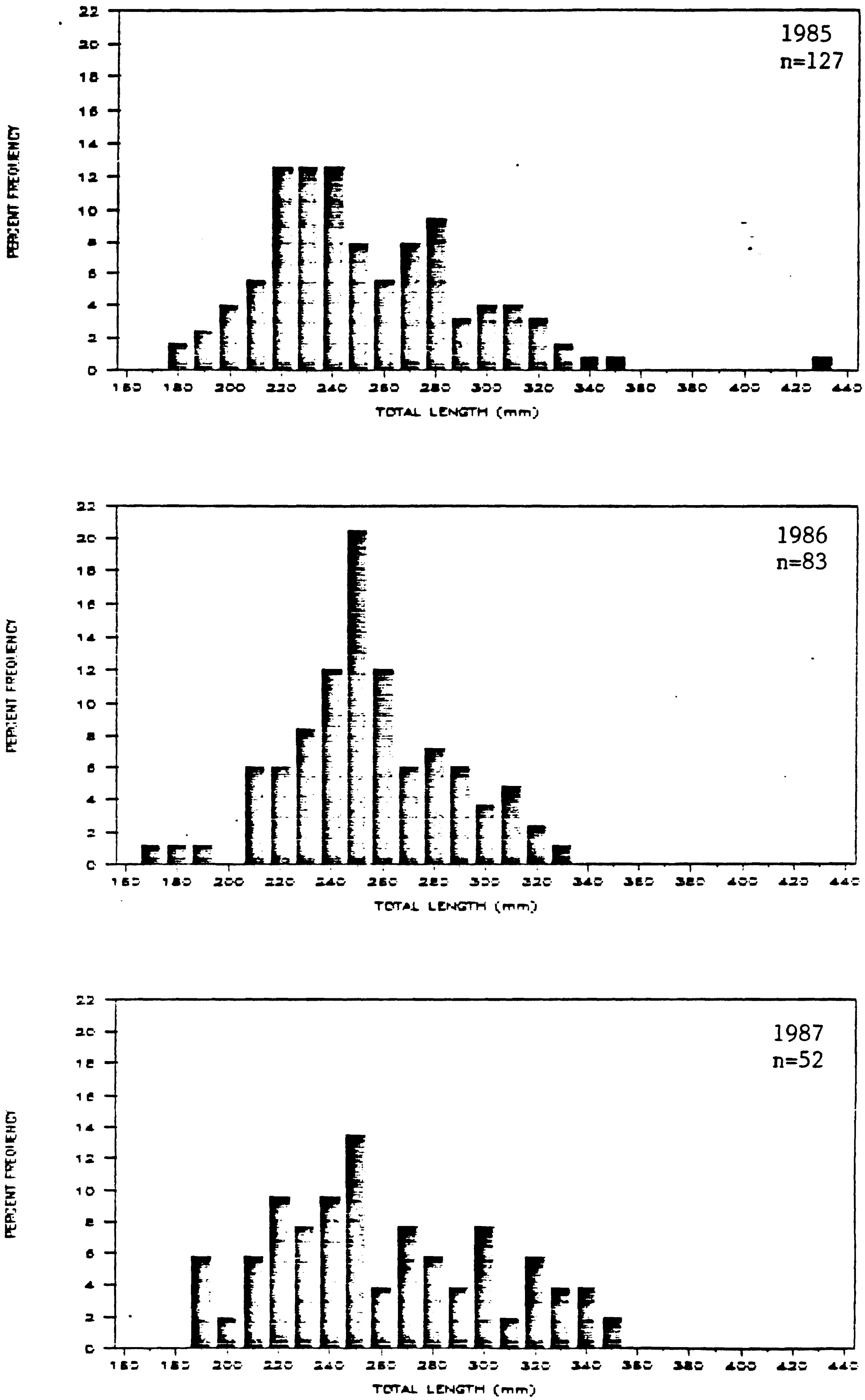
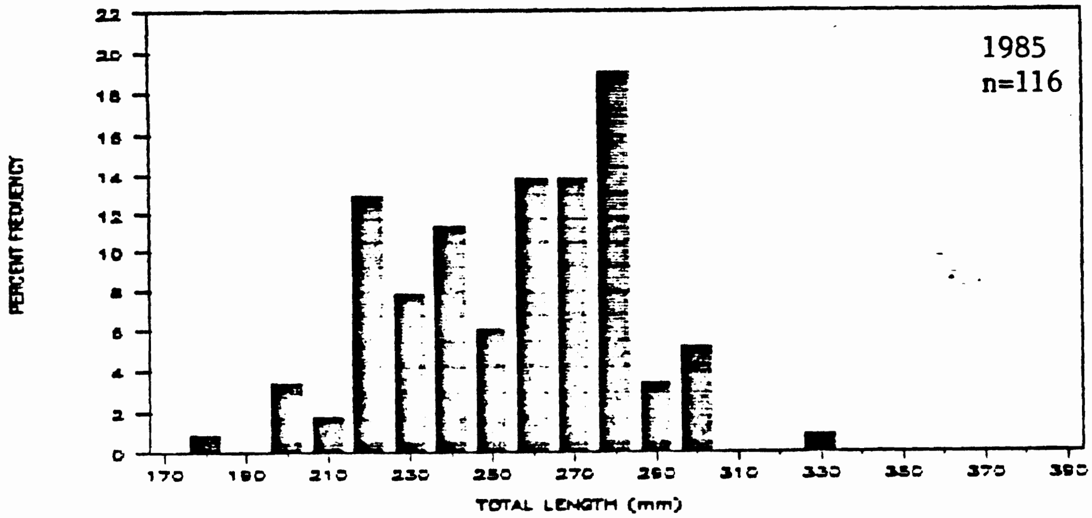



FIGURE 85. Size composition of blue rockfish from on-board observations of San Diego County commercial passenger fishing vessels.



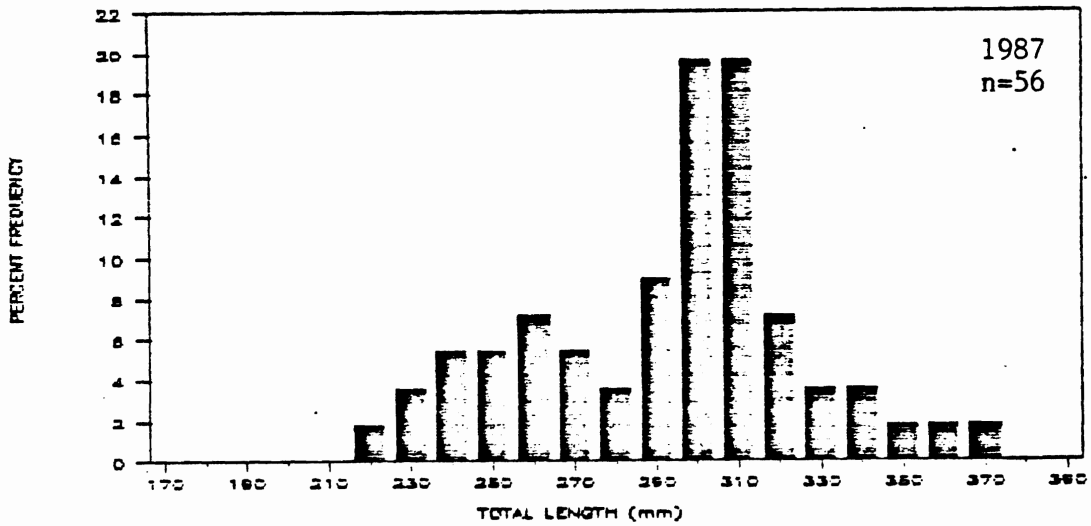




FIGURE 86. Size composition of blue rockfish from on-board observations of Los Angeles County commercial passenger fishing vessels.

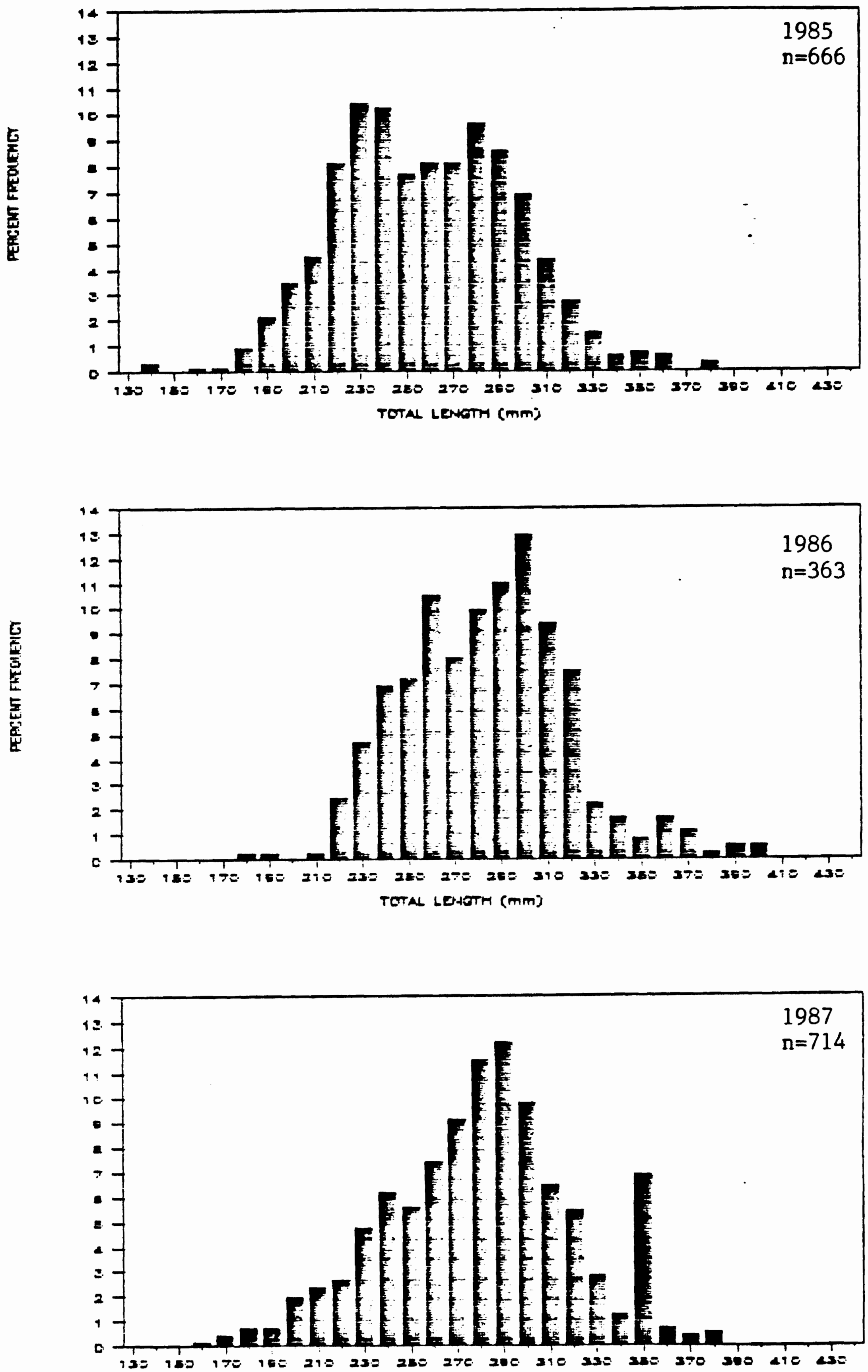



FIGURE 87. Size composition of blue rockfish from on-board observations of Ventura County commercial passenger fishing vessels.

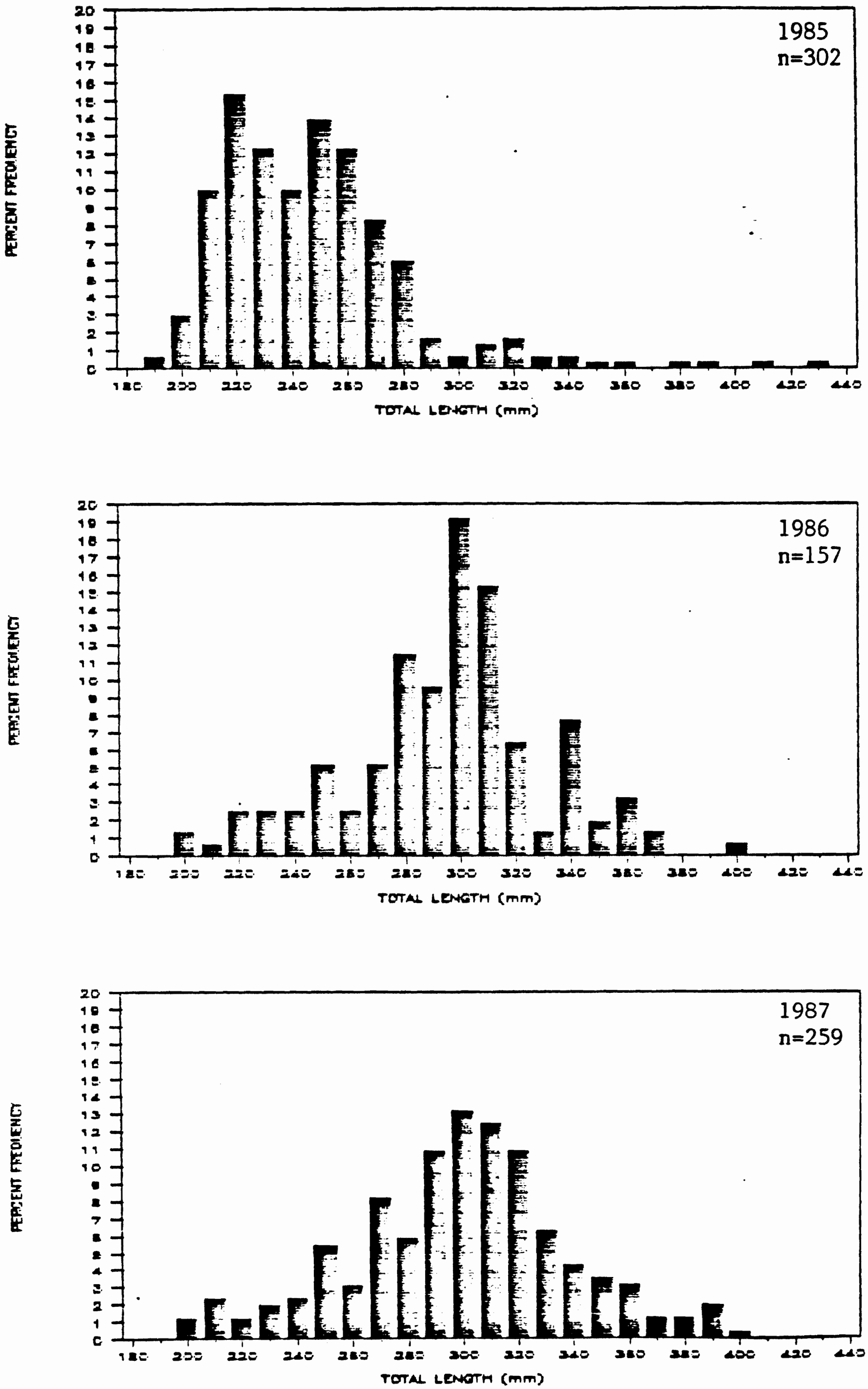



FIGURE 88. Size composition of blue rockfish from on-board observations of Santa Barbara County commercial passenger fishing vessels.

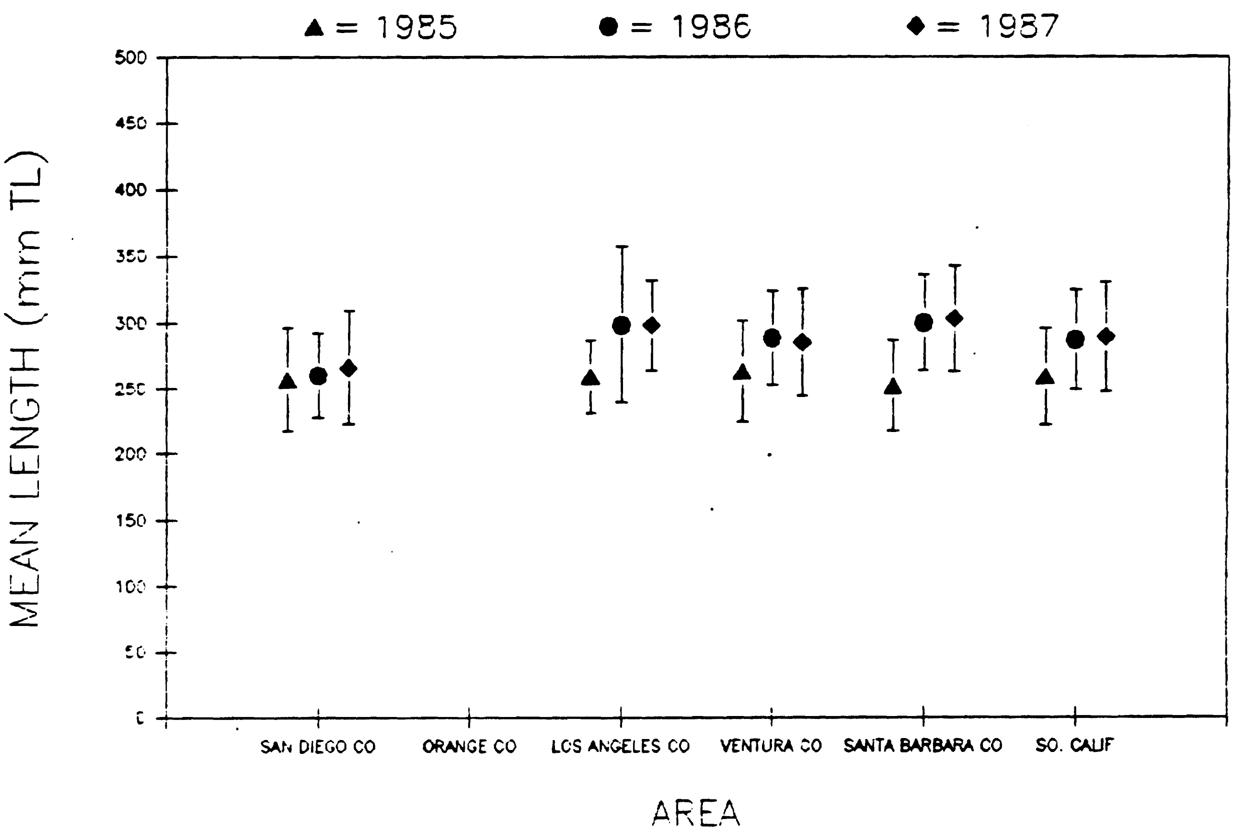



FIGURE 89. Mean lengths and standard deviations of blue rockfish measured on board southern California commercial passenger fishing vessels.

inshore skiff and CPFV fisheries (Miller and Geibel 1973). They discussed a 254-mm (10-in.) minimum size limit and temporal area closures as management options to prevent blue rockfish over-exploitation.

Southern California CPFV blue rockfish catches are concentrated at the northern Channel Islands of San Nicolas, Anacapa, Santa Cruz, Santa Rosa, and San Miguel. The relative inaccessibility of these offshore island fishing sites has limited the amount of skiff and CPFV fishing effort targeting blue rockfish and other fishes inhabiting their waters. The geographic distribution of blue rockfish populations has been a major factor in protecting the southern California blue rockfish stock from over-exploitation.

Our survey results indicate that the southern California CPFV blue rockfish total catches have remained relatively constant from 1985 to 1987. Also, the mean lengths of blue rockfish in the catch have risen within that time interval. Based on these factors, we recommend no changes in current management regulations governing the sport take of blue rockfish, except as they apply to the rockfish group.

## Bocaccio (Scorpaenidae)

### Catch Estimates

Southern California. Bocaccio, a mid-water to bottom-dwelling rockfish, is a major catch component of both the sport and commercial rockfish fisheries in California. The estimated CPFV total catch in southern California fluctuated between 194,000 fish ± 21,300 in 1985 to 107,340 ± 13,950 in 1987 (Table 38). In 1985 and 1986 the bocaccio catch peaked during the winter months of November, December, and January, while the 1987 catch was the greatest in the months of February through April (Figure 90). The southern California total catch estimates for bocaccio calculated by Collins and Crooke (unpublished manuscript) for the period 1976 through 1978 ranged from 342,741 ± 32,845 to 747,489 ± 51,913. This is approximately four times greater than the range of estimates generated from our survey. Apparently, the bocaccio stock being fished by the southern California CPFV fleet in the mid to late 1970's has been substantially reduced in size during the intervening 7 years of fishing activity.

Counties. Los Angeles and Ventura counties were the areas producing the greatest total catches of bocaccio during the 3 years of our study. In each year, they accounted for more than 90% of the total estimated southern California bocaccio catch. Up to 46% of the bocaccio total catch (1985) came from Los Angeles County landings (Table 38). The catch trend over the 3 years of the survey reflected a considerable decline (56%) in that county's bocaccio total catches, from 89,947 in 1985 to 41,124 in 1987. In 1986 up to 58% of the

TABLE 38. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of Bocaccio from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| AREA | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 3,847 | 25 | 4,836 | 32 | 2,902 | 49 | 127 | 53 | 0 | 0 | 0 | 0 | 3,974 | 25 | 4,836 | 32 | 2,902 | 49 |
| Orange County | 2,260 | 39 | 341 | 88 | 943 | 81 | 0 | 0 | 0 | 0 | 0 | 0 | 2,260 | 39 | 341 | 88 | 943 | 81 |
| Los Angeles County | 87,202 | 19 | 55,546 | 21 | 40,969 | 17 | 2,744 | 6 | 421 | 75 | 155 | 98 | 89,947 | 19 | 55,968 | 21 | 41,124 | 17 |
| Ventura County | 87,635 | 16 | 88,417 | 17 | 57,768 | 20 | 204 | 42 | 0 | 0 | 0 | 0 | 87,840 | 16 | 88,417 | 17 | 57,768 | 20 |
| Santa Barbara County | 9,314 | 39 | 1,456 | 38 | 4,607 | 38 | 275 | 61 | 13 | 96 | 0 | 0 | 9,588 | 38 | 1,469 | 38 | 4,607 | 38 |
| Southern California | 190,258 | 12 | 150,596 | 13 | 107,189 | 13 | 3,351 | 8 | 435 | 72 | 155 | 98 | 193,609 | 11 | 151,031 | 13 | 107,344 | 13 |

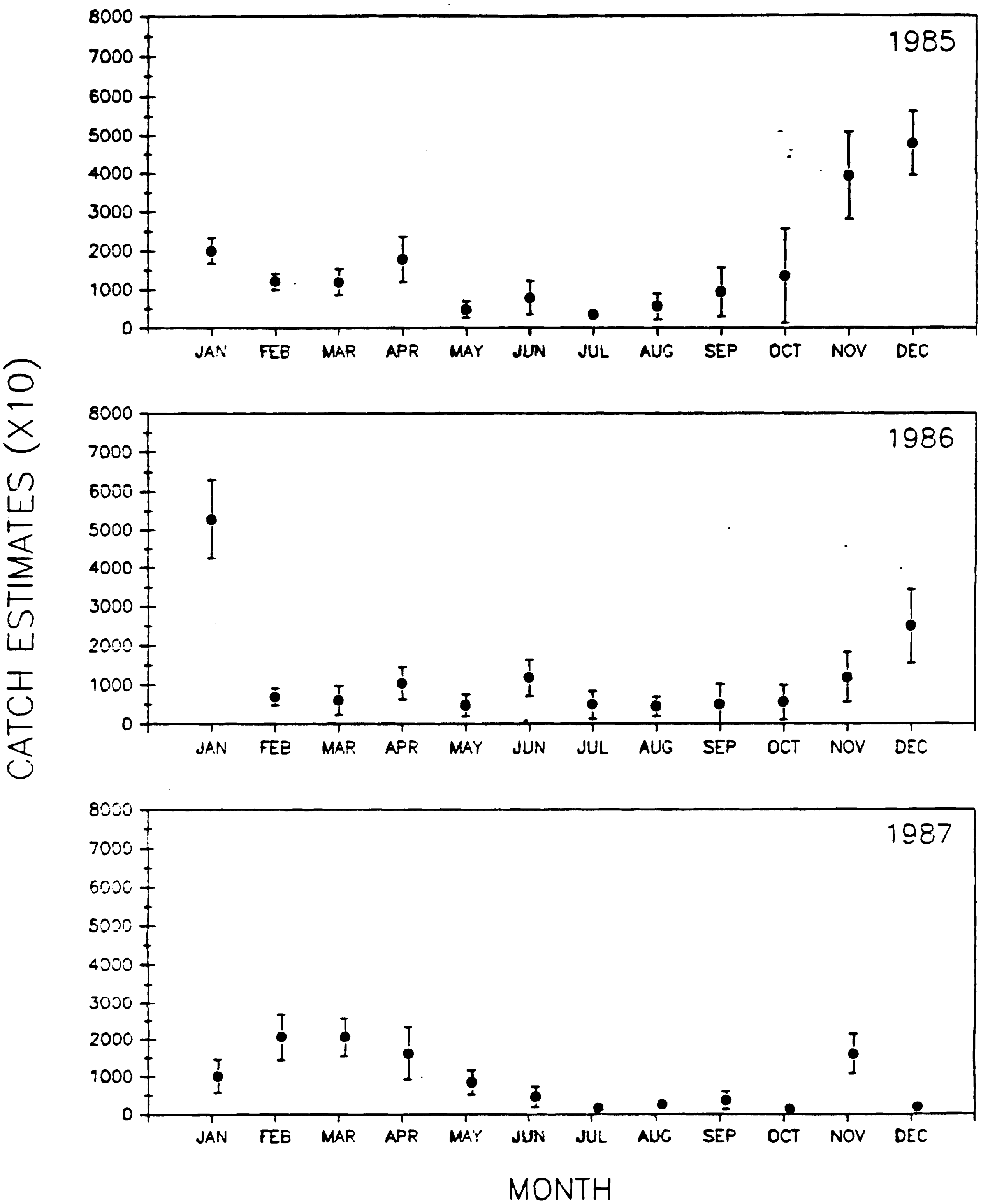



FIGURE 90. Monthly total catch estimates (number of fish) and standard deviations of bocaccio from on-board observations of southern California commercial passenger fishing vessels.

southern California bocaccio total catch was taken by Ventura County CPFV's. From an estimated total catch of 88,417 bocaccio in 1985 to 57,768 in 1987, there was a 35% decline in the Ventura County bocaccio total catch.

Size Composition

Southern California. The mean length of sampled bocaccio (Figure 91) ranged from 341 to 431 mm (13.4 to 17.0 in.). The length frequency distributions (Figure 92) each display a major modal length grouping, which encompasses a large portion of the measured bocaccio catch. Based on MacGregor's (1987) bocaccio length at age relationship, this modal group represents the 1983 year class, young fish which exhibited a rapid progression of growth for each year of this study. Hulbrock (1974) showed bocaccio at this age class range (2-4 years) growing approximately 76 mm (3 in.) per year. The recruitment of the 1983 year class into the fishery caused an upward shift of mean lengths over the 3-year survey period. The annual length frequency distributions for the 1975-78 CPFV bocaccio catch exhibited a similar pattern of a rapidly growing, single, dominant modal year class appearing in each year's catch, except for the final year of that study, 1978. In that year, a second strong year class was also recruited into the fishery, resulting in a lower overall length frequency mean (Collins and Crooke unpublished manuscript).

Counties. A length frequency analysis by county displayed a cline in which the mean length of bocaccio decreased from south to north (Figure 91). At the same time, the mean length by county increased each year in all five counties. This was probably the result of the

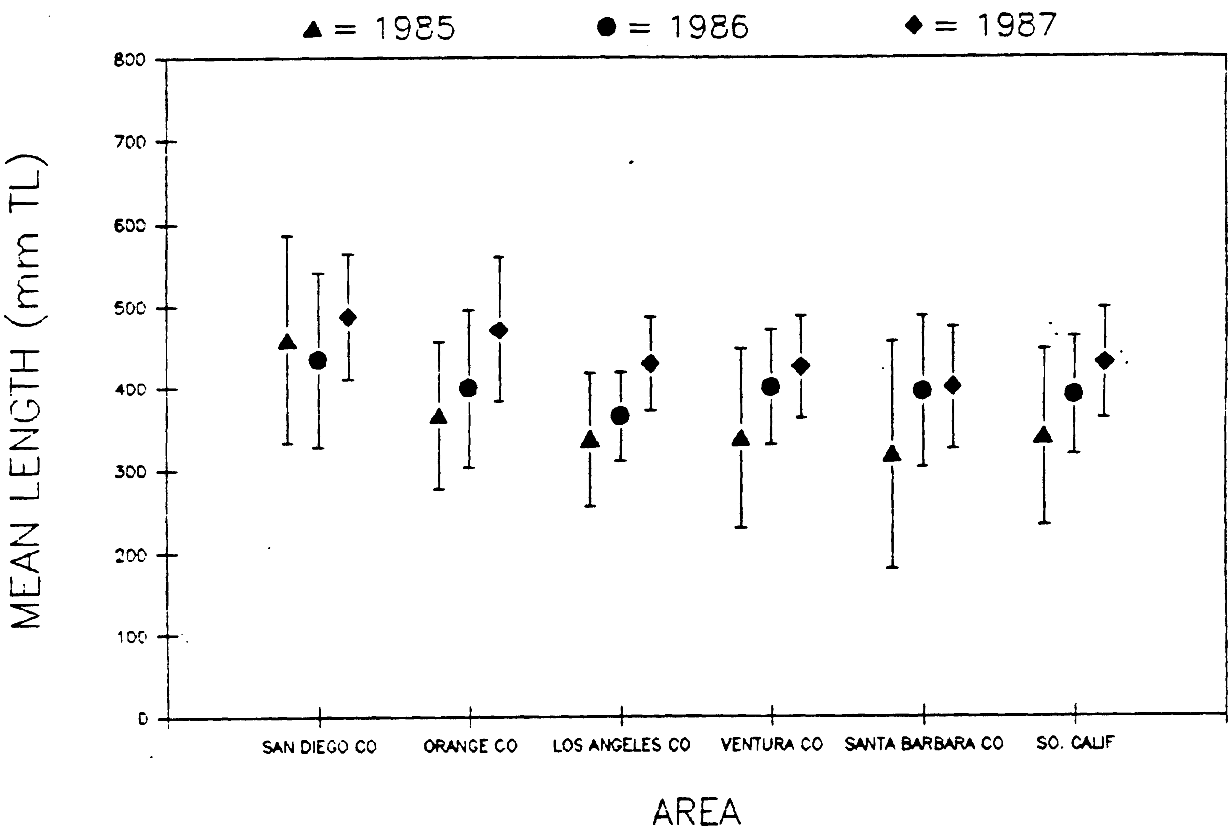



FIGURE 91. Mean lengths and standard deviations of bocaccio measured on board southern California commercial passenger fishing vessels.

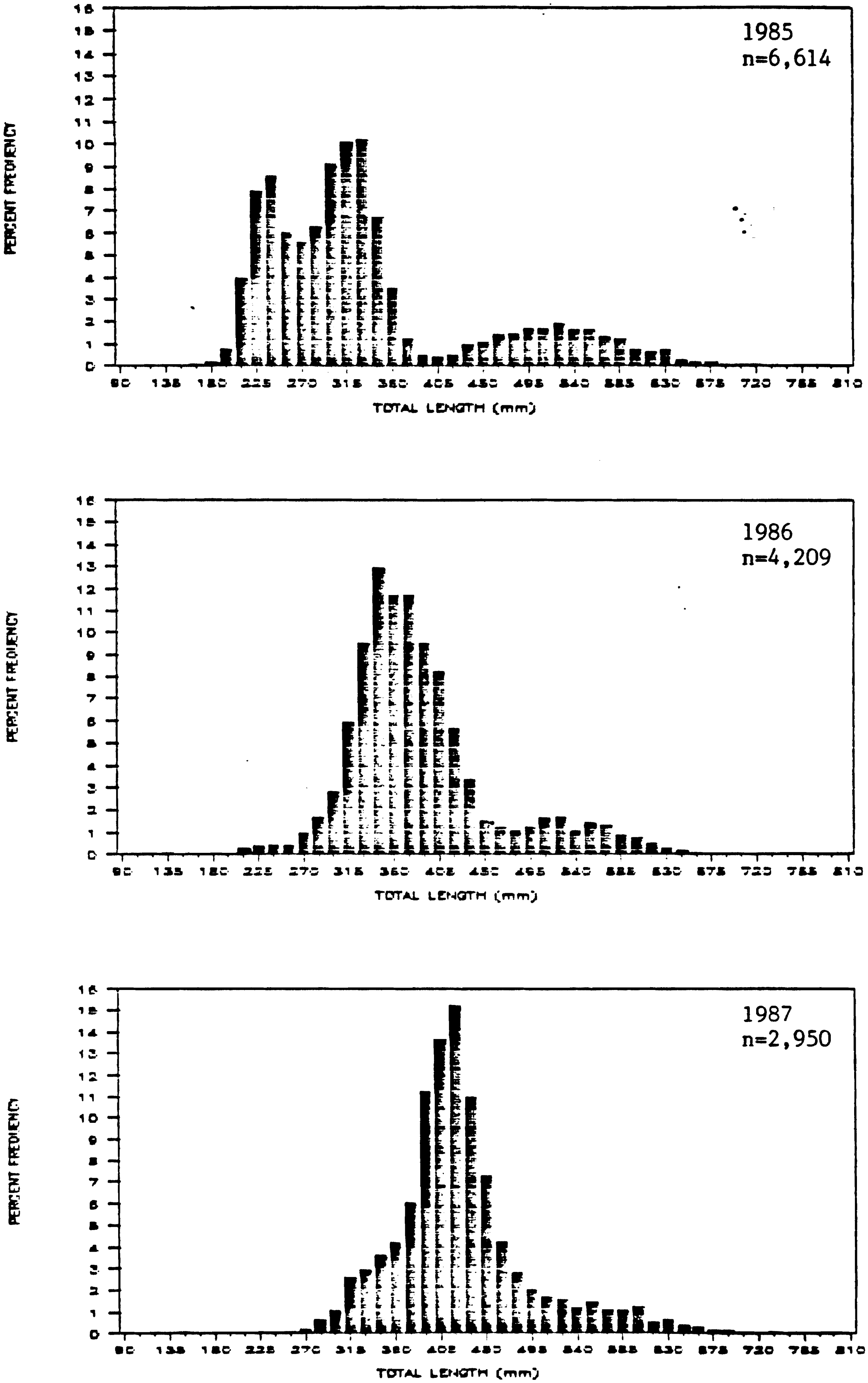



FIGURE 92. Size composition of bocaccio from on-board observations of southern California commercial passenger fishing vessels.

modal 1983 year class growing rapidly and contributing the major portion of each county's annual catch. The length frequency distributions for each county reflect the presence of the 1983 year class as the major modal contributor to the length frequency in each of the 3 years (Figures 93 through 97).

Management Recommendations

Bocaccio is one of the most abundant rockfishes in the southern California bight, and is a species that grows rapidly and can reproduce in as little as 3 years (Frey 1971). The results from Collins and Crooke (unpublished manuscript) and our survey indicate that the bocaccio stock in southern California is subject to large fluctuations at existing levels of fishing effort. The dependence of the current sport fishery on a few strong year classes suggests that the bocaccio fishery may experience large downward trends in the catch when there are several successive years of poor recruitment. Thus, the magnitude of the bocaccio catch may be more directly dependent on oceanic conditions and events, such as an El Nino, which can severely limit successful recruitment, than by the current level of sport and commercial fishing-induced mortality.

We conclude that the CPFV bocaccio catch has fluctuated greatly over the past decade, and, due to the population structure of the southern California stocks, is sensitive to environmental conditions, as well as the level of fishing effort targeting that stock. Because of the recent downward trend in the CPFV bocaccio catch, we feel that there is currently a need to closely monitor the affects of both sport and commercial fishing on the bocaccio stock. If the current catch

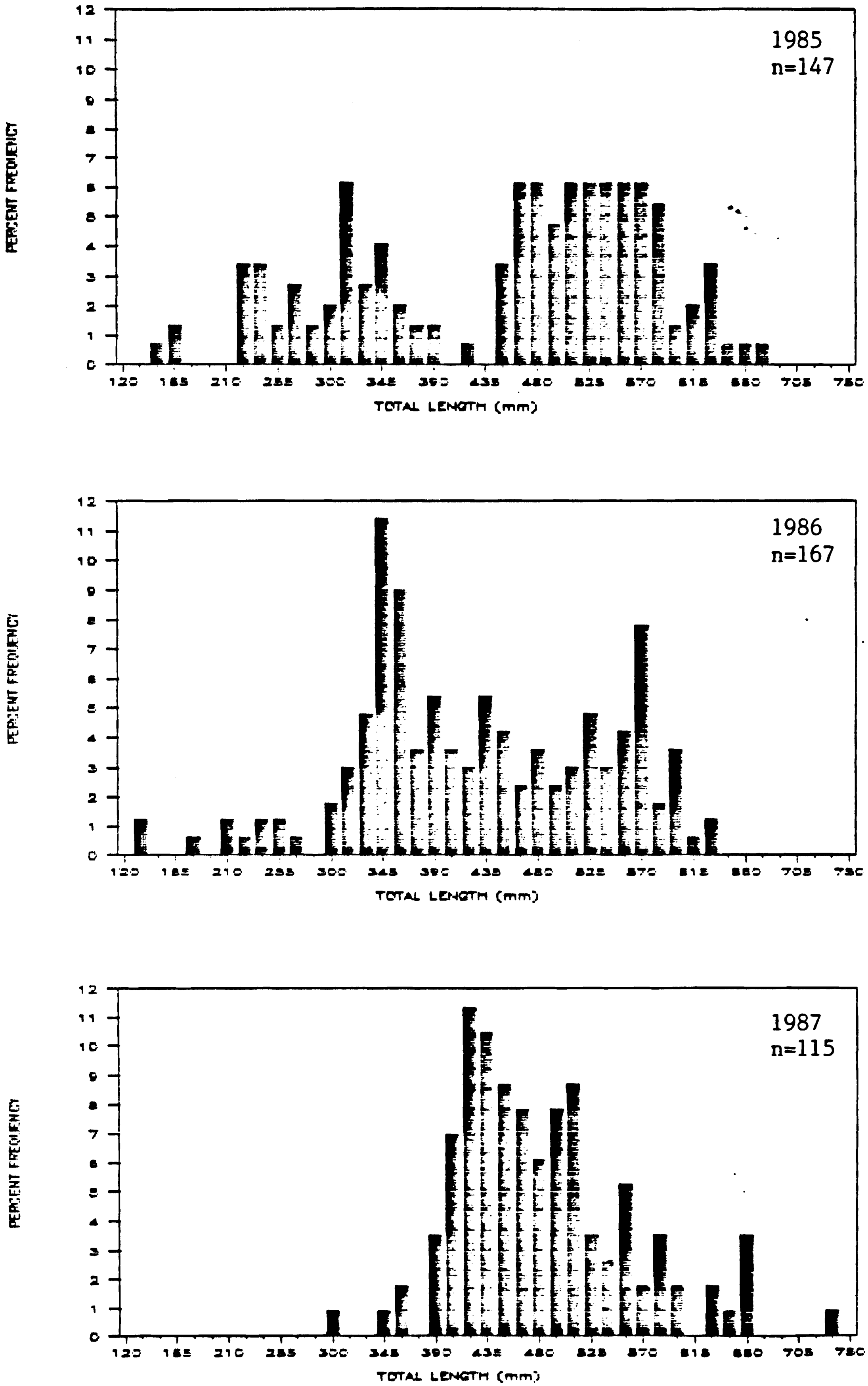



FIGURE 93. Size composition of bocaccio from on-board observations of San Diego County commercial passenger fishing vessels.

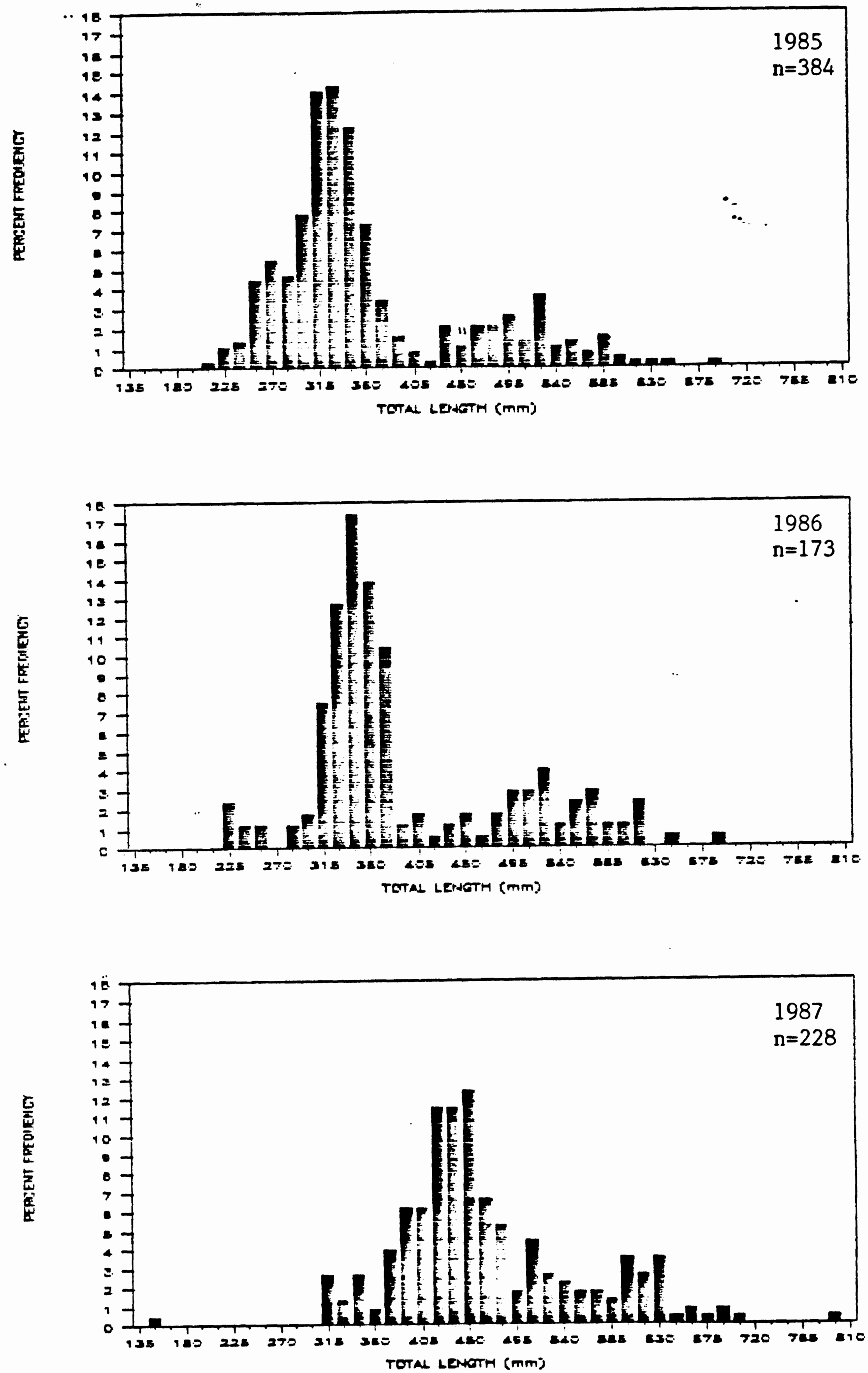



FIGURE 94. Size composition of bocaccio from on-board observations of Orange County commercial passenger fishing vessels.

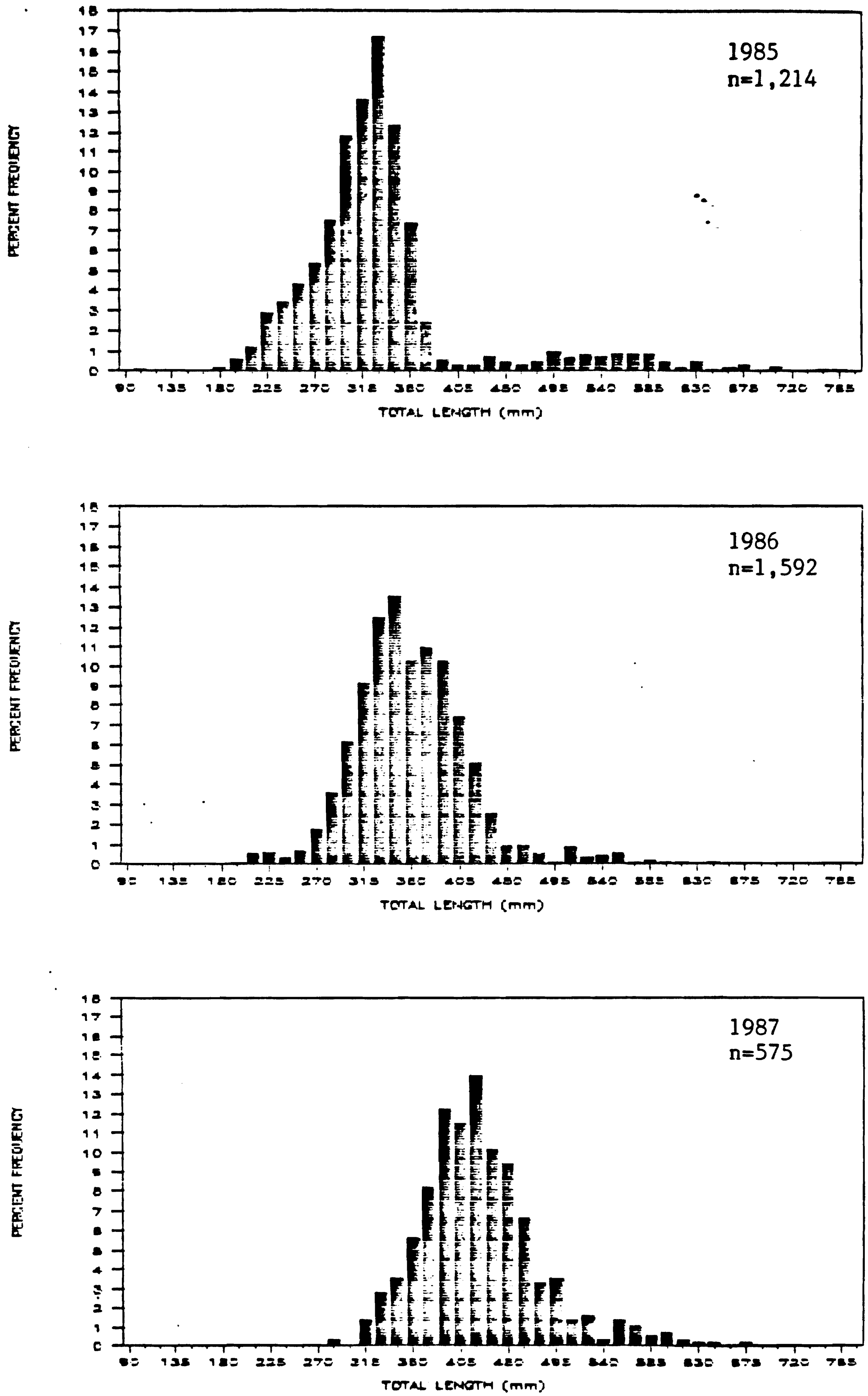



FIGURE 95. Size composition of bocaccio from on-board observations of Los Angeles County commercial passenger fishing vessels.

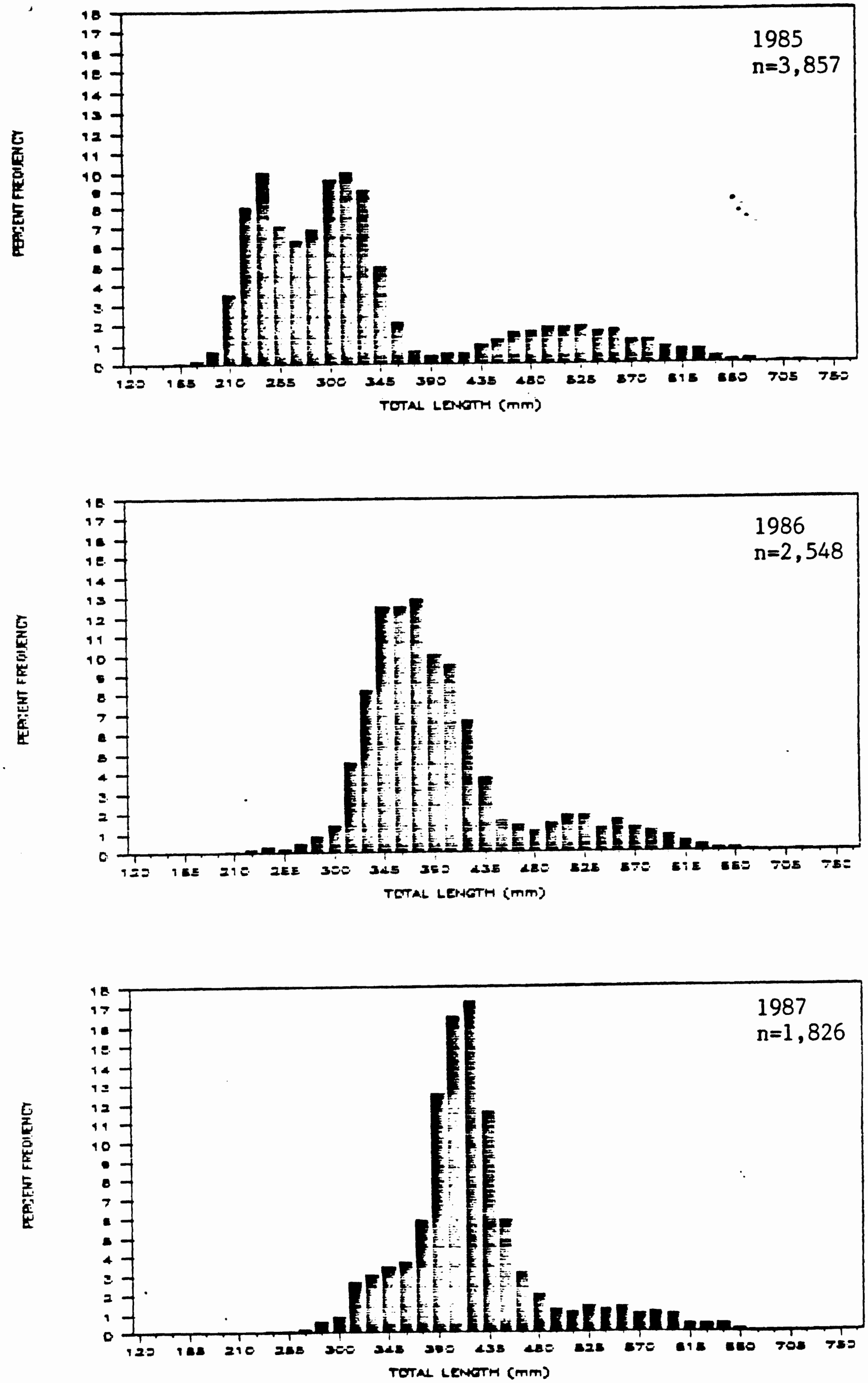



FIGURE 96. Size composition of bocaccio from on-board observations of Ventura County commercial passenger fishing vessels.

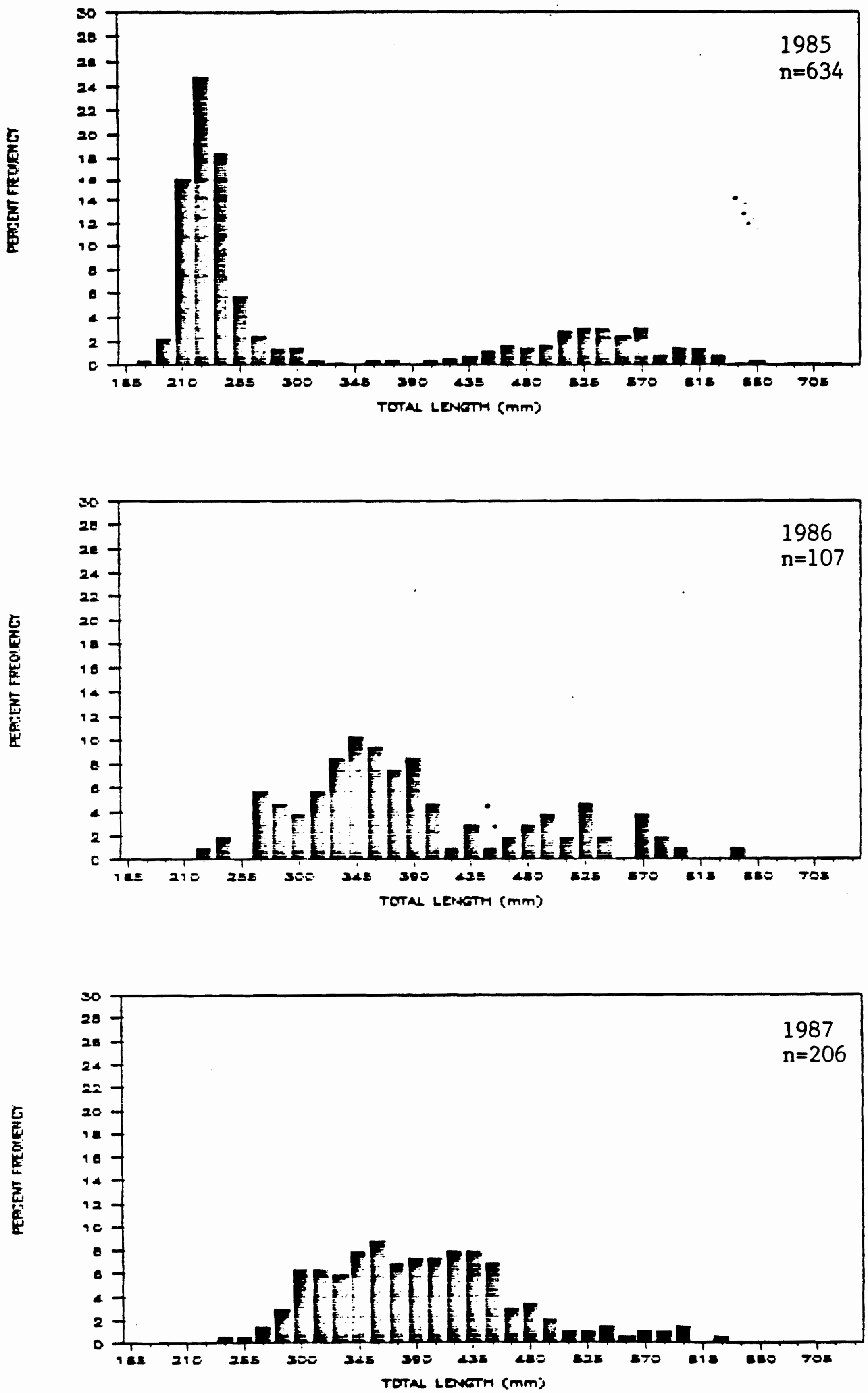



FIGURE 97. Size composition of bocaccio from on-board observations of Santa Barbara County commercial passenger fishing vessels.

decline continues, restrictions on both the sport and commercial harvest of bocaccio (beyond the recommendations for rockfishes as a group), should be implemented. In both fisheries, area closures might be the most effective means of reducing fishing pressure that targets bocaccio.

## Chilipepper (Scorpaenidae)

### Catch Estimates

Southern California. Chilipepper is a schooling, mid-water-dwelling rockfish species that is an important component of sport and commercial fisheries in southern California. Our chilipepper total catch estimates increased each year from 42,690 fish ± 7,684 in 1985 to 149,673 ± 28,438 in 1987 (Table 39). Collins and Crooke (unpublished manuscript) had chilipepper total catches ranging from 151,540 ± 15,554 in 1976 to 225,102 ± 34,687 in 1978. Chilipepper was the third ranked rockfish species in the 1975-1978 survey (11.2% frequency of occurrence), and was the second ranking rockfish species (12.1%) in our survey (Table 30).

The largest total catches of chilipepper were made in the late fall, winter, and spring (Figure 98). These are the months when the southern California CPFV fleet traditionally shifts much of its fishing effort away from surface species to target bottom fish species, including rockfishes. Chilipepper are particularly vulnerable to sport anglers from mid-November through mid-March, the time period during which pre-spawning and spawning schools are formed (Frey 1971). The anomalies in the expected fishing pattern, as in the low chilipepper catches in January and March of 1985, March of 1986, and December of 1987, were most likely due to weather conditions that limited fishing effort for chilipepper and other rockfishes during those months.

TABLE 39. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of Chilipepper from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| AREA | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 1,947 | 68 | 888 | 82 | 13,444 | 68 | 0 | 0 | 0 | 0 | 0 | 0 | 1,947 | 68 | 888 | 82 | 13,444 | 68 |
| Orange County | 2,239 | 56 | 1,380 | 99 | 493 | 72 | 0 | 0 | 0 | 0 | 0 | 0 | 2,239 | 56 | 1,380 | 99 | 493 | 72 |
| Los Angeles County | 4,108 | 26 | 26,932 | 44 | 35,243 | 44 | 58 | 98 | 0 | 0 | 62 | 98 | 4,166 | 27 | 26,932 | 44 | 35,305 | 44 |
| Ventura County | 34,060 | 22 | 40,868 | 23 | 98,693 | 22 | 279 | 98 | 34 | 99 | 0 | 0 | 34,339 | 22 | 40,902 | 23 | 98,693 | 22 |
| Santa Barbara County | 0 | 0 | 293 | 96 | 1,739 | 98 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 293 | 96 | 1,739 | 98 |
| Southern California | 42,354 | 18 | 70,362 | 22 | 149,611 | 19 | 337 | 83 | 34 | 99 | 62 | 98 | 42,690 | 18 | 70,396 | 22 | 149,673 | 19 |

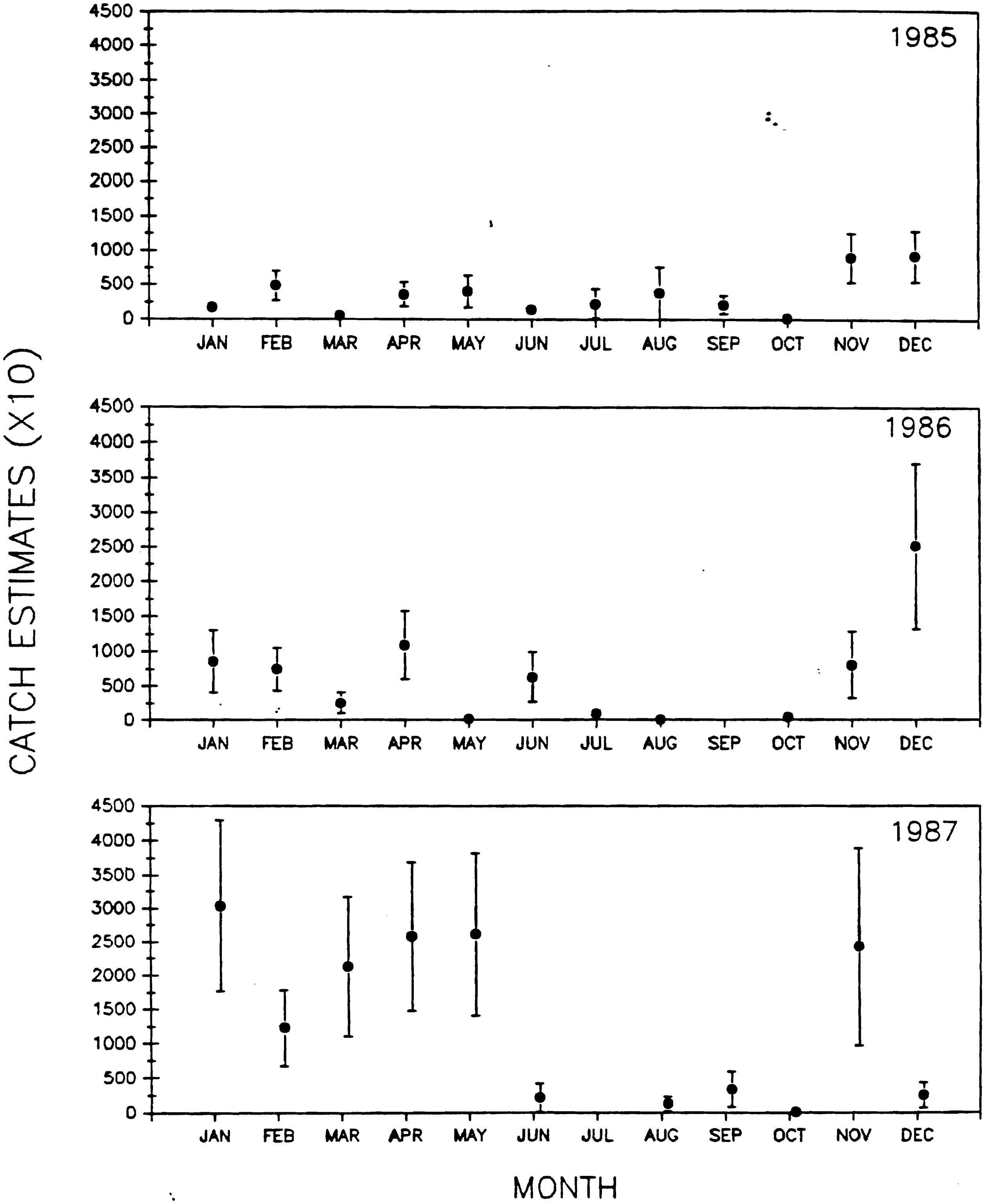



FIGURE 98. Monthly total catch estimates (number of fish) and standard deviations of chilipepper from on-board observations of southern California commercial passenger fishing vessels.

Counties. The largest chilipepper total catches came from Ventura County, which accounted for from 58% (1986) to 80% (1985) of the southern California chilipepper total catch. Most of the Ventura catch came from a relatively small number of fishing sites. In 1986 and 1987, four fishing sites provided 75% and 94%, respectively, of the Ventura County chilipepper catches (Ally et al. 1988). These sites were two areas in the Santa Barbara Channel, Rincon Dome Reef and Short Banks, and the northern and southern sections of the Santa Rosa Flats area around Santa Rosa Island.

Size Composition

Southern California. The length frequency distributions show a shift in size class structure over the 3 survey years (Figure 99). In 1985 the sample mean was at 333 mm (13.1 in.) and there were two clearly defined modal length groups, one centered at 220 to 229 mm (8.7 to 9.0 in.) and one at 340 to 349 mm (13.4 to 13.8 in.) These corresponded to 3-year-old and 5-year-old chilipepper, respectively (MacGregor 1987). In 1986 the mean was 330 mm (13.0 in.) and there were three prominent modal groups at 280 to 289 mm (11.0 to 11.4 in.), 350 to 359 mm (14.0 to 14.2 in.), and 430 to 439 mm (17.0 to 17.3 in.). These groups were representative of 4-, 6-, and 8-year-old and older chilipepper, respectively (MacGregor 1987). In 1987 the mean length was 307 mm (12.1 in.) and a single modal group at 290 to 299 mm (11.4 to 11.8 in.) dominates the distribution. Chilipepper at that size would be approximately 5 years old. Modal age classes older than age five did not appear in the 1987 sampled catch. Based on the progression of chilipepper size classes in the CPFV catch, it appears

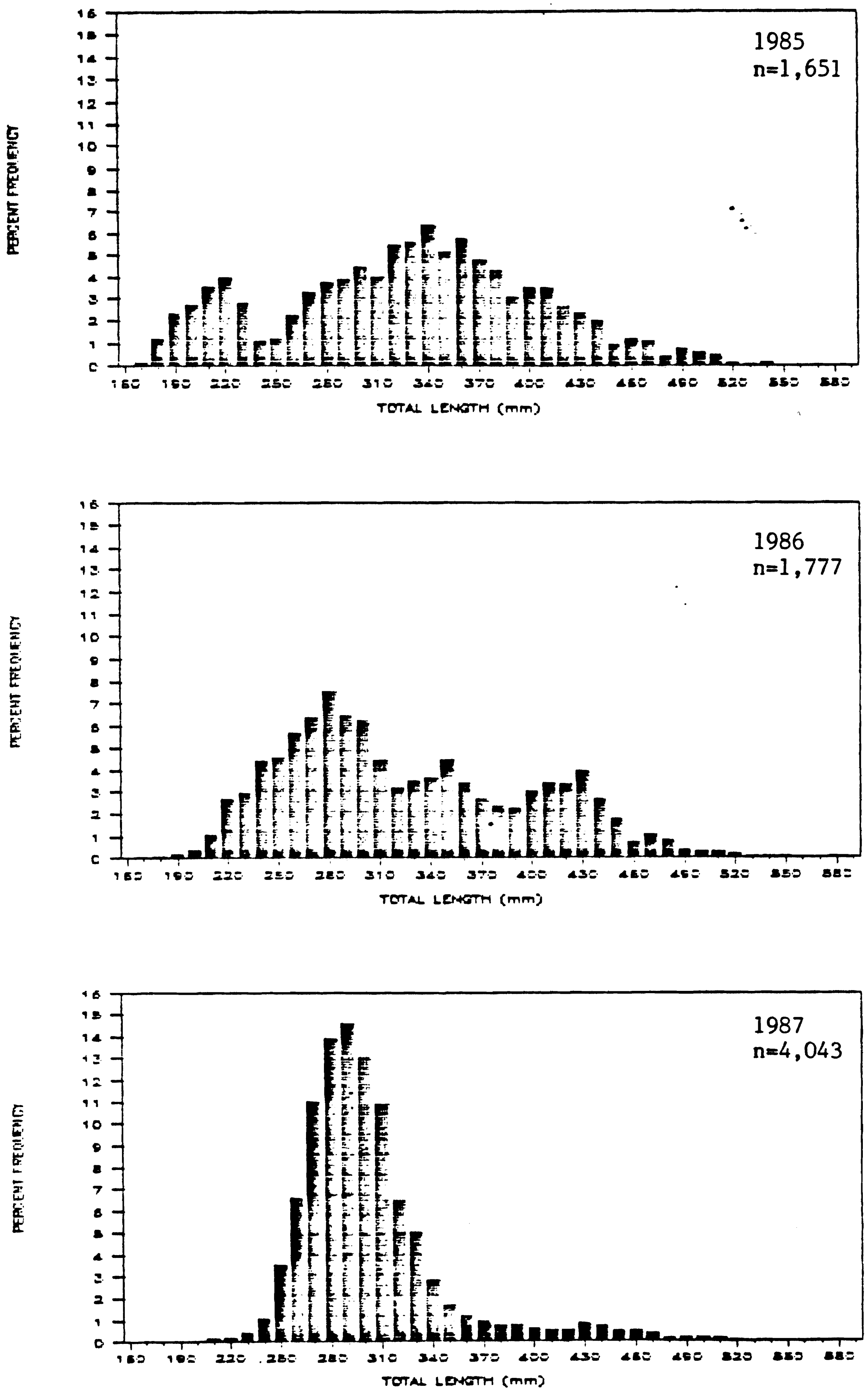



FIGURE 99. Size composition of chilipepper from on-board observations of southern California commercial passenger fishing vessels.

that the fishery was heavily dependent on a 1982 year class that, by 1987, accounted for a major portion of the sampled catch.

During the 1975 to 1978 period surveyed by Collins and Crooke (unpublished manuscript), the 4-year length frequency mean was 380 mm (15 in.), and there were no major shifts in length frequency modes until 1978, when a new mode at 300 to 309 mm (11.8 to 12.2 in.) entered the fishery.

Counties. The length frequency distributions for Orange, Los Angeles, and Ventura counties reflect the shift to younger age classes in chilipepper from 1985 through 1987 (Figures 100 through 102). San Diego County chilipepper length frequencies display a different sequence in which the size structure shifted to larger, older fish between 1985 and 1986, and then reverted to distinctly younger modal age groups in 1987 (Figure 103). There were insufficient data to develop length frequency distributions for Santa Barbara County in 1985 and 1986. The 1987 length frequency plot displays a single modal length group at 330 to 339 mm (12.9 to 13.3 in.), which, based on MacGregor's (1987) study, was representative of 5-year-old chilipepper (Figure 104).

The county mean length plots closely follow the trends displayed in the length frequency analyses (Figure 105). For each county, the mean lengths for 1987 were 25 mm (0.9 in.) or more lower than the 1985 mean lengths.

## Management Recommendations

Chilipepper range from Vancouver Island, British Columbia to Magdelena Bay, Baja California, and are commonly found in depths of 40

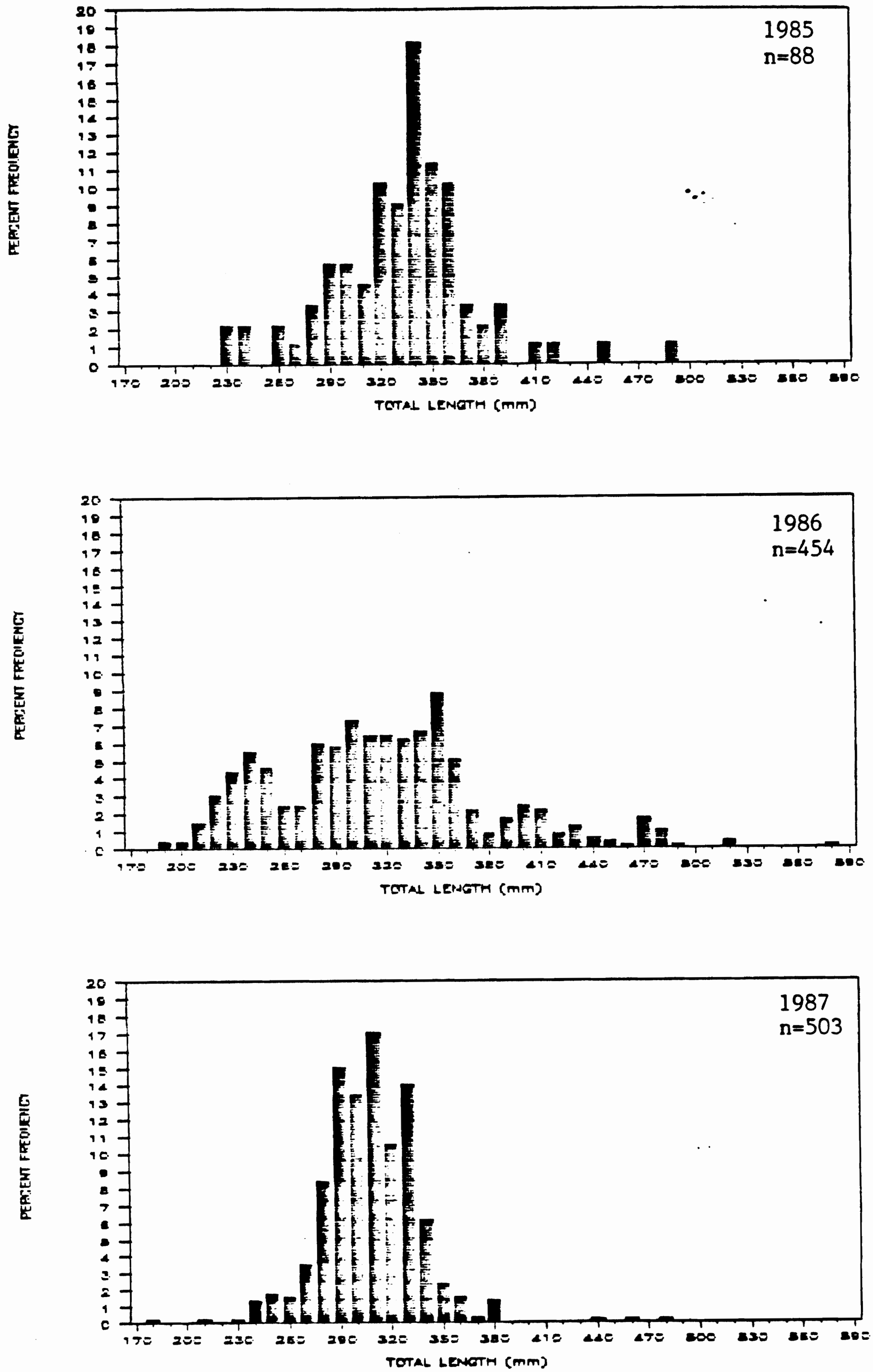



FIGURE 100. Size composition of chilipepper from on-board observations of Orange County commercial passenger fishing vessels.

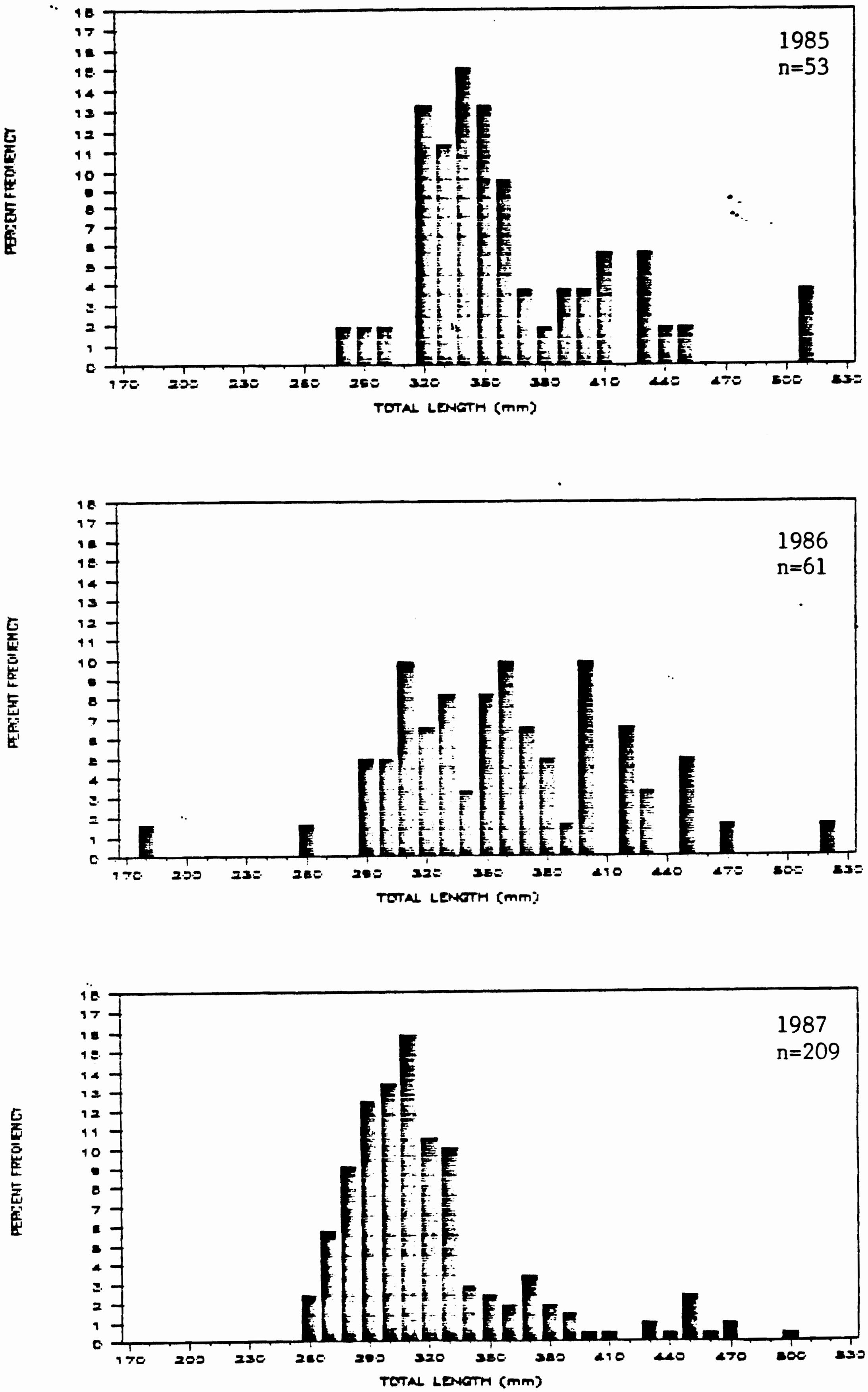



FIGURE 101. Size composition of chilipepper from on-board observations of Los Angeles County commercial passenger fishing vessels.

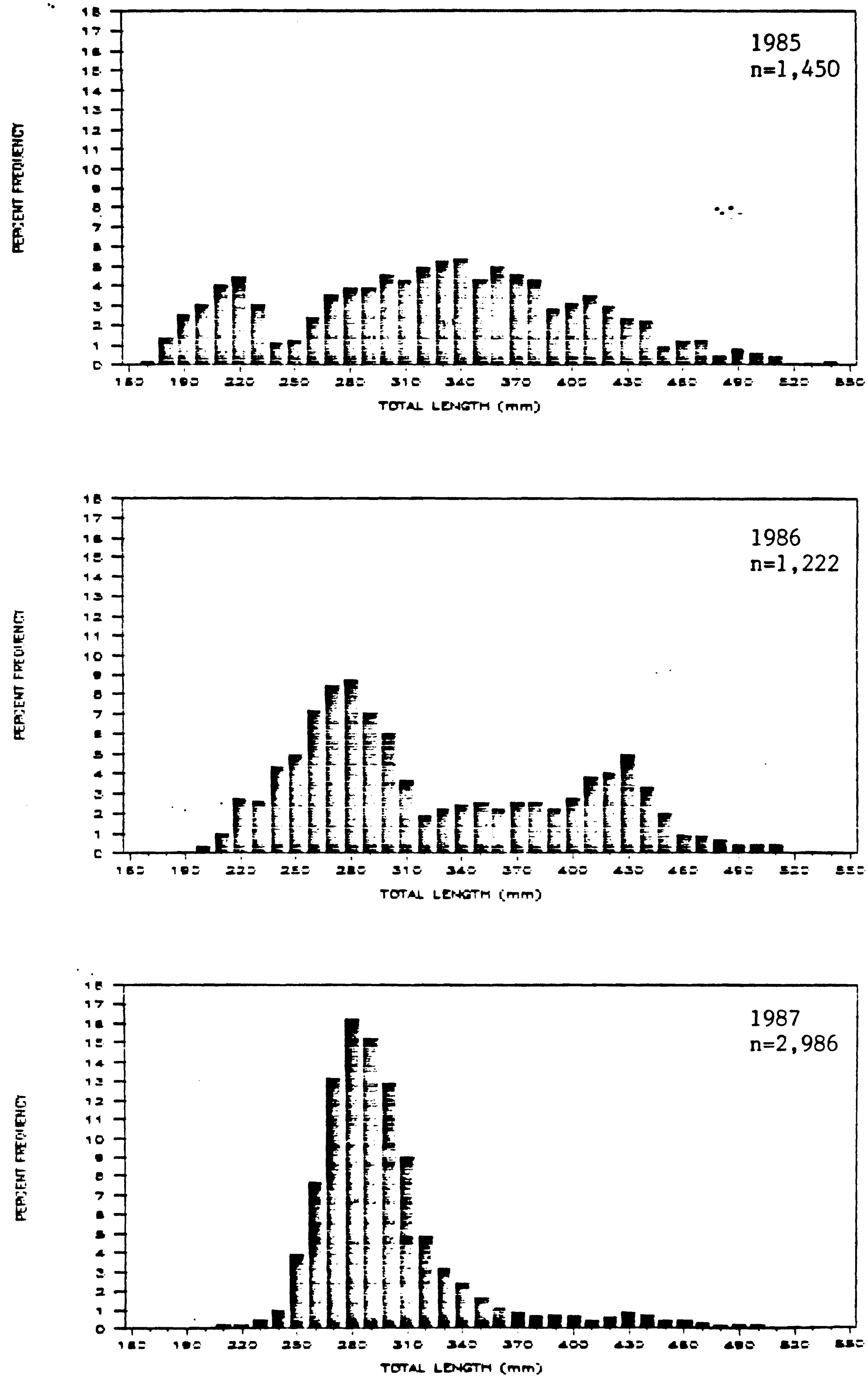



FIGURE 102. Size composition of chilipepper from on-board observations of Ventura County commercial passenger fishing vessels.

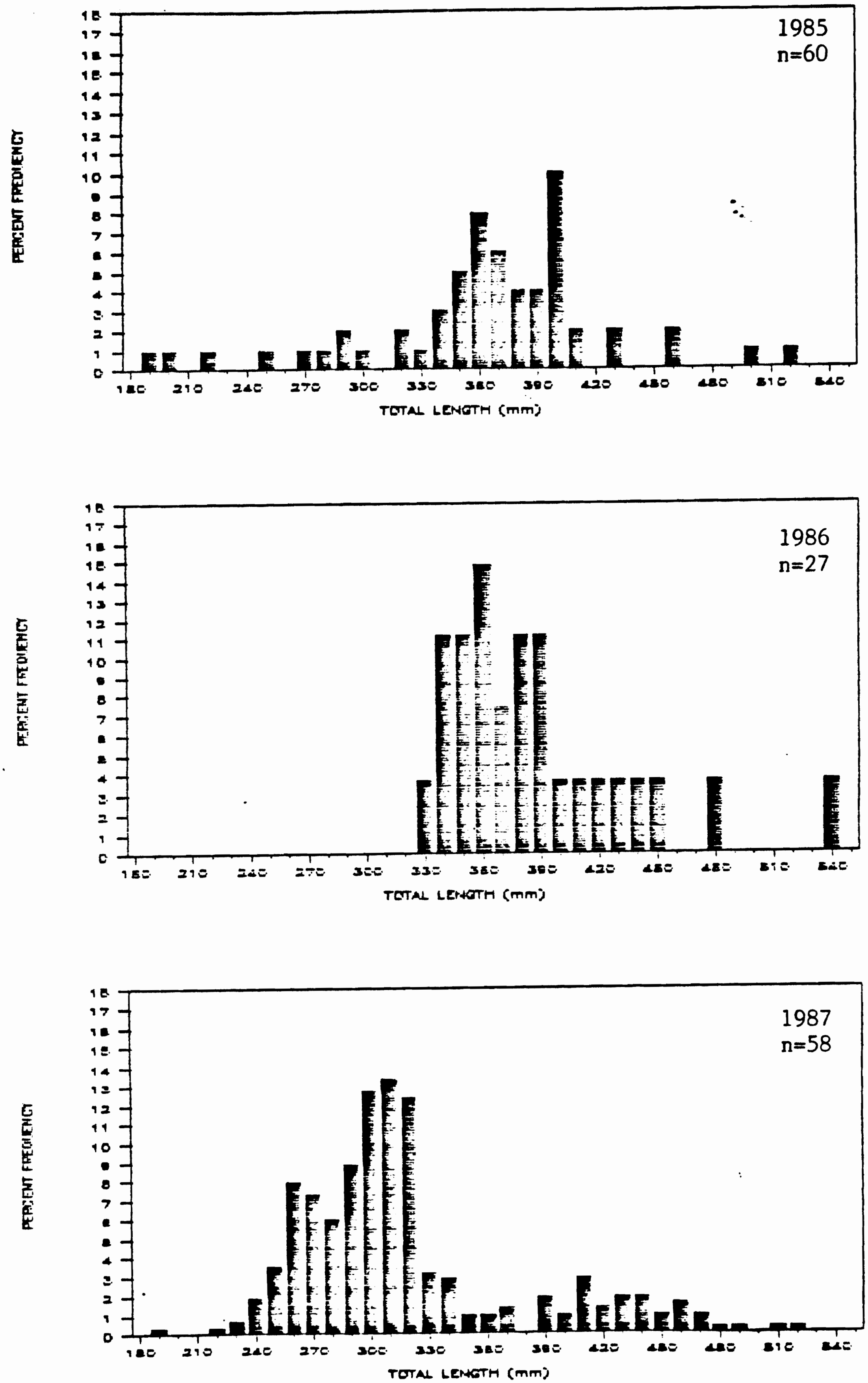



FIGURE 103. Size composition of chilipepper from on-board observations of San Diego County commercial passenger fishing vessels.

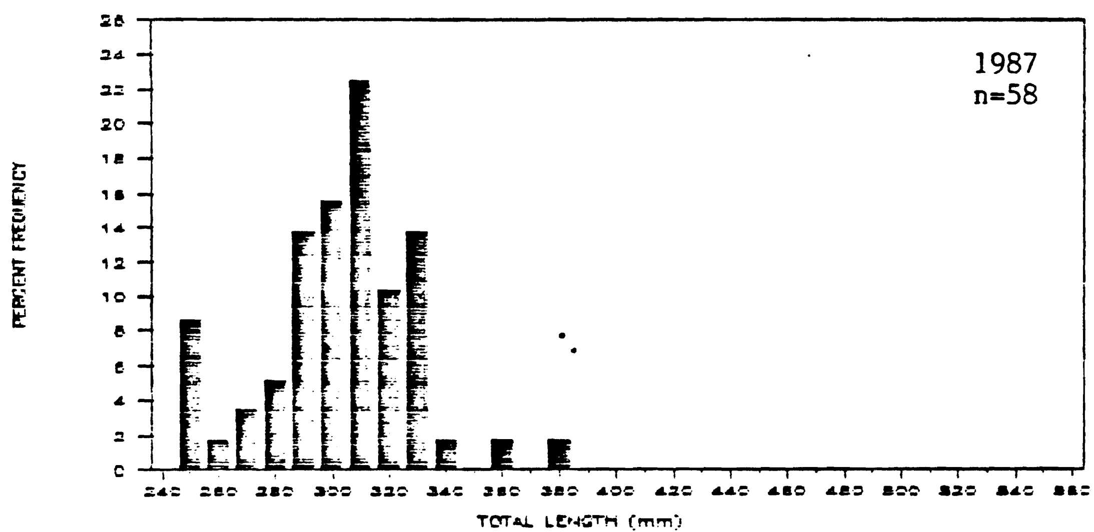



FIGURE 104. Size composition of chilipepper from on-board observations of Santa Barbara County commercial passenger fishing vessels.

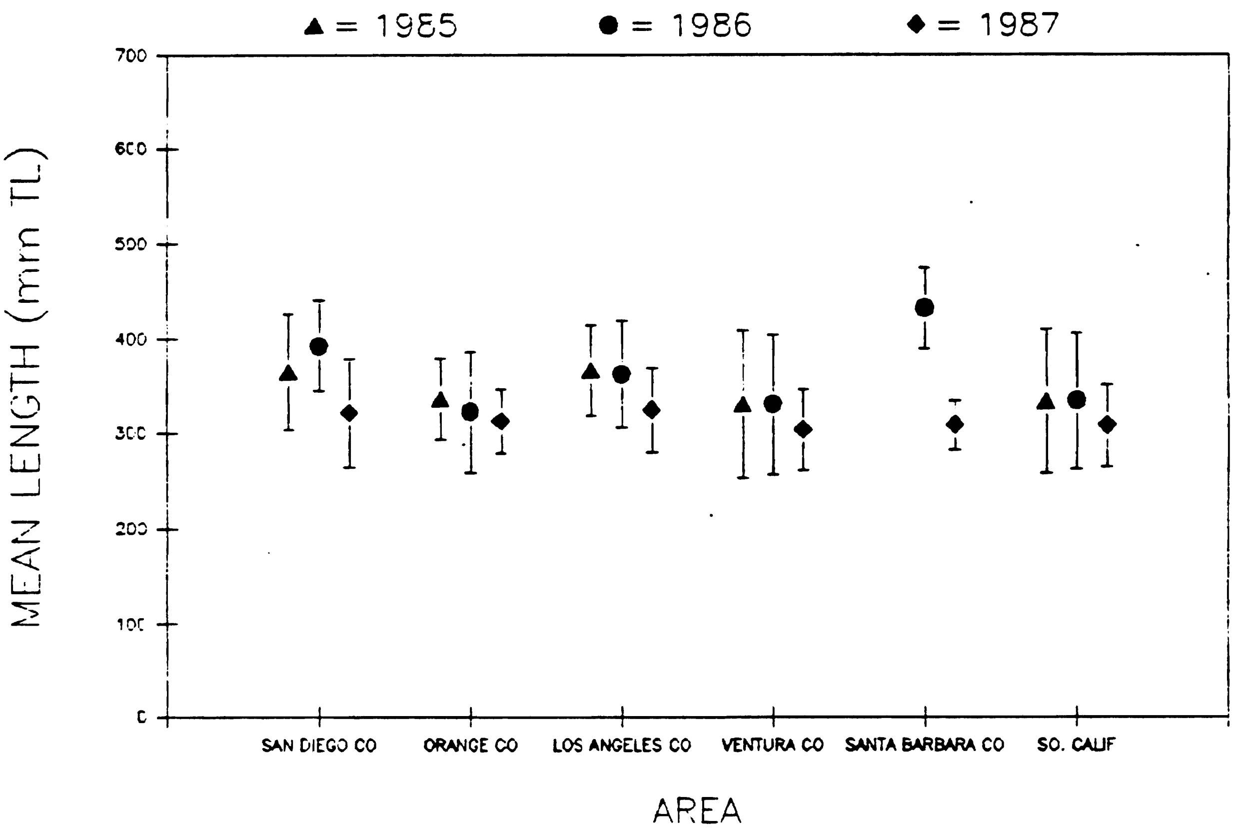



FIGURE 105. Mean lengths and standard deviations of chilipepper measured on board southern California commercial passenger fishing vessels.

to 183 fm (Miller and Lea 1972). In California, chilipepper are fished commercially from San Diego to Fort Bragg, and the sport fishery for chilipepper occurs throughout the state.

In a 1958 to 1960 northern California sport fish survey, the average annual CPFV catch of chilipepper was estimated at 2,165 fish, or approximately 0.3% of the CPFV rockfish catch (Miller and Gotshall 1965).

Frey (1971) stated that the chilipepper catch was stable and overfishing was not occurring. He also stated that, in the area of maximum chilipepper abundance (Santa Barbara to Fort Bragg), the exploitable stocks were restricted to a narrow 3-mile band of continental shelf within the chilipepper preferred habitat depth range.

The results of our survey, when compared to catch data from Collins and Crooke (unpublished manuscript), and Miller and Gotshall's (1965) sport fish survey, point to an increased utilization of chilipepper by the CPFV fishery over the past 20 years. In southern California, chilipepper ranked among the top 10 rockfish species in each of the 3 years surveyed (Table 30). In 1987 chilipepper was the most abundant rockfish species in the CPFV catch, composing 22% of the estimated rockfish total catch.

Chilipepper have consistently maintained a position as one of the most important rockfish in the CPFV catch over the past 15 years. It also continues to be a commercially important catch species in southern California. The dependence of the CPFV fishery on a few age classes, and the shift to younger age classes seen in our length frequency data, may indicate that chilipepper stocks are being harvested at or near the maximum sustainable yield. Also, the fact that the major portion of the chilipepper catch is concentrated at a relatively few fishing sites is potential cause for concern. We recommend that the chilipepper catch be closely monitored over the next few years in order to sort out the environmental and man-caused impacts on the southern California chilipepper stock. If sport fishing pressure and/or commercial fishing pressure is/are found to be depleting the chilipepper stock, then appropriate conservation measures should be formulated and implemented.

## Cowcod (Scorpaenidae)

### Catch Estimates

Southern California. Cowcod is a deep-water, bottom-dwelling rockfish species that is eagerly sought by anglers because of the large sizes it can attain. In our survey, cowcod total catch estimates ranged from 1,840 fish ± 443 to a high of 2,763 ± 387 (Table 40). Cowcod composed an average of 0.3% of the rockfish total catch during the 3 years surveyed (Table 30). Collins and Crooke (unpublished manuscript) computed cowcod total catch estimates ranging from 6,729 ± 1,067 in 1977 to 9,987 ± 1,209 in 1976. Over the 4 years of their survey, cowcod composed 0.6% of the rockfish total catch.

The cowcod total catch peaked in late fall through early spring, the time of year when southern California CPFV's normally target offshore bottom fishes (Figure 106). Although the seasonal time period of heavy cowcod catches did not vary over the 3 years, the total catch peaks did occur in different months each year: in December during 1985, in January during 1986, and in April during 1987.

Counties. Los Angeles and Ventura county landings had the largest cowcod total catches in each of the 3 years. The two counties contributed an average of 91% of the southern California cowcod total catch.

### Size Composition

Southern California. The cowcod length frequency distributions display considerable variation from year to year (Figure 107). A core group of fish larger than 420 mm (16.5 in.) was present in the sampled

TABLE 40. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of Cowcod from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| AREA | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 180 | 45 | 106 | 72 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 180 | 45 | 106 | 72 | 0 | 0 |
| Orange County | 206 | 84 | 0 | 0 | 38 | 99 | 0 | 0 | 0 | 0 | 0 | 0 | 206 | 84 | 0 | 0 | 38 | 99 |
| Los Angeles County | 1,383 | 20 | 498 | 40 | 988 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 1,383 | 20 | 498 | 40 | 988 | 33 |
| Ventura County | 887 | 21 | 1,223 | 30 | 1,078 | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 887 | 21 | 1,223 | 30 | 1,078 | 36 |
| Santa Barbara County | 107 | 75 | 13 | 96 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 107 | 75 | 13 | 96 | 0 | 0 |
| Southern California | 2,763 | 14 | 1,840 | 23 | 2,103 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 2,763 | 14 | 1,840 | 23 | 2,103 | 24 |

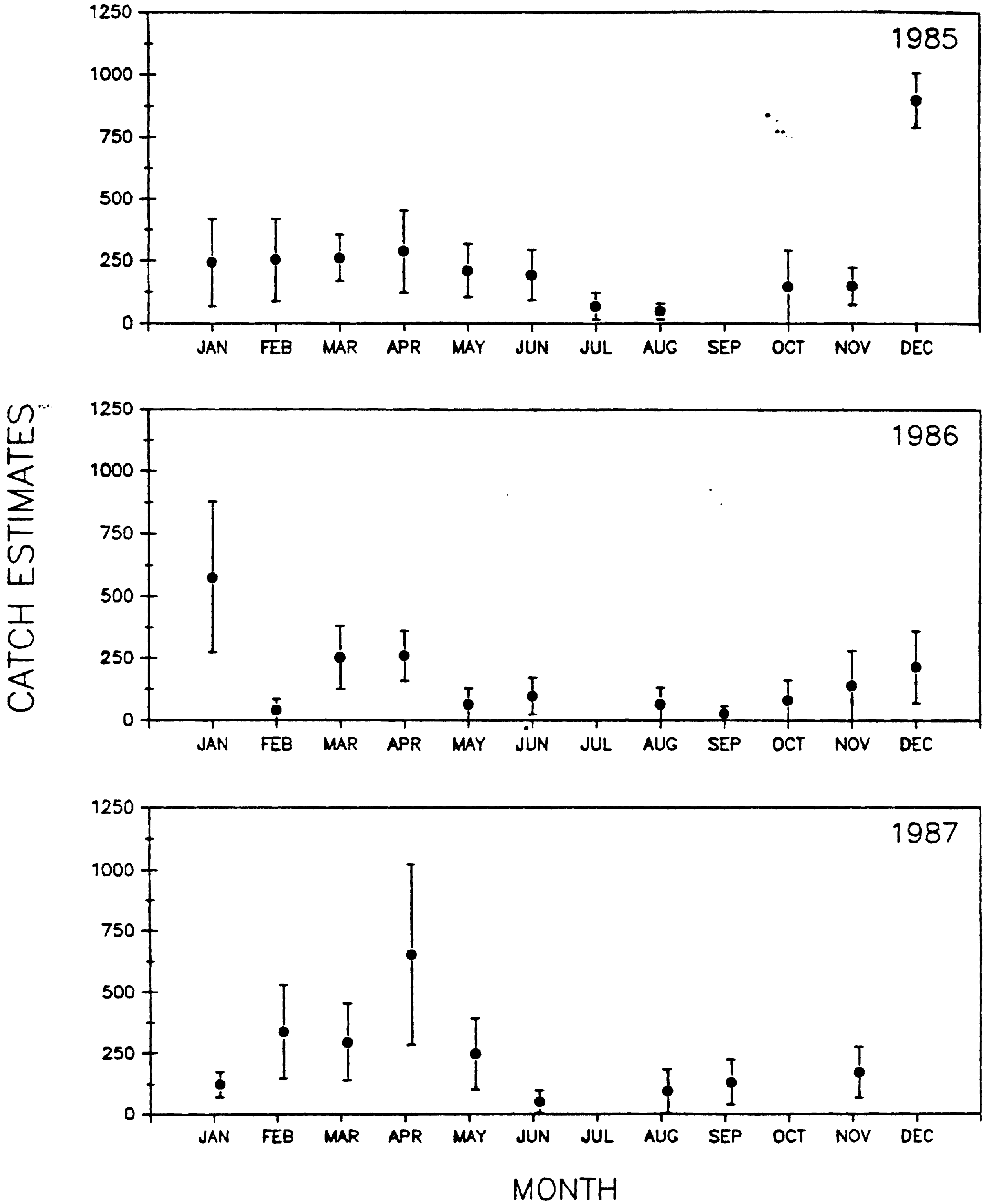
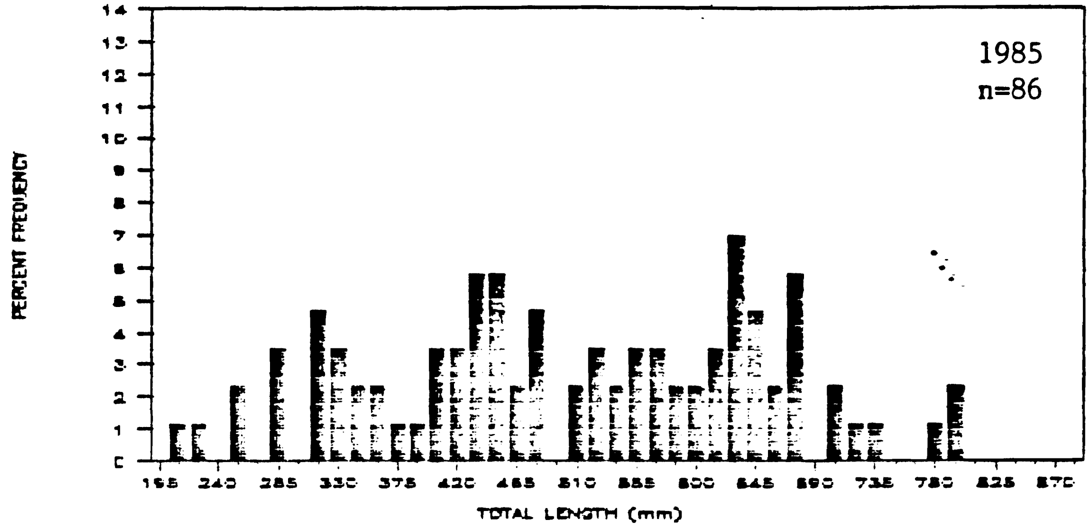
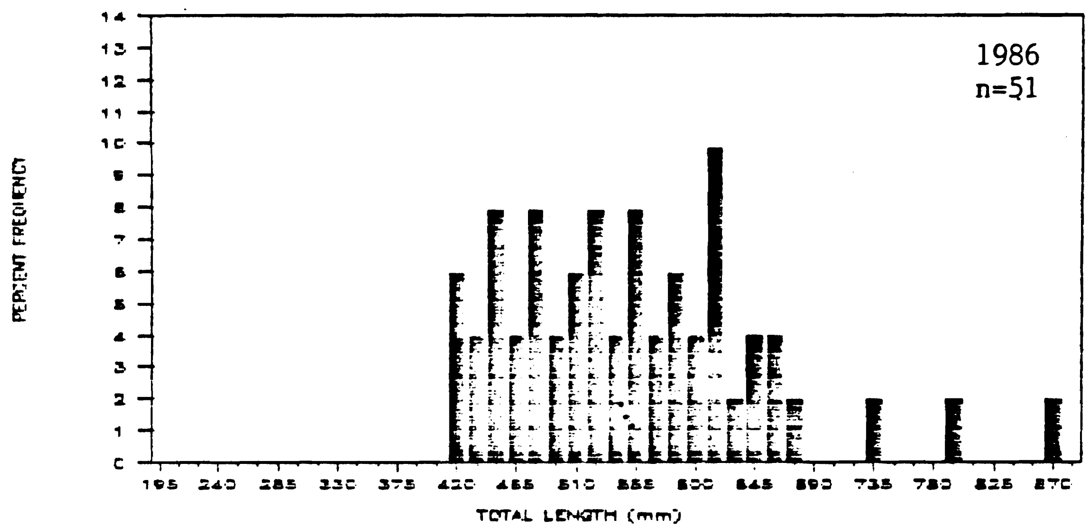



FIGURE 106. Monthly total catch estimates (number of fish) and standard deviations of cowcod from on-board observations of southern California commercial passenger fishing vessels.



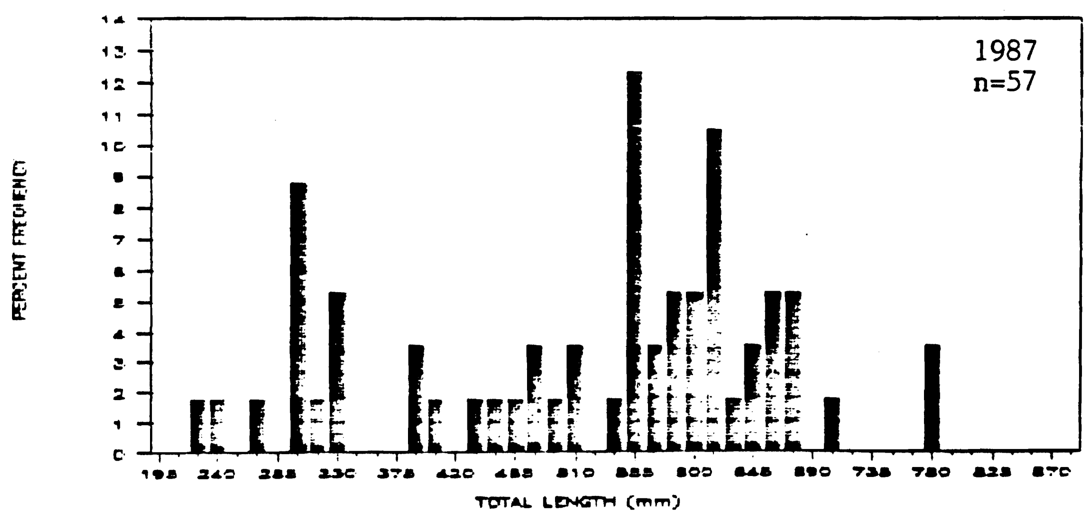




*FIGURE 107.* Size composition of cowcod from on-board observations of southern California commercial passenger fishing vessels.

catch in each year, while smaller cowcod were completely absent from the 1986 length frequency. The modal grouping of young cowcod, centered at the 300-344 mm (11.8-13.5 in.) length group, was present in 1985 and 1987, and was, according to Fitch and Lavenberg (1971), the size representative of immature 3-year-old cowcod. The absence of this size range of fish in the 1986 catch may indicate very weak recruitment of juvenile cowcod during that time period.

Counties. There was insufficient length frequency data available to construct length plots for San Diego, Orange, and Santa Barbara counties. In Los Angeles and Ventura counties, the distributions (Figures 108 and 109) display an extremely broad range of cowcod lengths, from 210 to 884 mm (8.3 to 34.8 in.). The Los Angeles County length frequency distribution is dispersed and does not exhibit distinct modal length groups. The Ventura County plots do display modal length groups of 465 to 615 mm (18.3 to 24.2 in.).

The mean length distribution among the five southern California Counties did not display any obvious patterns or trends, although the lack of sufficient length frequency data in San Diego, Orange, and Santa Barbara counties may have precluded any meaningful comparisons (Figure 110).

Management Recommendations

Although cowcod have been given special attention by CPFV anglers, they constitute only a fraction of the annual CPFV catch. This is apparently not a recent development, since cowcod composed less than 1% of the CPFV rockfish catch in 1961 (Miller and Gotshall 1965) and in Collins and Crooke's (unpublished manuscript) CPFV survey in the

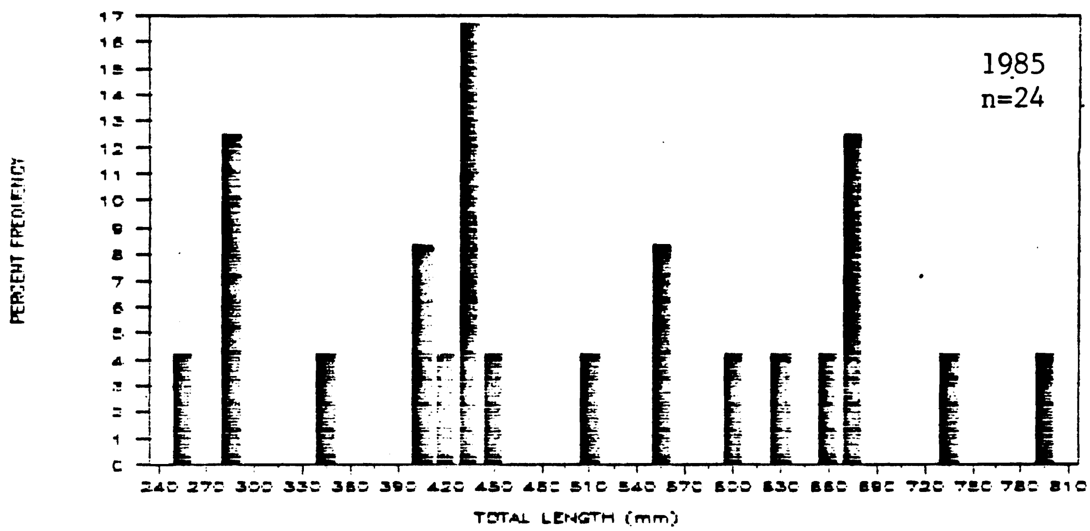



FIGURE 108. Size composition of cowcod from on-board observations of Los Angeles County commercial passenger fishing vessels.

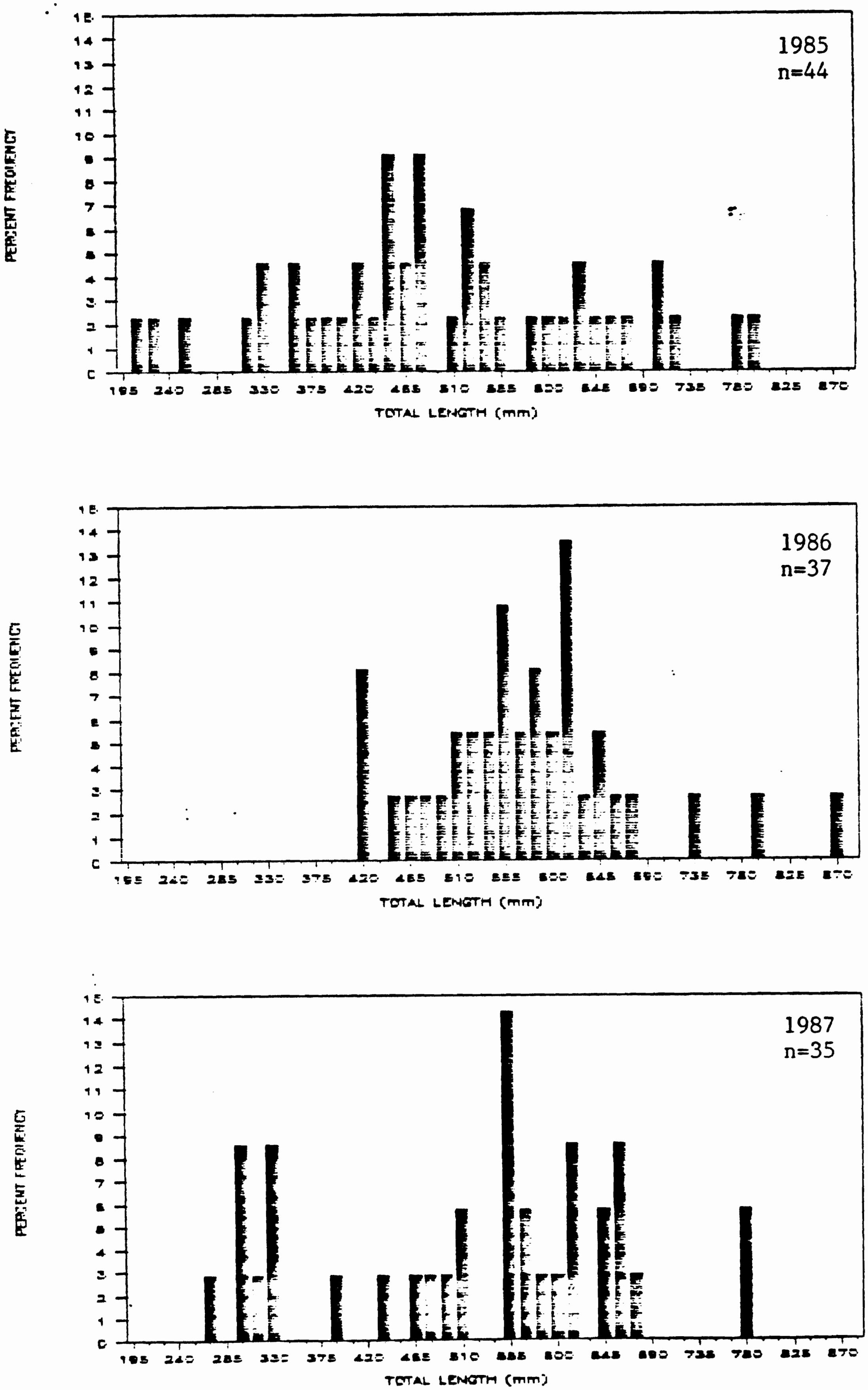



FIGURE 109. Size composition of cowcod from on-board observations of Ventura County commercial passenger fishing vessels.

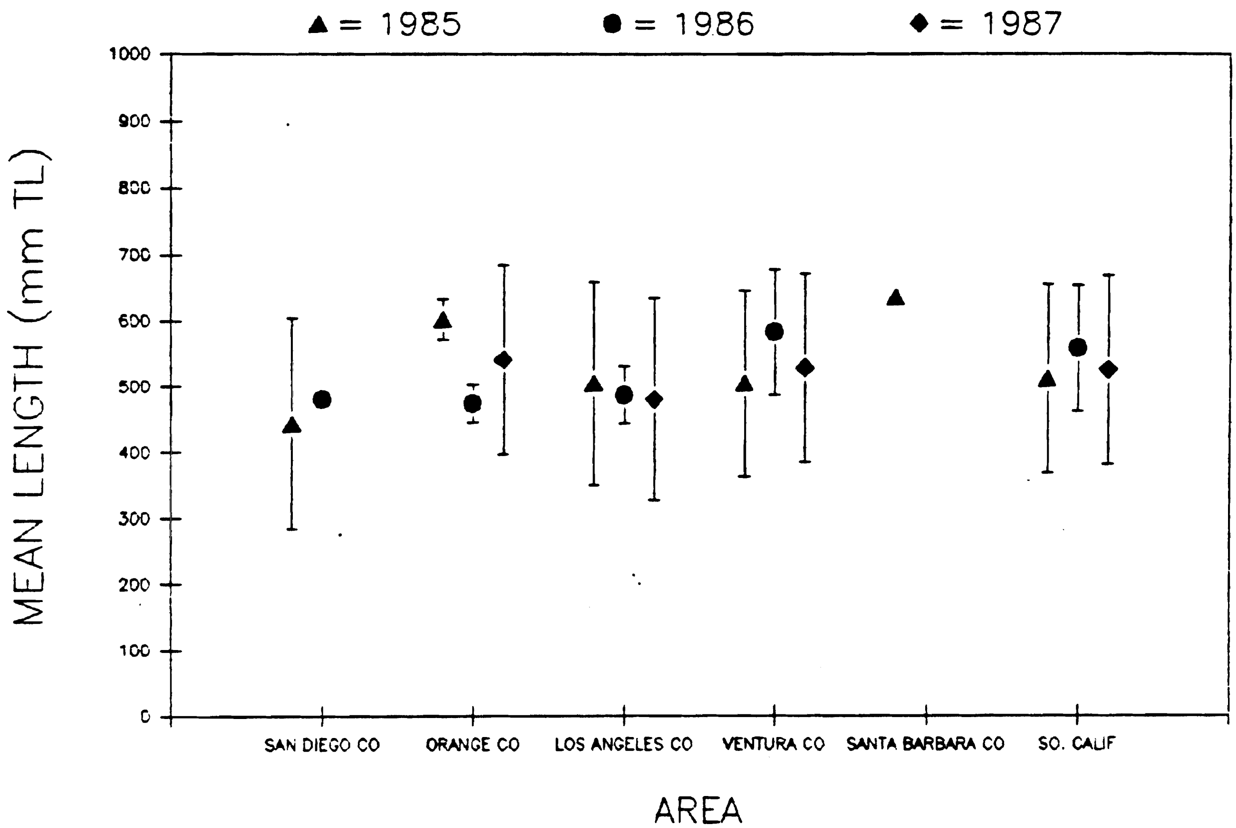



FIGURE 110. Mean lengths and standard deviations of cowcod measured on board southern California commercial passenger fishing vessels.

1970's. Cowcod are rarely the sole target of CPFV's, and are normally captured in an aggregate catch along with other offshore rockfish species.

Since cowcod landings are such a minor component of the current rockfish catch, we do not feel that any regulatory changes are necessary to protect the cowcod stock, except as they apply to the rockfish group.

## Greenspotted Rockfish (Scorpaenidae)

### Catch Estimates

Southern California. Greenspotted rockfish is a deep-water, bottom-dwelling species very common in rockfish catches from depths of 73 m (40 fm) and greater. In our survey, greenspotted rockfish total catch estimates ranged from 36,366 fish ± 5,455 in 1987 to 61,797 ± 7,415 in 1985 (Table 41). It was the fourth ranking rockfish species in our survey (Table 30). Collins and Crooke (unpublished manuscript) had greenspotted rockfish total catch estimates ranging from 35,406 ± 4,245 in 1976 to 42,452 ± 6,760 in 1978, and it was the seventh ranked rockfish species, with a 2.4% frequency of occurrence.

The greenspotted rockfish total catch distribution displayed catch peaks in January through April and October through December in 1985 and 1986 (Figure 111). These time intervals are when CPFV's normally target offshore bottom fishes. In 1987 a different catch pattern emerged; March was the greenspotted rockfish catch peak, and the January and December catches were relatively minor.

Counties. Ventura County consistently recorded the highest estimated total catches of greenspotted rockfish, ranging from 50% (1985) to 61% (1987) of the southern California greenspotted rockfish total catch (Table 41).

### Size Composition

Southern California. The southern California length frequency distributions display one mode ranging from the 240 to 249 mm (9.5 to 9.8 in.) length group in 1985 to the 280 to 289 mm (11.0 to 11.4 in.)

TABLE 41. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of Greenspotted Rockfish from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| AREA | FISH KEPT 1985 EST | FISH KEPT 1985 CV | FISH KEPT 1986 EST | FISH KEPT 1986 CV | FISH KEPT 1987 EST | FISH KEPT 1987 CV | FISH RELEASED 1985 EST | FISH RELEASED 1985 CV | FISH RELEASED 1986 EST | FISH RELEASED 1986 CV | FISH RELEASED 1987 EST | FISH RELEASED 1987 CV | TOTAL CATCH 1985 EST | TOTAL CATCH 1985 CV | TOTAL CATCH 1986 EST | TOTAL CATCH 1986 CV | TOTAL CATCH 1987 EST | TOTAL CATCH 1987 CV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| San Diego County | 3,141 | 49 | 2,556 | 41 | 4,301 | 38 | 0 | 0 | 28 | 98 | 88 | 98 | 3,141 | 49 | 2,583 | 40 | 4,389 | 38 |
| Orange County | 3,850 | 26 | 1,500 | 99 | 75 | 99 | 0 | 0 | 0 | 0 | 0 | 0 | 3,850 | 26 | 1,500 | 99 | 75 | 99 |
| Los Angeles County | 18,963 | 27 | 6,992 | 35 | 7,520 | 28 | 918 | 6 | 0 | 0 | 144 | 71 | 19,881 | 26 | 6,992 | 35 | 7,634 | 28 |
| Ventura County | 300,739 | 13 | 24,847 | 19 | 22,078 | 21 | 72 | 5 | 67 | 71 | 0 | 0 | 30,811 | 13 | 24,914 | 19 | 22,078 | 21 |
| Santa Barbara County | 4,115 | 55 | 2,275 | 74 | 2,138 | 50 | 0 | 0 | 13 | 96 | 53 | 72 | 4,115 | 55 | 2,288 | 73 | 2,191 | 49 |
| Southern California | 60,808 | 12 | 38,169 | 16 | 36,111 | 15 | 989 | 7 | 108 | 52 | 255 | 49 | 61,797 | 12 | 38,278 | 15 | 36,366 | 15 |

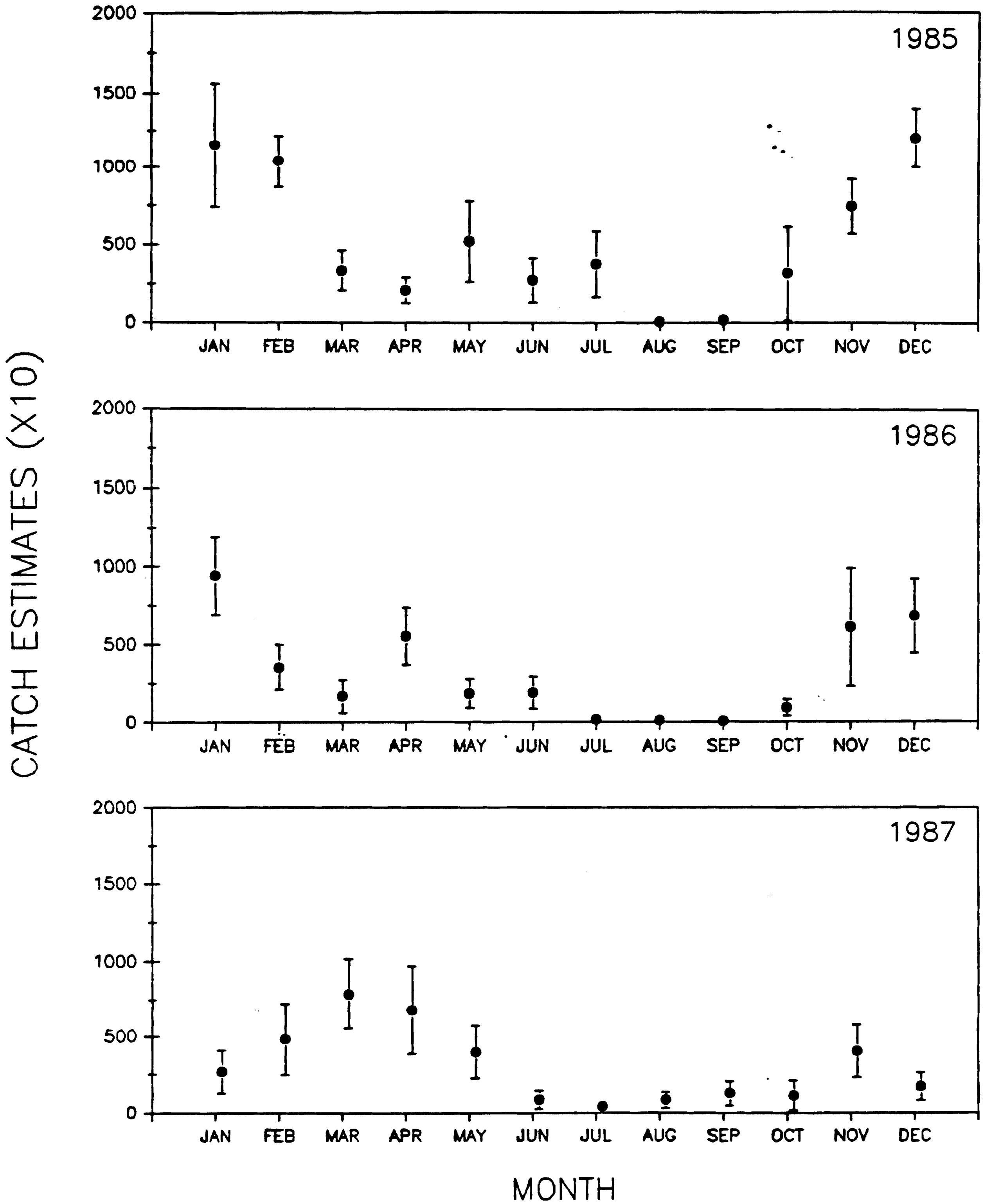



FIGURE 111. Monthly total catch estimates (number of fish) and standard deviations of greenspotted rockfish from on-board observations of southern California commercial passenger fishing vessels.

length group in 1987 (Figure 112). We found it difficult to assign an age class to this mode, based on MacGregor's (1987) length-at-age data, because it appears that several overlapping age classes were combining to produce the observable mode. The possible range of ages represented by the major mode is 5 through 10.

Greenspotted rockfish length frequency means ranged from 282 to 317 mm (11.1 to 12.5 in.), and averaged 300 mm (11.8 in.) in our survey (Figure 113). The mean length of greenspotted rockfish ranged from 314 mm (12.4 in.) to 332 mm (13.1 in.) and averaged 321 mm (13.0 in.) in Collins and Crooke's (unpublished manuscript) CPFV survey.

Counties. The greenspotted rockfish caught in Ventura and Santa Barbara counties were generally larger than those caught in the southernmost counties (Figures 113 through 118). We believe that this is the result of CPFV's from Ventura and Santa Barbara counties fishing comparatively unexploited greenspotted rockfish population segments in the Santa Barbara Channel and in the vicinity of the northern Channel Islands. Our analysis of site catch data for 1986 and 1987 showed that the largest catches of greenspotted rockfish came from the Santa Rosa Flats area around Santa Rosa Island, off San Miguel Island, and Rincon Dome Reef in the Santa Barbara Channel (Ally et al. 1988).

Management Recommendations

Greenspotted rockfish was ranked among the top 10 CPFV rockfish catch species in Collins and Crooke's (unpublished manuscript) 1975 to 1978 survey and in our current study. The range of greenspotted rockfish annual total catch estimates was roughly equivalent in both studies.

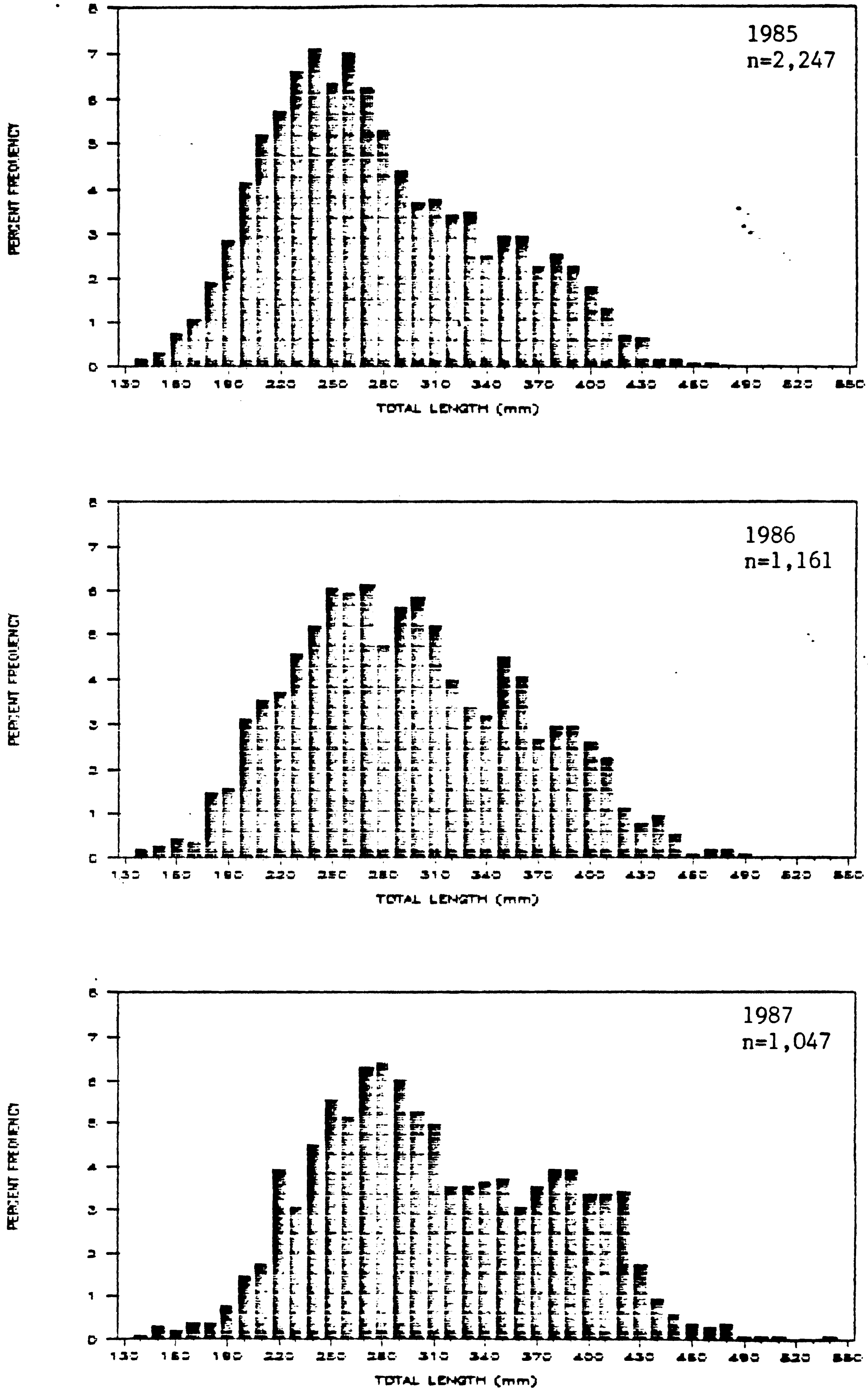



FIGURE 112. Size composition of greenspotted rockfish from on-board observations of southern California commercial passenger fishing vessels.

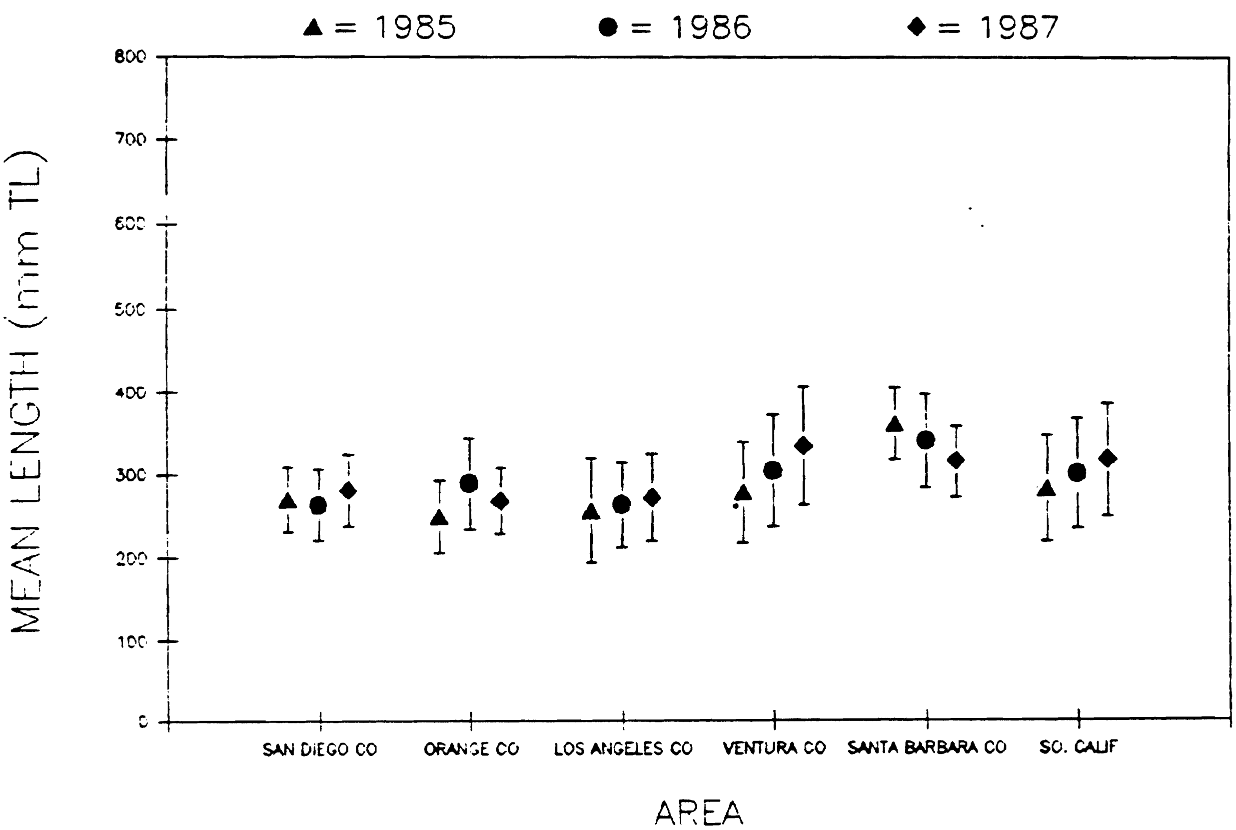



FIGURE 113. Mean lengths and standard deviations of greenspotted rockfish measured on board southern California commercial passenger fishing vessels.

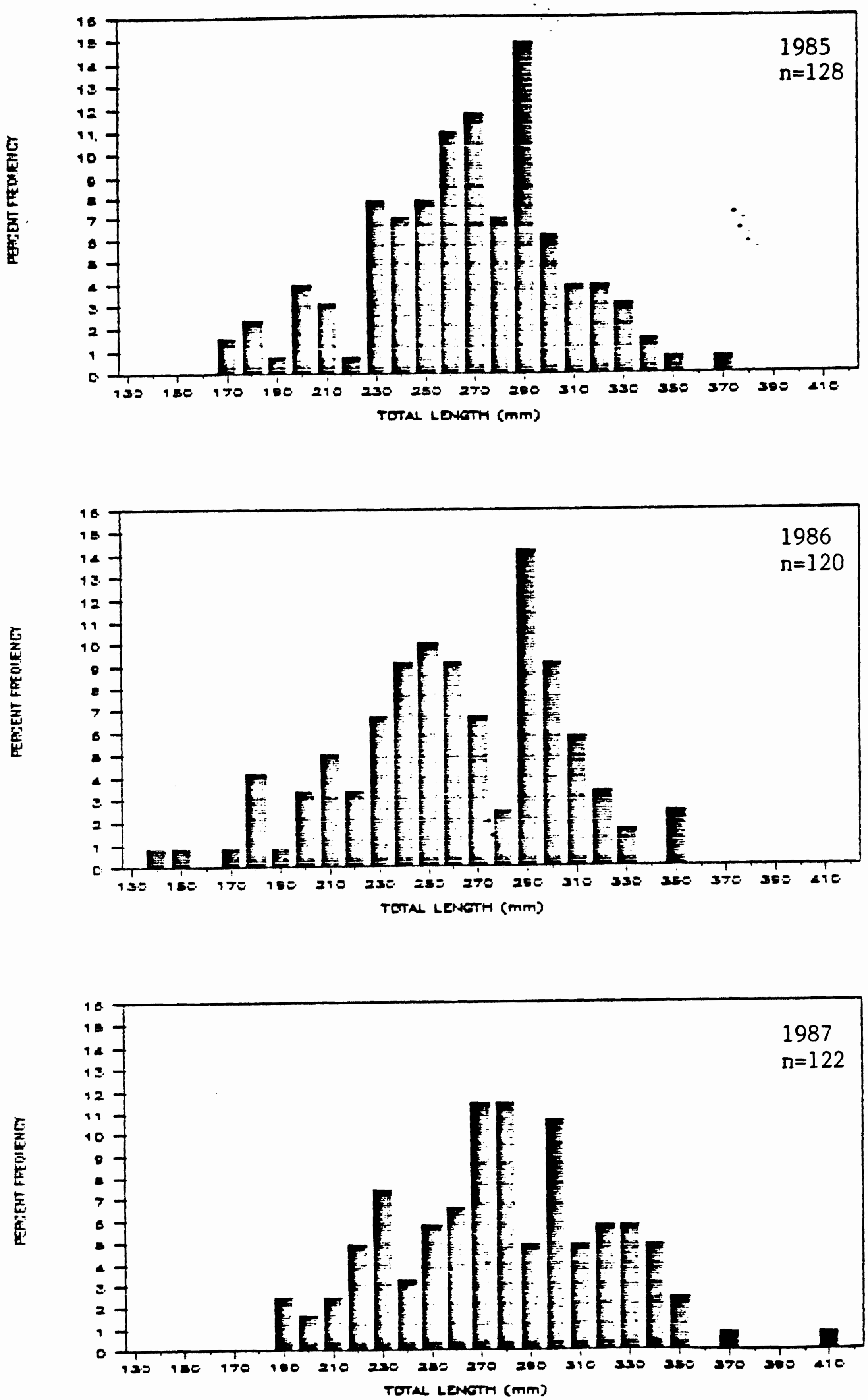



FIGURE 114. Size composition of greenspotted rockfish from on-board observations of San Diego County commercial passenger fishing vessels.

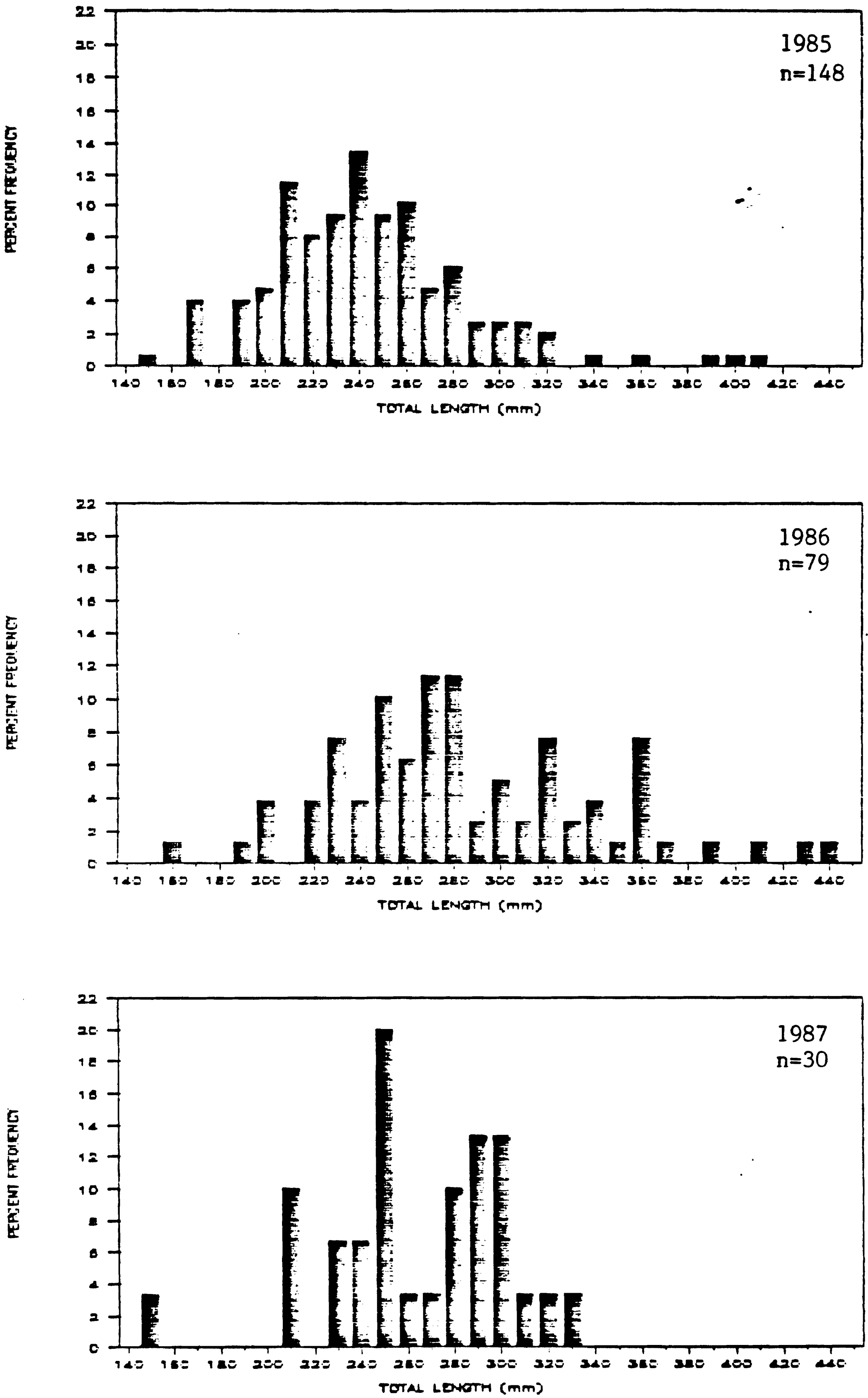



FIGURE 115. Size composition of greenspotted rockfish from on-board observations of Orange County commercial passenger fishing vessels.

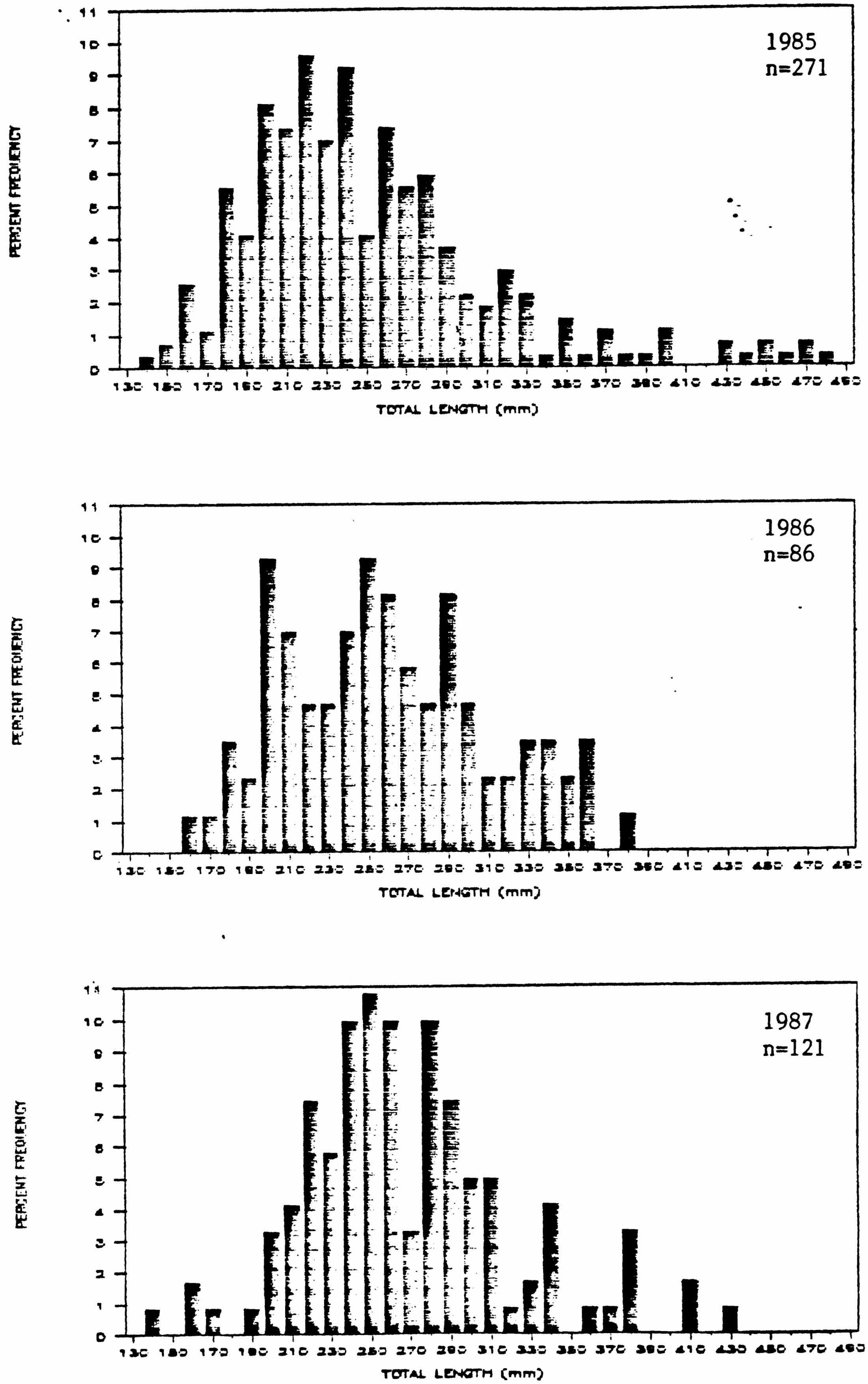



FIGURE 116. Size composition of greenspotted rockfish from on-board observations of Los Angeles County commercial passenger fishing vessels.

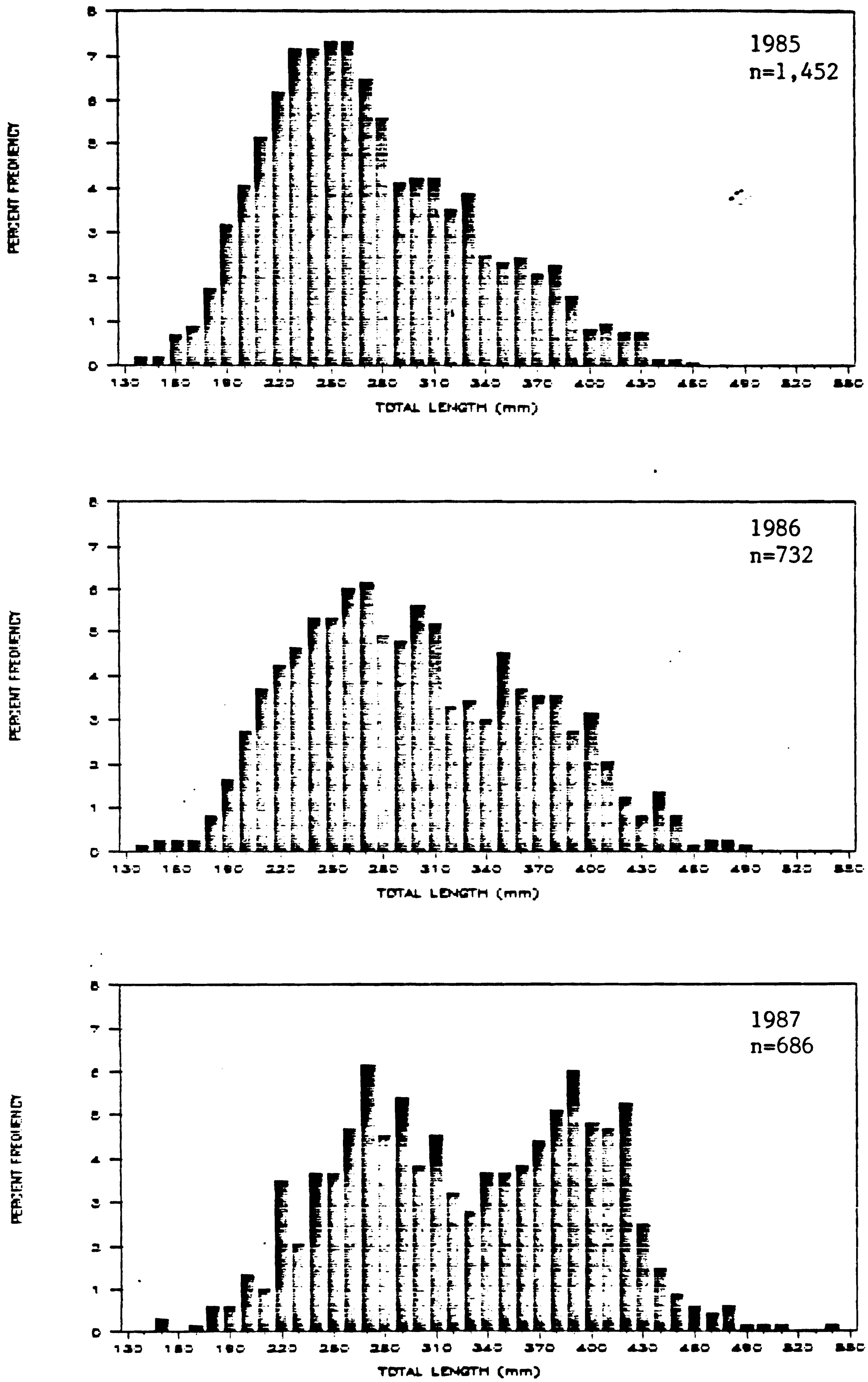



FIGURE 117. Size composition of greenspotted rockfish from on-board observations of Ventura County commercial passenger fishing vessels.

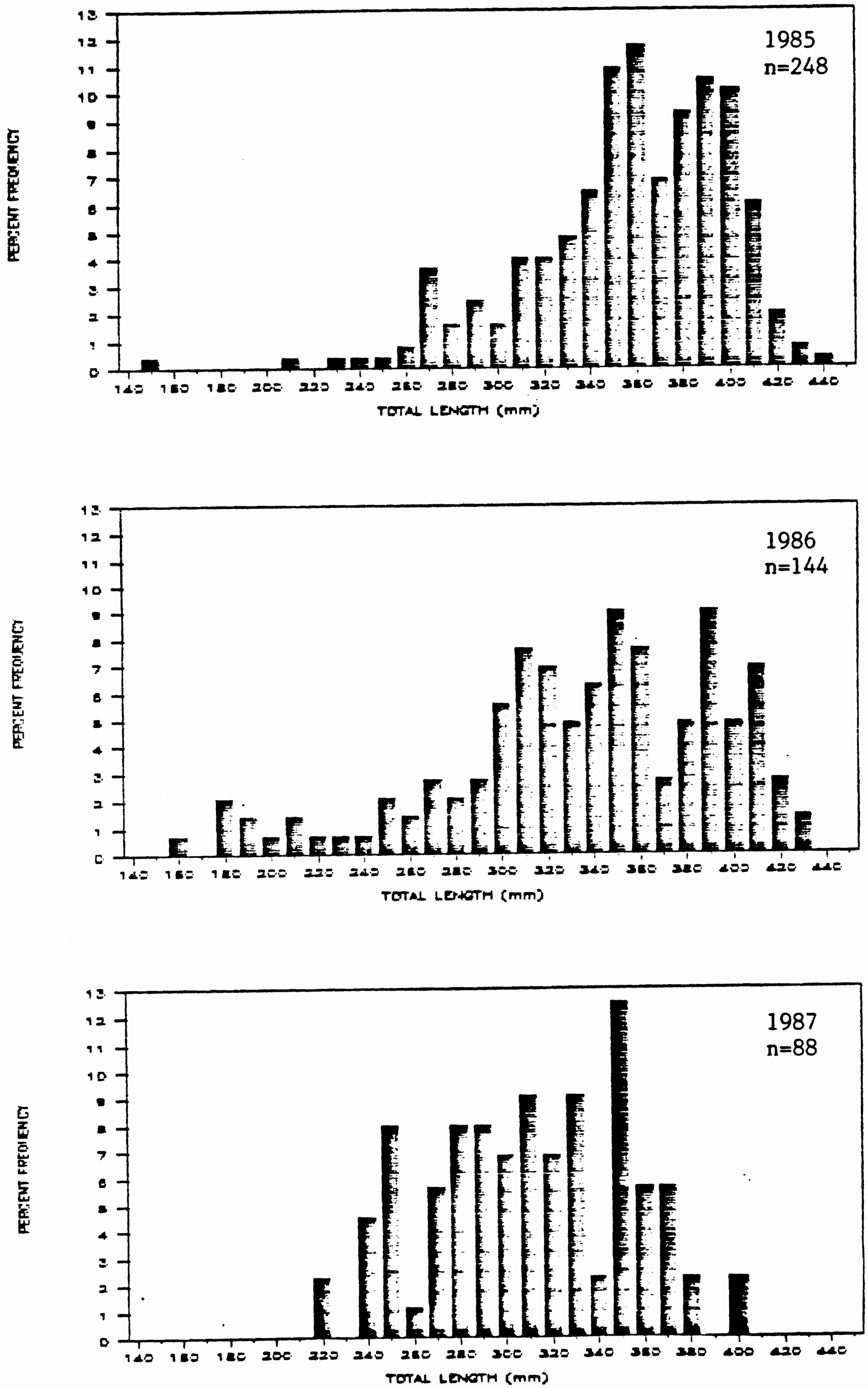



FIGURE 118. Size composition of greenspotted rockfish from on-board observations of Santa Barbara County commercial passenger fishing vessels.

Our length frequency analysis revealed that the CPFV fishery exploits a wide range of age classes, lessening the possibility of large declines in the catch due to a series of poor year class recruitments.

Although the greenspotted rockfish catch exhibited a 40% decline from 1985 to 1986 and a 4% decline from 1986 to 1987, the relative constancy of greenspotted rockfish catches over a long period of time, and the broad age structure of the exploited population indicate that the species can withstand current levels of harvest by CPFV's. We do not recommend changes in the sport fish regulations governing greenspotted rockfish catches, except as they apply to the rockfish group.

## Honeycomb Rockfish (Scorpaenidae)

### Catch Estimates

Southern California. Honeycomb rockfish is a bottom-dwelling species that is found in depths of 73 m (40 fm) or less (Eschmeyer, et al. 1983). Our survey produced honeycomb rockfish total catch estimates ranging from 26,629 fish ± 4,125 in 1987 to a high of 34,602 ± 6,228 in 1986 (Table 42). Honeycomb rockfish was the eighth ranked species in the rockfish catch, composing 4.0% of the estimated rockfish total catch (Table 30). Collins and Crooke (unpublished manuscript) had honeycomb rockfish total catch estimates ranging from 12,460 ± 2,558 in 1975 to a high of 19,797 ± 3,625 in 1977. It was the 17th ranked rockfish species in their survey, composing 0.9% of the 1975 to 1978 rockfish catch.

The catch distribution of honeycomb rockfish was variable from year to year, exhibiting a winter peak in 1985, a summer catch peak in 1986, and a spring and summer dual catch peak in 1987 (Figure 119). Since honeycomb rockfish were present in the CPFV catch during all months of the year, it appears that the magnitude of the catch is directly related to the frequency with which CPFV's target shallow-water rockfishes.

Counties. San Diego and Los Angeles county landings were the source of most of the honeycomb rockfish total catch (Table 42). Over the 3 years they provided 64% and 31%, respectively, of the southern California honeycomb rockfish catch.

TABLE 42. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of Honeycomb Rockfish from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| AREA | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 13,914 | 17 | 21,760 | 19 | 14,628 | 22 | 1,756 | 51 | 1,930 | 21 | 1,454 | 39 | 15,670 | 18 | 23,690 | 18 | 16,082 | 22 |
| Orange County | 2,911 | 65 | 617 | 54 | 38 | 99 | 32 | 98 | 0 | 0 | 0 | 0 | 2,943 | 65 | 617 | 54 | 38 | 99 |
| Los Angeles County | 10,335 | 27 | 9,576 | 45 | 4,177 | 49 | 1,597 | 37 | 636 | 39 | 308 | 45 | 11,932 | 27 | 10,212 | 43 | 4,486 | 48 |
| Ventura County | 428 | 56 | 34 | 99 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 428 | 56 | 34 | 99 | 0 | 0 |
| Santa Barbara County | 206 | 38 | 50 | 75 | 24 | 98 | 100 | 97 | 0 | 0 | 0 | 0 | 306 | 52 | 50 | 75 | 24 | 98 |
| Southern California | 27,795 | 15 | 32,036 | 19 | 18,867 | 20 | 3,484 | 31 | 2,566 | 19 | 1,762 | 33 | 31,279 | 15 | 34,602 | 18 | 20,629 | 20 |

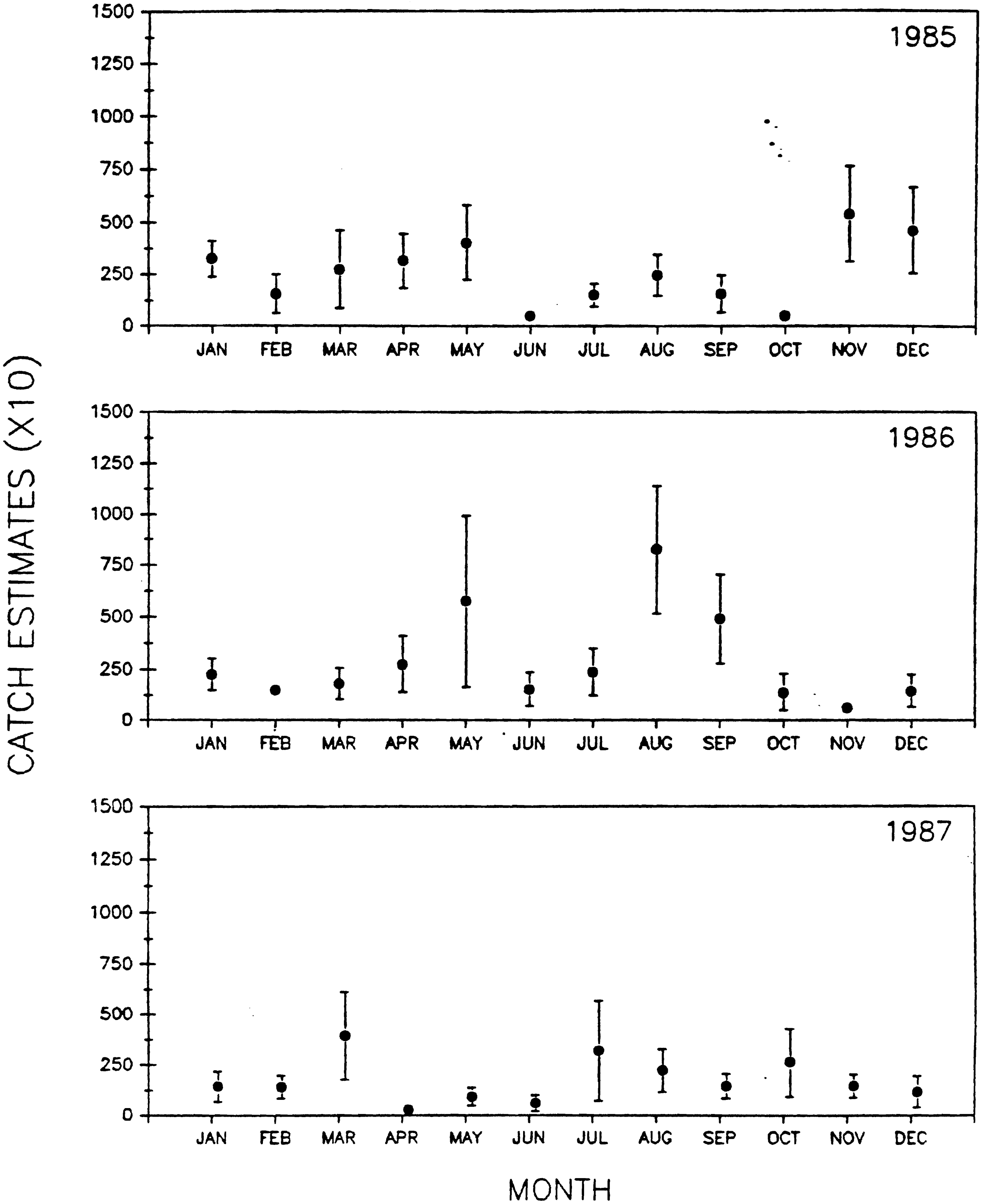



FIGURE 119. Monthly total catch estimates (number of fish) and standard deviations of honeycomb rockfish from on-board observations of southern California commercial passenger fishing vessels.

Size Composition

Southern California. The length frequency distribution for each of the 3 years (Figure 120) approximates a normal distribution encompassing several age groups, with the modal age groups representing 4- to 9-year-old fish (MacGregor 1987).

Counties. There was insufficient length frequency data to plot length frequency distributions for Ventura and Santa Barbara counties. In San Diego County (Figure 121), the modal length groups range from 190 to 220 mm (7.5 to 8.7 in.). According to MacGregor's (1987) length-at-age criteria this length range would encompass 4- to 7-year-old honeycomb rockfish. Orange County was the source of enough length frequency data for only a 1985 length plot (Figure 122). A single, strong mode at 210 to 219 mm (8.2 to 8.6 in.), representing 5-year-old and older honeycomb rockfish is present. The Los Angeles County length plots also reveal a single dominant mode, ranging between 180 to 199 mm (7.1 to 7.8 in.) over the 3 years surveyed (Figure 123). Honeycomb rockfish between 4 to 5 years old, based on MacGregor's (1987) length at age data, were the age groups which dominated the Los Angeles County catches.

The mean length plot showed very little variability among the five counties (Figure 124). Annual changes in mean length did not display a discernible trend from county to county.

Management Recommendations

Honeycomb rockfish is a species whose small maximum size [270 mm (10.6 in.)] limits its desirability with CPFV anglers. Its position among the top 10 rockfish species in the CPFV catch is a result of honeycomb rockfishes' ubiquitous presence in mixed catches of

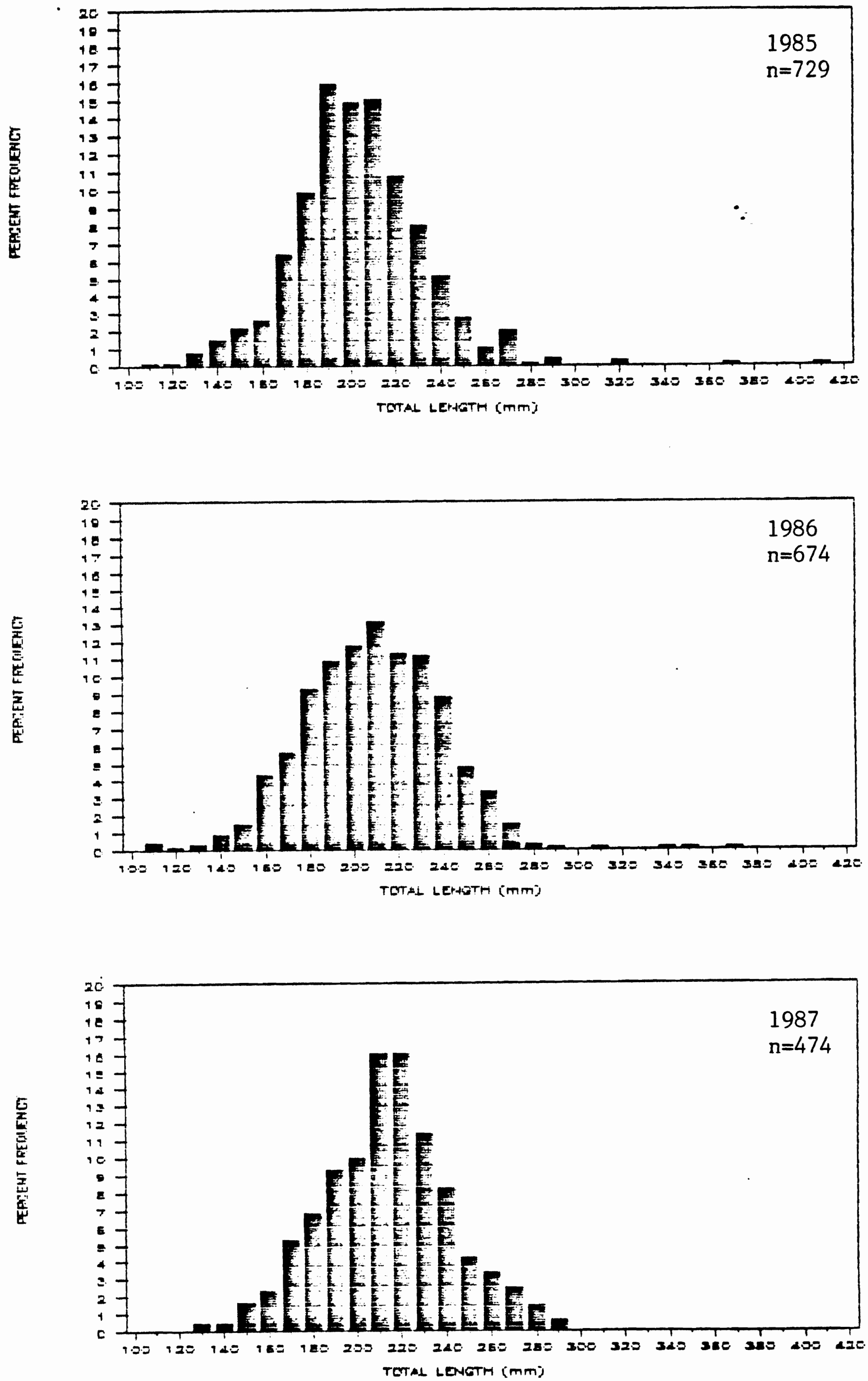



FIGURE 120. Size composition of honeycomb rockfish from on-board observations of southern California commercial passenger fishing vessels.

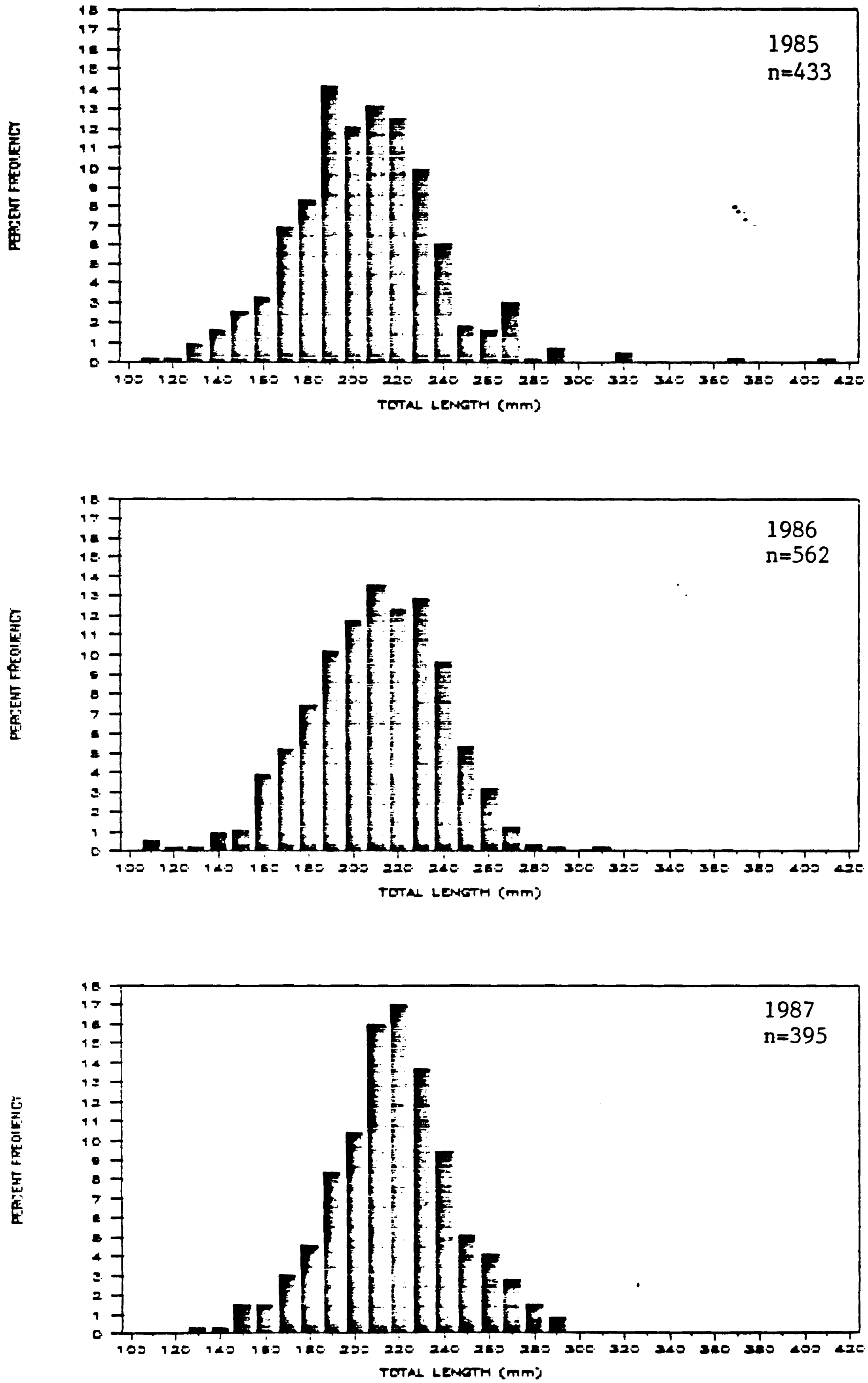



FIGURE 121. Size composition of honeycomb rockfish from on-board observations of San Diego County commercial passenger fishing vessels.

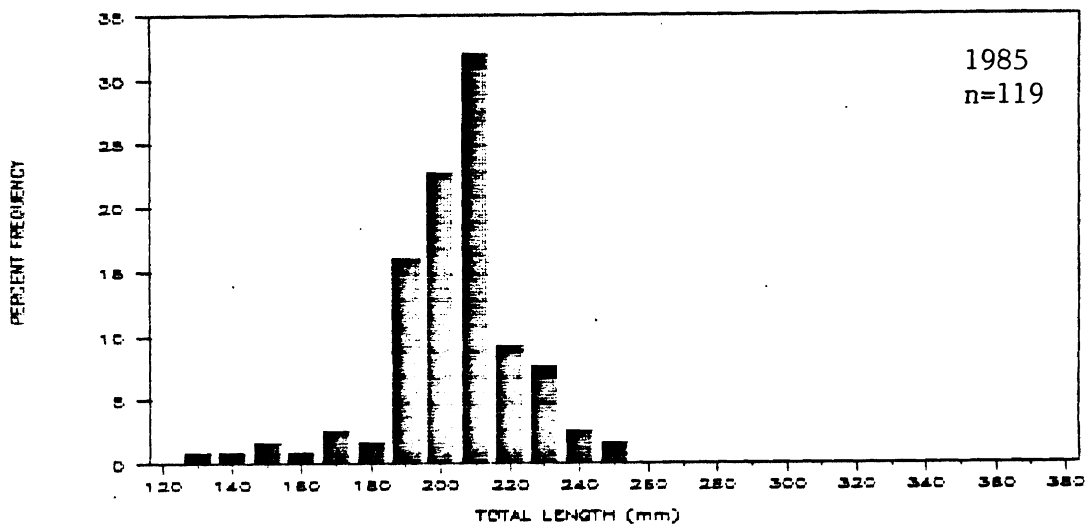



FIGURE 122. Size composition of honeycomb rockfish from on-board observations of Orange County commercial passenger fishing vessels.

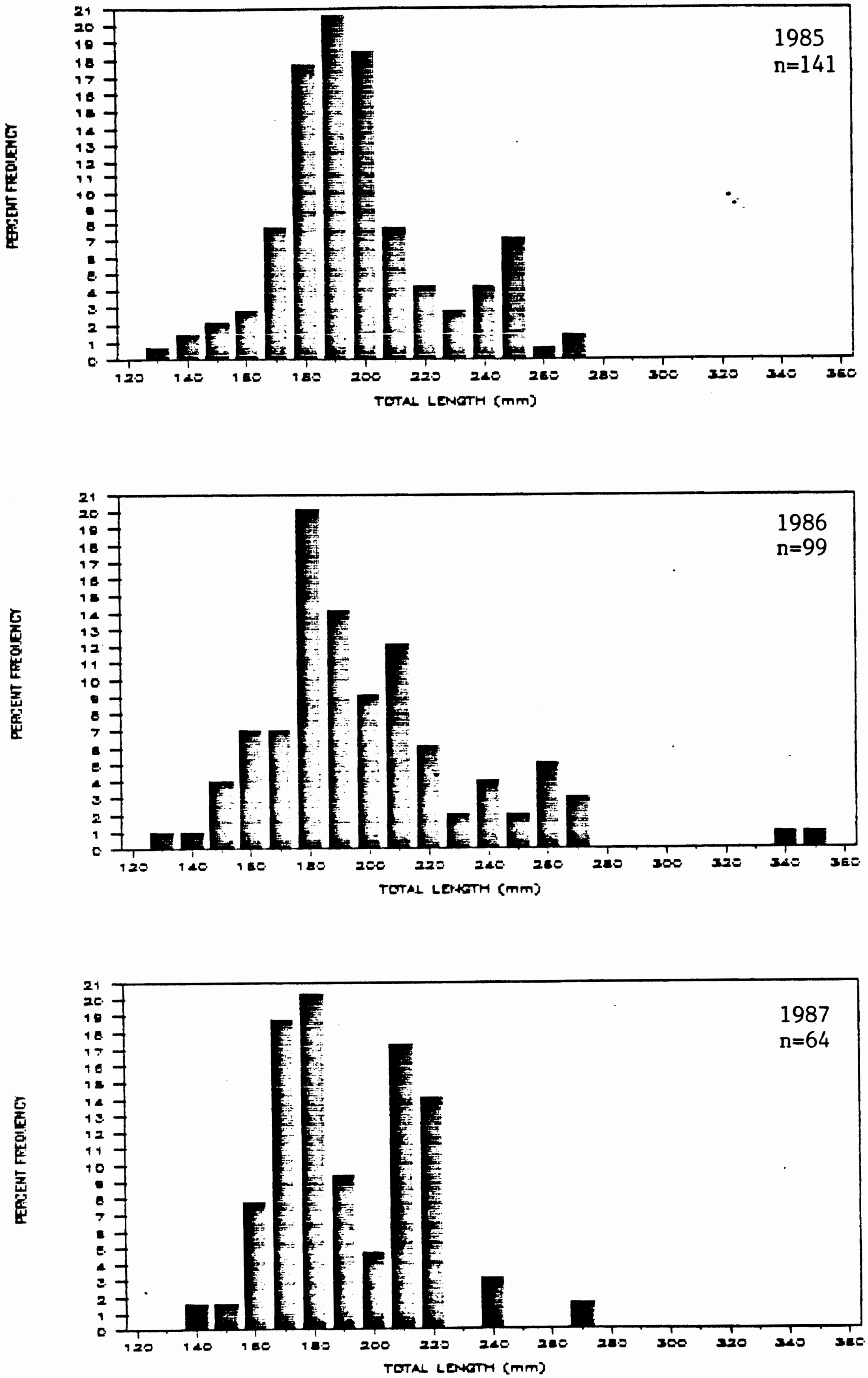



FIGURE 123. Size composition of honeycomb rockfish from on-board observations of Los Angeles County commercial passenger fishing vessels.

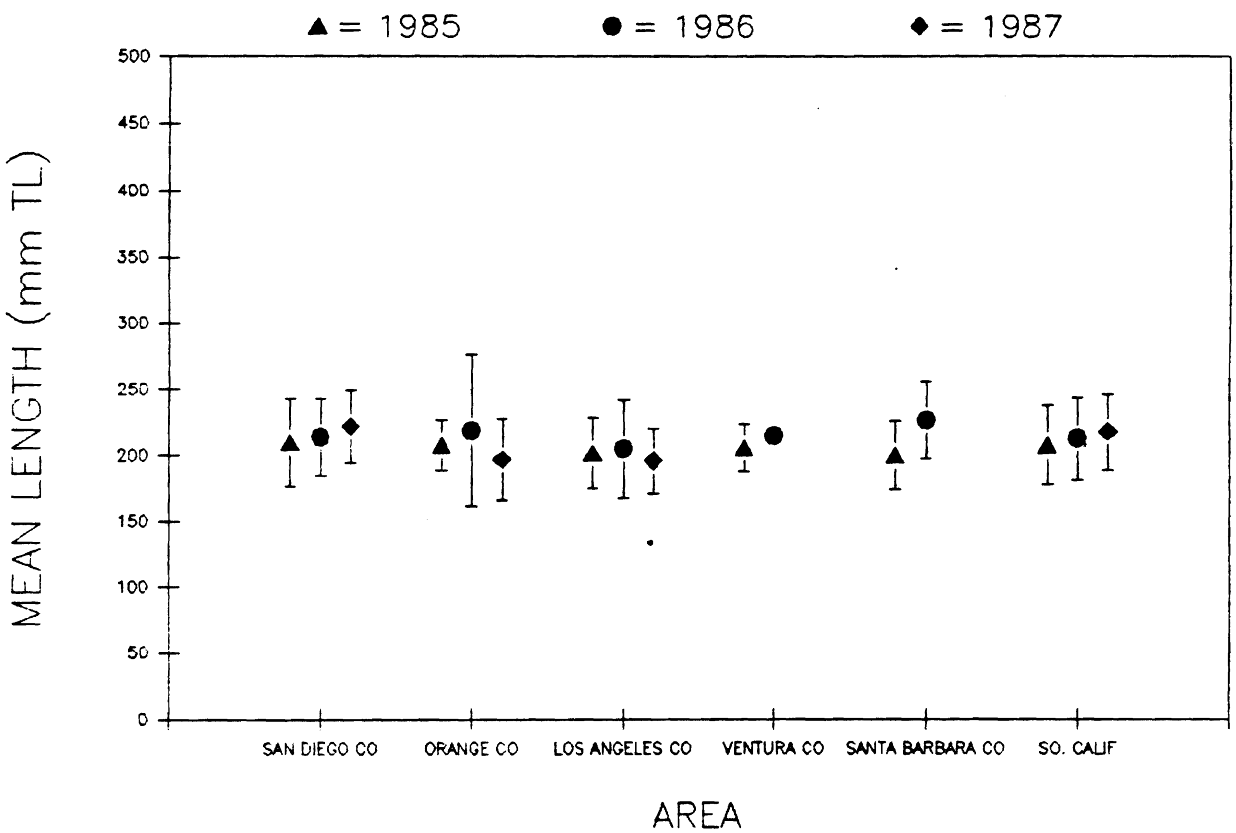



FIGURE 124. Mean lengths and standard deviations of honeycomb rockfish measured on board southern California commercial passenger fishing vessels.

shallow-water rockfishes, especially in San Diego County. The rockfish index of relative importance for San Diego County ranked honeycomb rockfish first in 2 out of the 3 years surveyed (Table 31).

We do not feel that there is currently a need for additional sport fish regulations designed to specifically protect honeycomb rockfish, except as the regulations apply to the rockfish group.

## Olive Rockfish (Scorpaenidae)

### Catch Estimates

Southern California. Olive rockfish is a shallow-depth, mid-water-dwelling rockfish species, usually associated with kelp bed habitats. The estimated olive rockfish total catch increased during each year of our survey. The total catch rose from 16,857 fish $\pm$ 2,191 in 1985 to 44,485 $\pm$ 4,448 in 1987 (Table 43). Over the 3 years surveyed, olive rockfish represented an average 4.0% of the estimated rockfish total catch and was the sixth ranking species (Table 30). In Collins and Crooke's (unpublished manuscript) survey, olive rockfish total catch estimates ranges from 154,198 $\pm$ 21,720 in 1978 to 232,344 $\pm$ 20,454 in 1977. It was their second ranked rockfish species, at 12.3% frequency of occurrence.

Olive rockfish total catches peaked during the summer and fall months of June through October (Figure 125). This coincides with the seasonal emphasis of southern California CPFV'S on surface and mixed-depth fishing trips. We have observed in our survey that, besides the olive rockfish caught on shallow-water bottom fishing trips, considerable quantities are caught, incidentally, on surface fishing trips targeting species such as kelp bass, barracuda, etc.

Counties. The olive rockfish total catch varied considerably within each county. The most extreme fluctuation in the total catch occurred in Orange County, where it increased 2,000% (from 100 in 1985 to 1,970 in 1987). San Diego and Ventura Counties also displayed large increases in olive rockfish total catches over the 3 years. By 1987,

TABLE 43. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of Olive Rockfish from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| AREA | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 1,395 | 22 | 10,405 | 11 | 16,866 | 12 | 670 | 34 | 1,446 | 29 | 181 | 46 | 2,065 | 20 | 11,854 | 11 | 17,047 | 12 |
| Orange County | 32 | 98 | 1,727 | 21 | 1,459 | 36 | 68 | 99 | 240 | 47 | 511 | 62 | 100 | 74 | 1,966 | 21 | 1,970 | 34 |
| Los Angeles County | 2,439 | 44 | 2,186 | 24 | 3,645 | 24 | 87 | 71 | 328 | 63 | 1,190 | 36 | 2,526 | 42 | 2,514 | 24 | 4,835 | 24 |
| Ventura County | 3,614 | 31 | 5,051 | 39 | 13,747 | 22 | 216 | 47 | 703 | 30 | 1,591 | 33 | 3,830 | 30 | 5,754 | 35 | 15,339 | 21 |
| Santa Barbara County | 8,237 | 19 | 2,277 | 33 | 4,719 | 27 | 100 | 62 | 905 | 72 | 574 | 33 | 8,337 | 19 | 3,182 | 43 | 5,294 | 25 |
| Southern California | 15,716 | 14 | 21,647 | 12 | 40,437 | 10 | 1,141 | 24 | 3,623 | 23 | 4,047 | 19 | 16,857 | 13 | 25,271 | 11 | 44,485 | 10 |

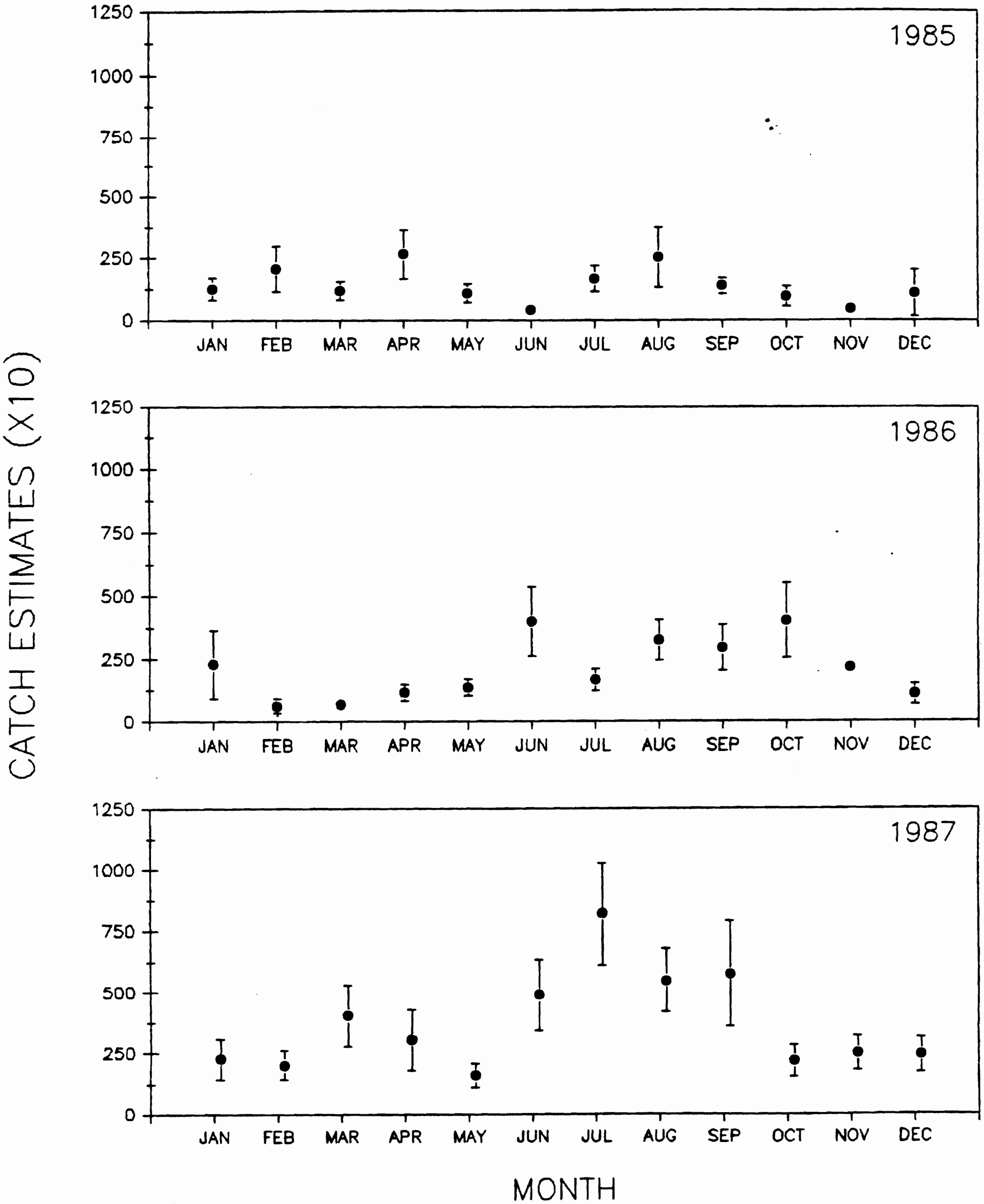



FIGURE 125. Monthly total catch estimates (number of fish) and standard deviations of olive rockfish from on-board observations of southern California commercial passenger fishing vessels.

the two counties contributed 73% to the southern California olive rockfish total catch.

## Size Composition

Southern California. Several strong modal groups are displayed in each annual length frequency distribution (Figure 126). These modes represent 1982 and 1983 year class fish (Love and Westphal 1981; MacGregor 1987).

Counties. Olive rockfish caught from Los Angeles and Ventura county landings were generally larger than those from the other three counties, based on a comparison of mean lengths (Figure 127). Each county length frequency analysis (there was sufficient data for only a 1987 Orange County length frequency plot) reveals a strong modal group representing 1983 year class olive rockfish (Figure 128 through 132). The Los Angeles, Ventura, and Santa Barbara County plots each display modes representing larger fish, greater than 350 mm (13.8 in.); we attributed the presence of these large fish to the targeting by CPFV's of relatively unexploited, offshore island components of the olive rockfish stock.

## Management Recommendations

The southern California olive rockfish total catch has declined from an estimated average annual catch of 183,000 in 1976-1978 (Collins and Crooke unpublished manuscript) to one of 28,870 in our study. A large portion of the catch is composed of olive rockfish less than 280 mm (11 in.), which is the size of first maturity (Love and Westphal 1981).

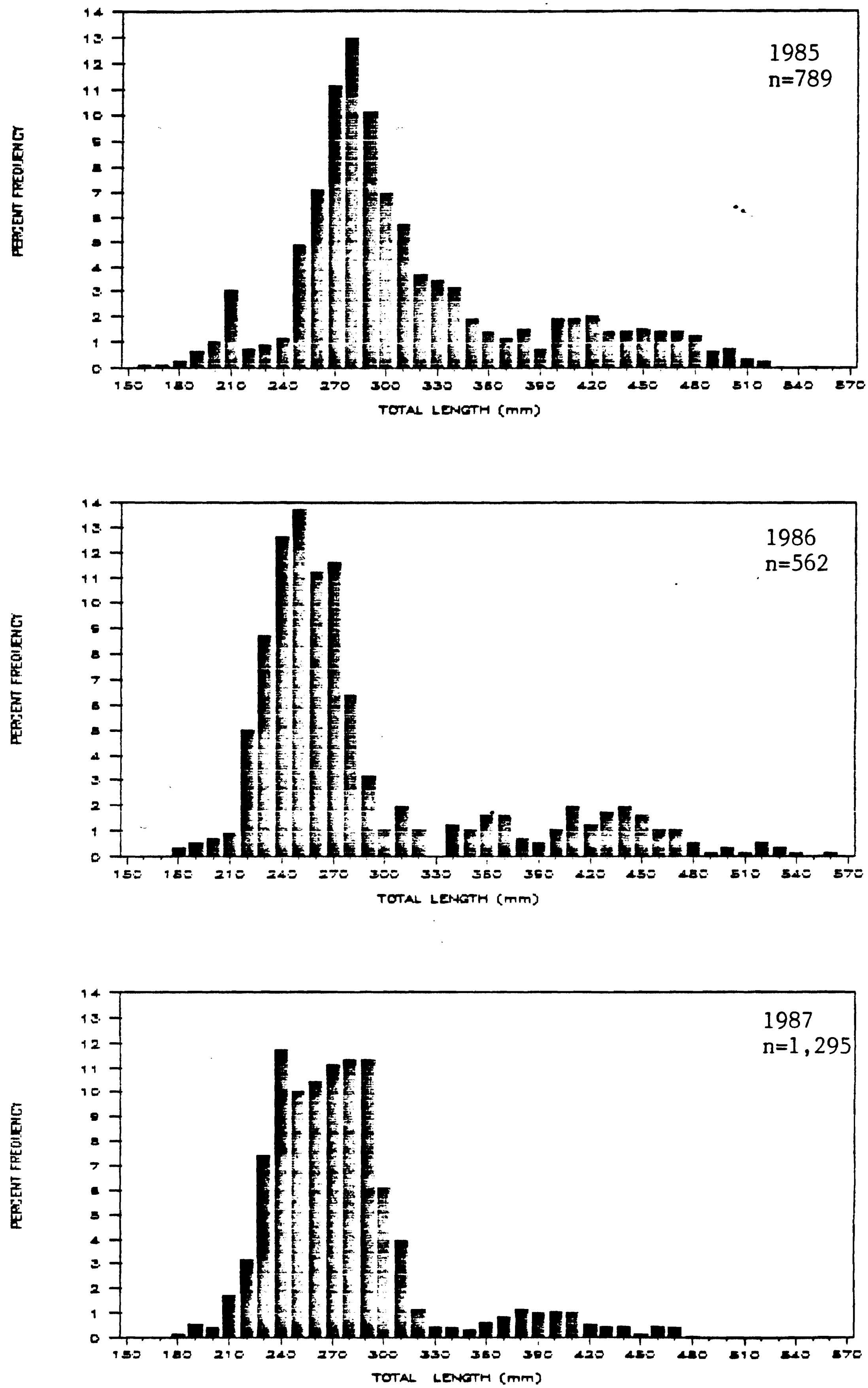



FIGURE 126. Size composition of olive rockfish from on-board observations of southern California commercial passenger fishing vessels.

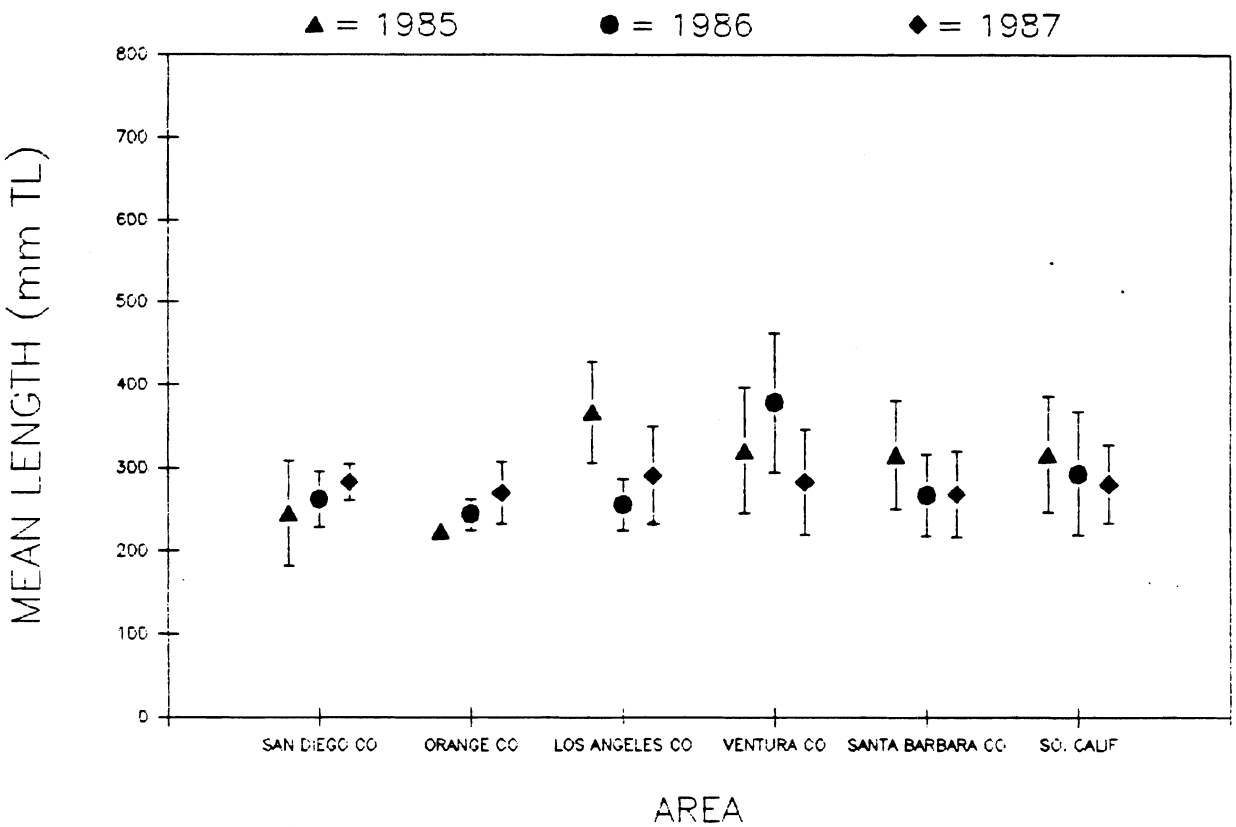



FIGURE 127. Mean lengths and standard deviations of olive rockfish measured on board southern California commercial passenger fishing vessels.

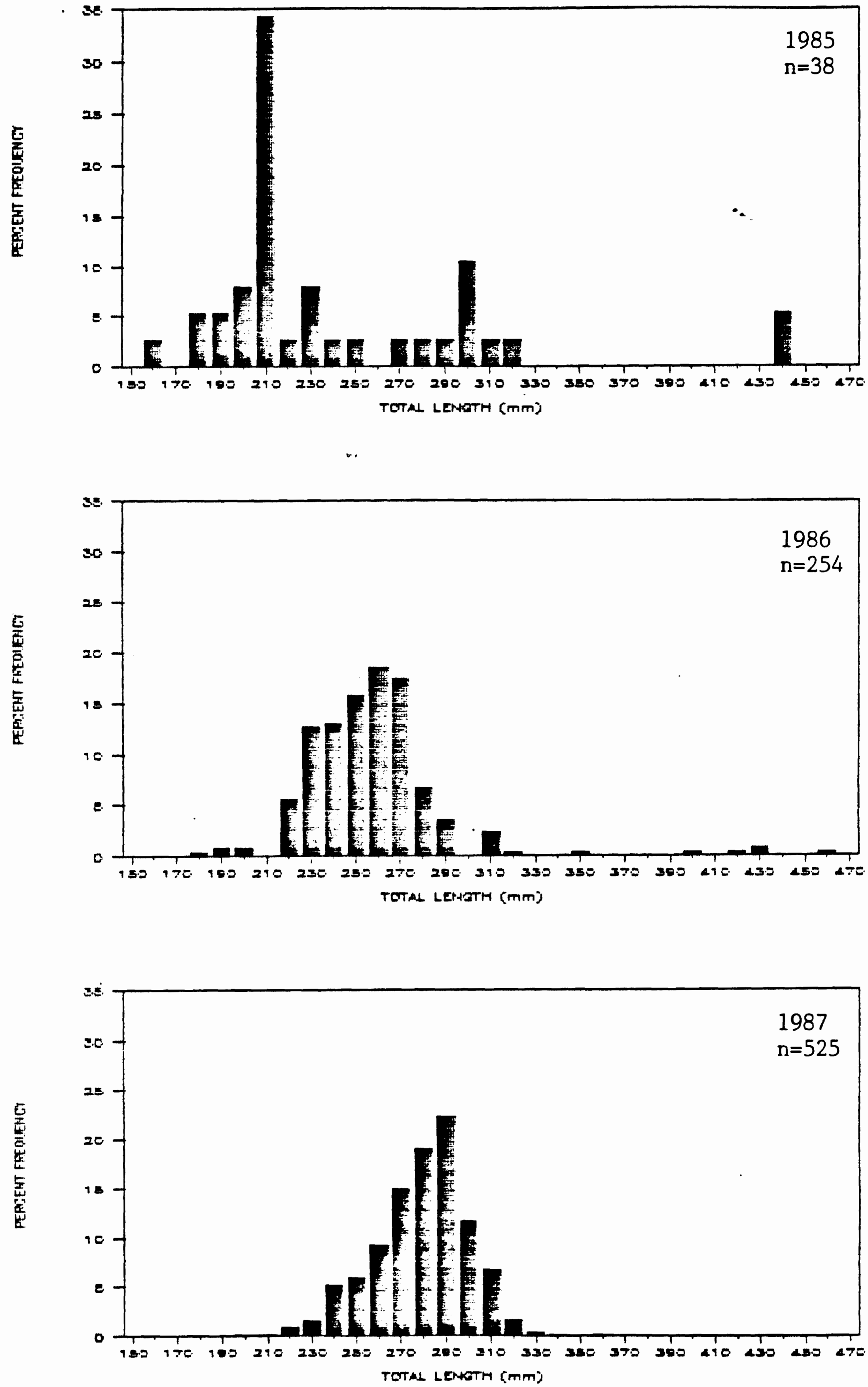



FIGURE 128. Size composition of olive rockfish from on-board observations of San Diego County commercial passenger fishing vessels.

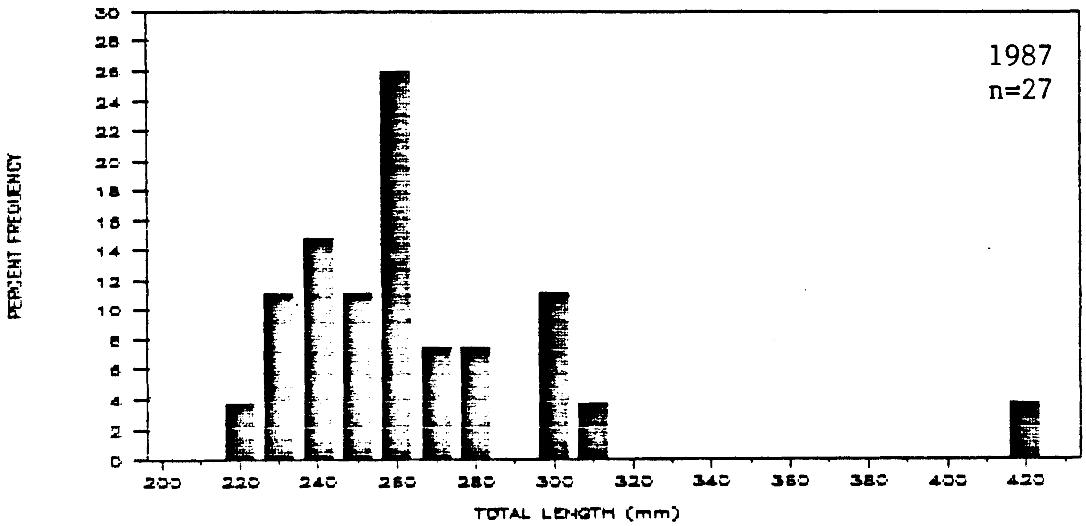



FIGURE 129. Size composition of olive rockfish from on-board observations of Orange County commercial passenger fishing vessels.

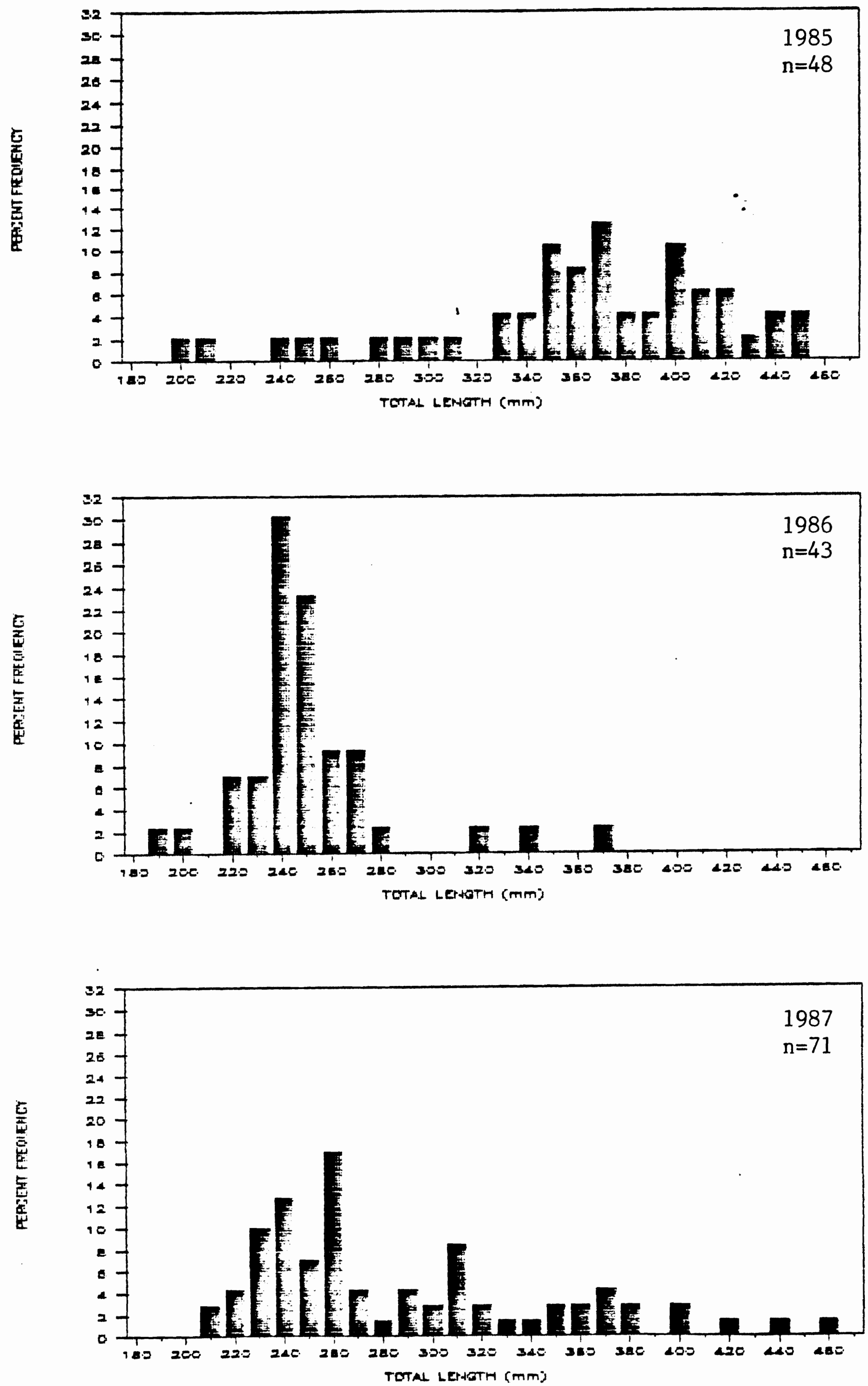



FIGURE 130. Size composition of olive rockfish from on-board observations of Los Angeles County commercial passenger fishing vessels.

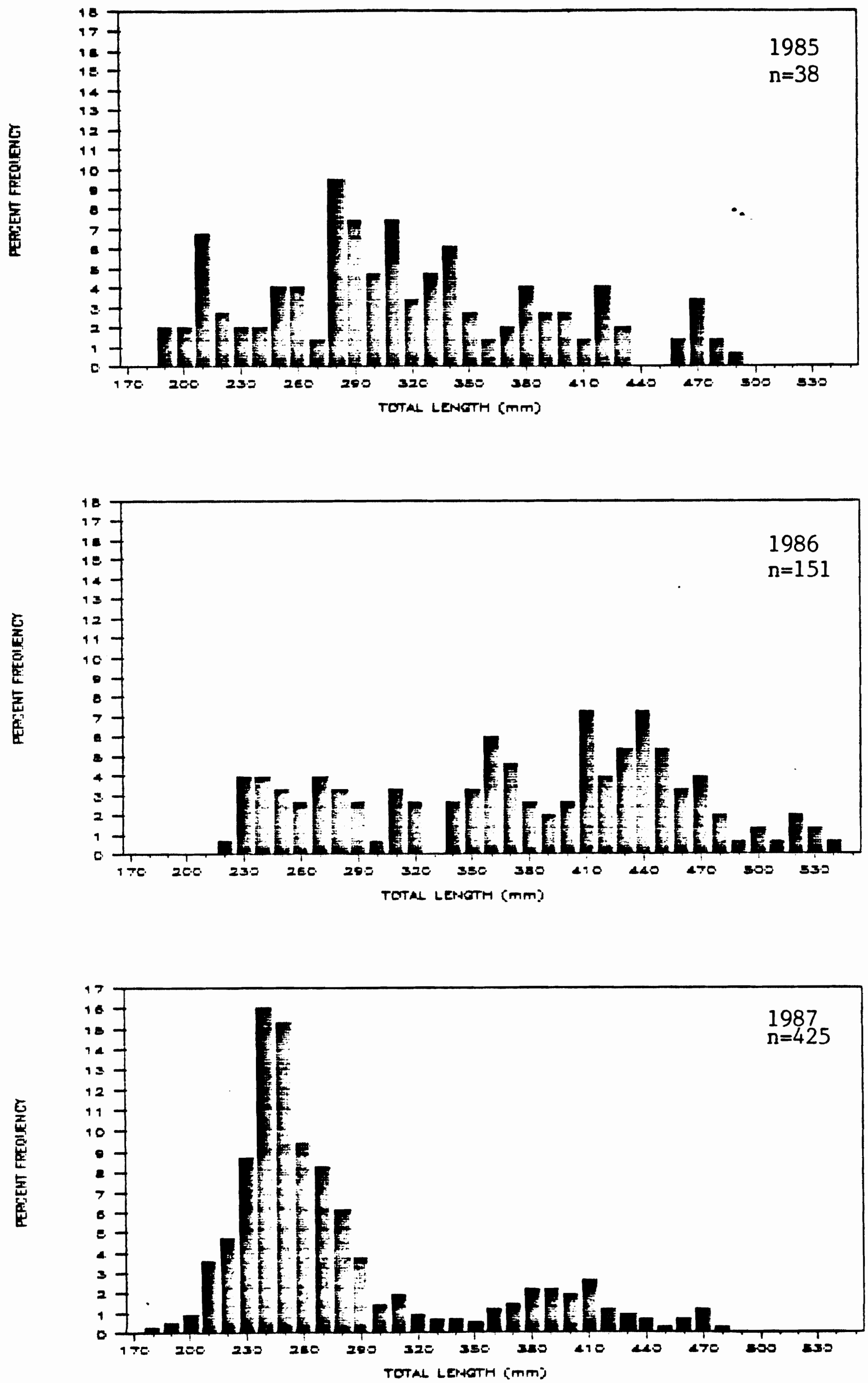



FIGURE 131. Size composition of olive rockfish from on-board observations of Ventura County commercial passenger fishing vessels.

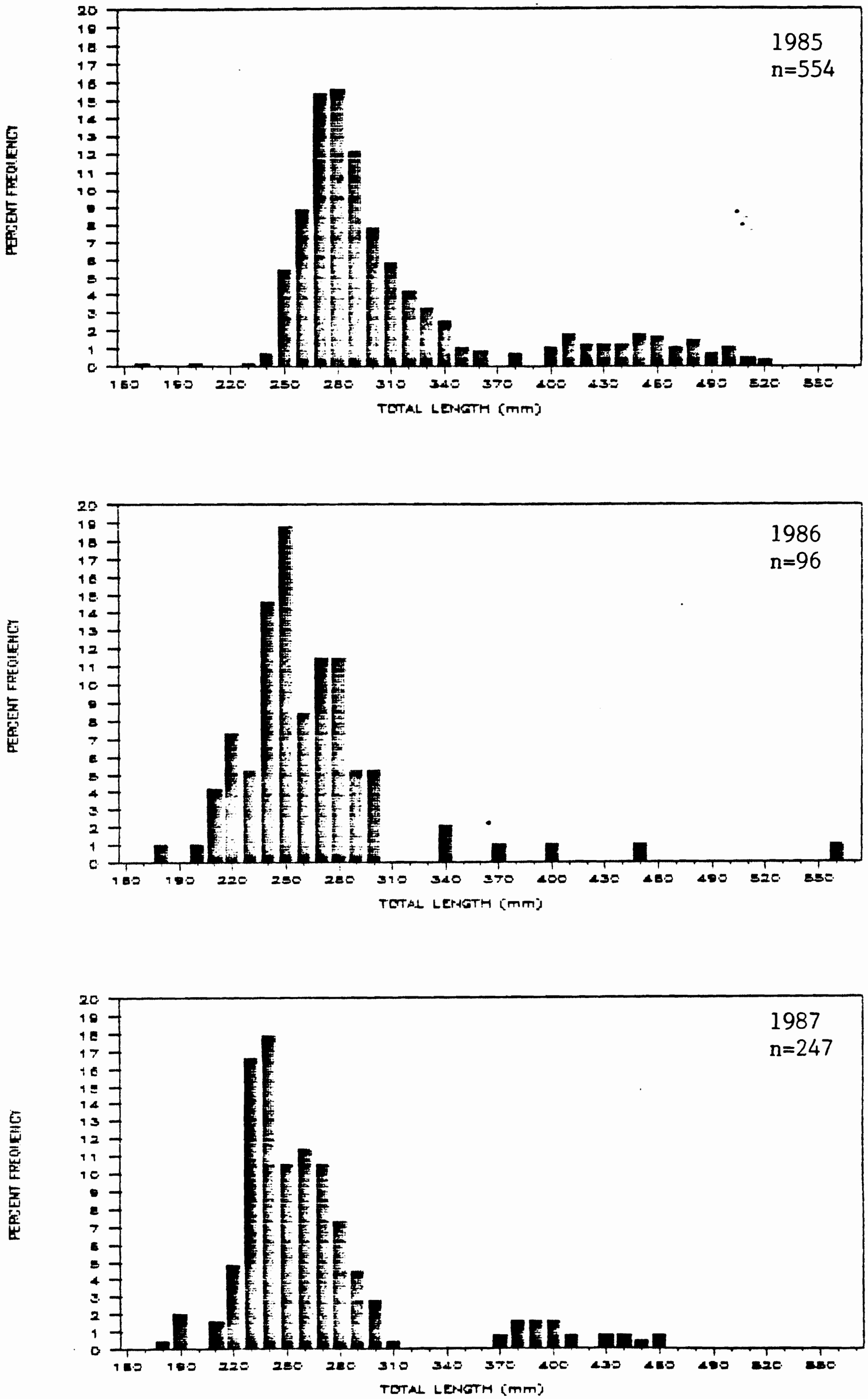



FIGURE 132. Size composition of olive rockfish from on-board observations of Santa Barbara County commercial passenger fishing vessels.

Love (1980) stated that olive rockfish populations can be overfished, in part, because of the lack of significant movement among reef-dwelling individuals. On one of the heavily fished reefs investigated, juvenile and prereproductive olive rockfish composed almost the entire resident population, indicating that adult olive rockfish were particularly vulnerable to sport hook and line gear.

It appears from our length frequency data that the major portion of the current olive rockfish catch is composed of 2- to 3-year-old fish that are just beginning to enter the reproductive population.

The apparent decline in the CPFV olive rockfish catch since 1978, coupled with the narrow age structure of the harvested fish, indicate that the species should be closely monitored. If the southern California olive rockfish stock is found to be overexploited, regulatory options, in addition to those that apply to the rockfish group, should be considered. These might include area fishing closures or a minimum olive rockfish size limit.

## Squarespot Rockfish (Scorpaenidae)

### Catch Estimates

Southern California. Squarespot rockfish total catch estimates decreased from 39,113 fish ± 8,605 in 1985 to 7,679 ± 1,613 in 1987 (Table 44). It was the 10th ranked rockfish species, composing 3.7% of the estimated rockfish total catch (Table 30). Collins and Crooke (unpublished manuscript) had squarespot rockfish total catch estimates ranging from 12,912 ± 3,310 in 1975 up to 64,051 ± 11,170 in 1978, and ranked sixth at 2.5% (frequency of occurrence) among the rockfish catch.

The total catch distribution for squarespot rockfish displayed peaks in the fall and winter of 1985 and 1986, while that for 1987 reflected uniformly low monthly total catch levels with an absence of large-scale fluctuations (Figure 133).

Counties. Los Angeles County landings were the major source of the squarespot rockfish catch (Table 44). Seventy-six percent of the southern California squarespot rockfish total catch came from Los Angeles County. In 1986 and 1987, the largest Los Angeles County squarespot rockfish total catches came from two sites, Santa Monica Canyon, and the Submarine Wreck off Los Angeles Harbor (Ally et al. 1988).

### Size Composition

Southern California. The squarespot rockfish length frequency distributions display single, strong modes in what approximate normal distributions (Figure 134). These modal groups ranged from 210 to 239

TABLE 44. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of Squarespot Rockfish from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| AREA | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 4,681 | 41 | 4,382 | 26 | 1,784 | 38 | 53 | 57 | 110 | 51 | 0 | 0 | 4,734 | 40 | 4,492 | 26 | 1,784 | 38 |
| Orange County | 586 | 41 | 2,013 | 9 | 270 | 86 | 0 | 0 | 84 | 99 | 0 | 0 | 586 | 41 | 2,097 | 10 | 270 | 86 |
| Los Angeles County | 29,725 | 27 | 24,511 | 50 | 4,743 | 30 | 1,028 | 24 | 456 | 61 | 212 | 46 | 30,753 | 27 | 24,967 | 50 | 4,955 | 29 |
| Ventura County | 2,271 | 30 | 1,450 | 41 | 361 | 36 | 133 | 82 | 0 | 0 | 0 | 0 | 2,404 | 32 | 1,450 | 41 | 361 | 36 |
| Santa Barbara County | 506 | 33 | 219 | 53 | 310 | 48 | 130 | 49 | 0 | 0 | 0 | 0 | 637 | 31 | 219 | 53 | 310 | 48 |
| Southern California | 37,770 | 22 | 32,575 | 38 | 7,467 | 22 | 1,344 | 21 | 650 | 46 | 212 | 46 | 39,113 | 22 | 33,225 | 38 | 7,679 | 21 |

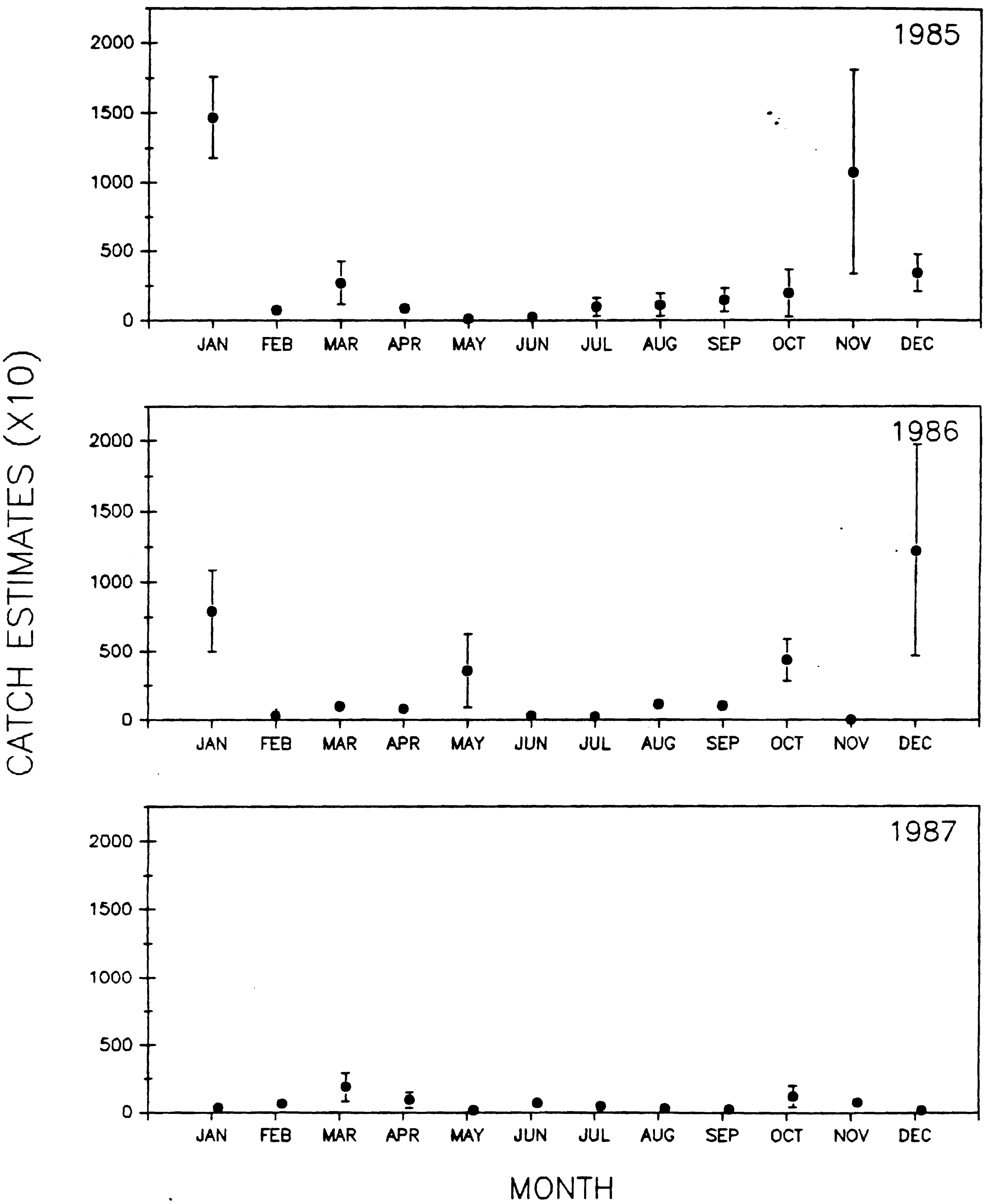



FIGURE 133. Monthly total catch estimates (number of fish) and standard deviations of squarespot rockfish from on-board observations of southern California commercial passenger fishing vessels.

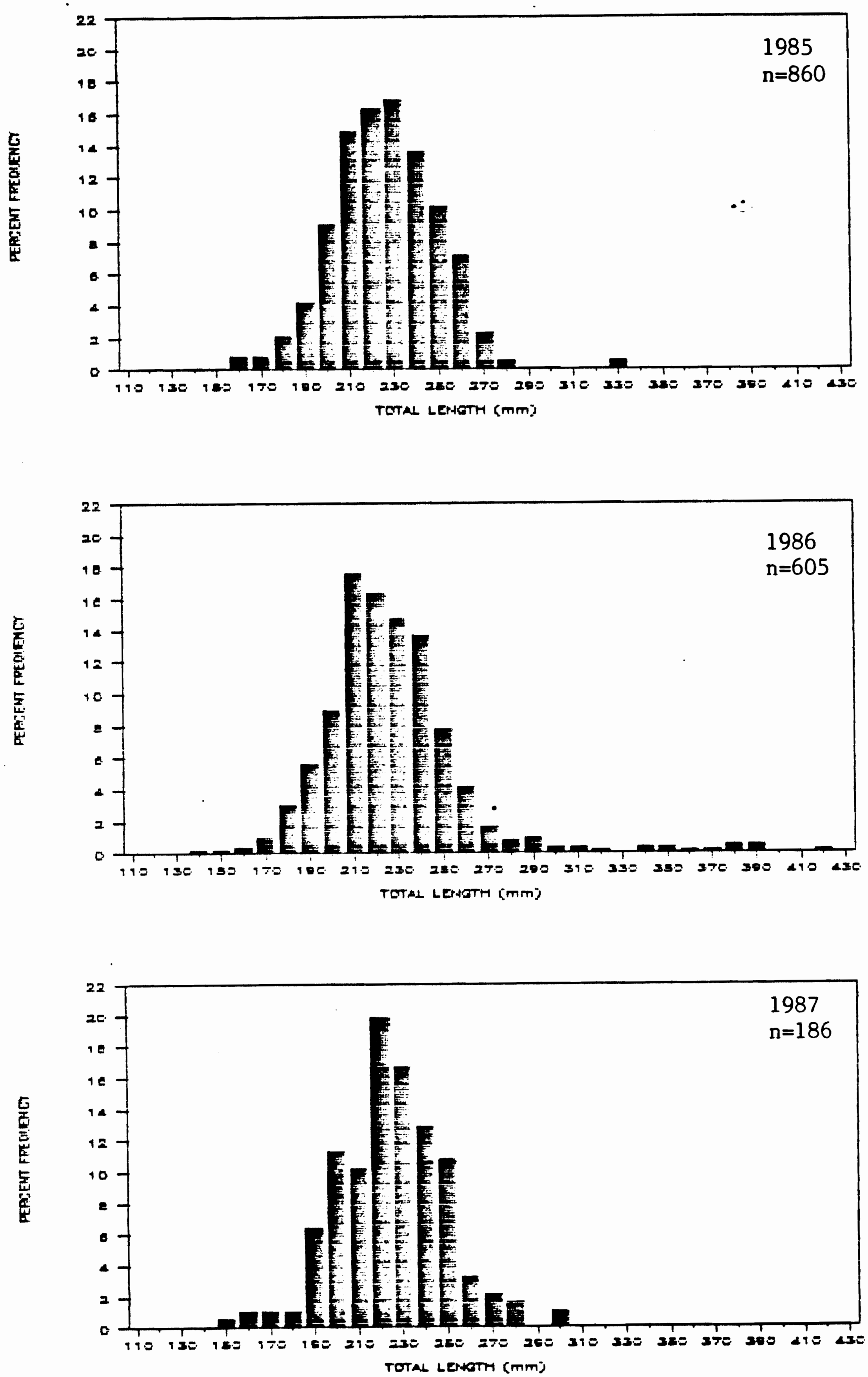



FIGURE 134. Size composition of squarespot rockfish from on-board observations of southern California commercial passenger fishing vessels.

mm (8.3 to 9.4 in.) during the 3 years surveyed, representing 5- to 8-year-old squarespot rockfish (MacGregor 1987).

Counties. The length frequency plots of the five southern California counties display length frequency modes within the 210 to 239 mm (8.3 to 9.4 in.) range, indicating that a large portion of the squarespot rockfish catch in each county was composed of 5- to 8-year-old fish (Figures 135 through 139), based on MacGregor's (1987) study. The squarespot rockfish mean lengths were relatively uniform among the counties, and were, for the most part, coincident with the range of modal values for each county (Figure 140).

Management Recommendations

Squarespot rockfish is a species whose small size (Eschmeyer et al. 1983) limits its desirability as a target species for CPFV anglers. Their relative prominence in the CPFV catch may simply indicate that they are readily available to CPFV's at nearshore fishing sites. In the case of Los Angeles County, where most of the southern California squarespot rockfish catch occurred, two nearshore fishing sites located near a concentration of partyboat landings produced a large portion of the catch in 1986 and 1987 (Ally, et al. 1988).

An observation can be made concerning the squarespot rockfish catch that may be applicable to some of the other, smaller rockfish species. Even though squarespot rockfish is not a desired catch species, and is even considered to be a nuisance species by some anglers, very few fish (less than 3.0%) were caught and released (Table 44). This may indicate that the majority of CPFV anglers have been educated against the practice of wasting fish, even small fish that will count against their bag limit.

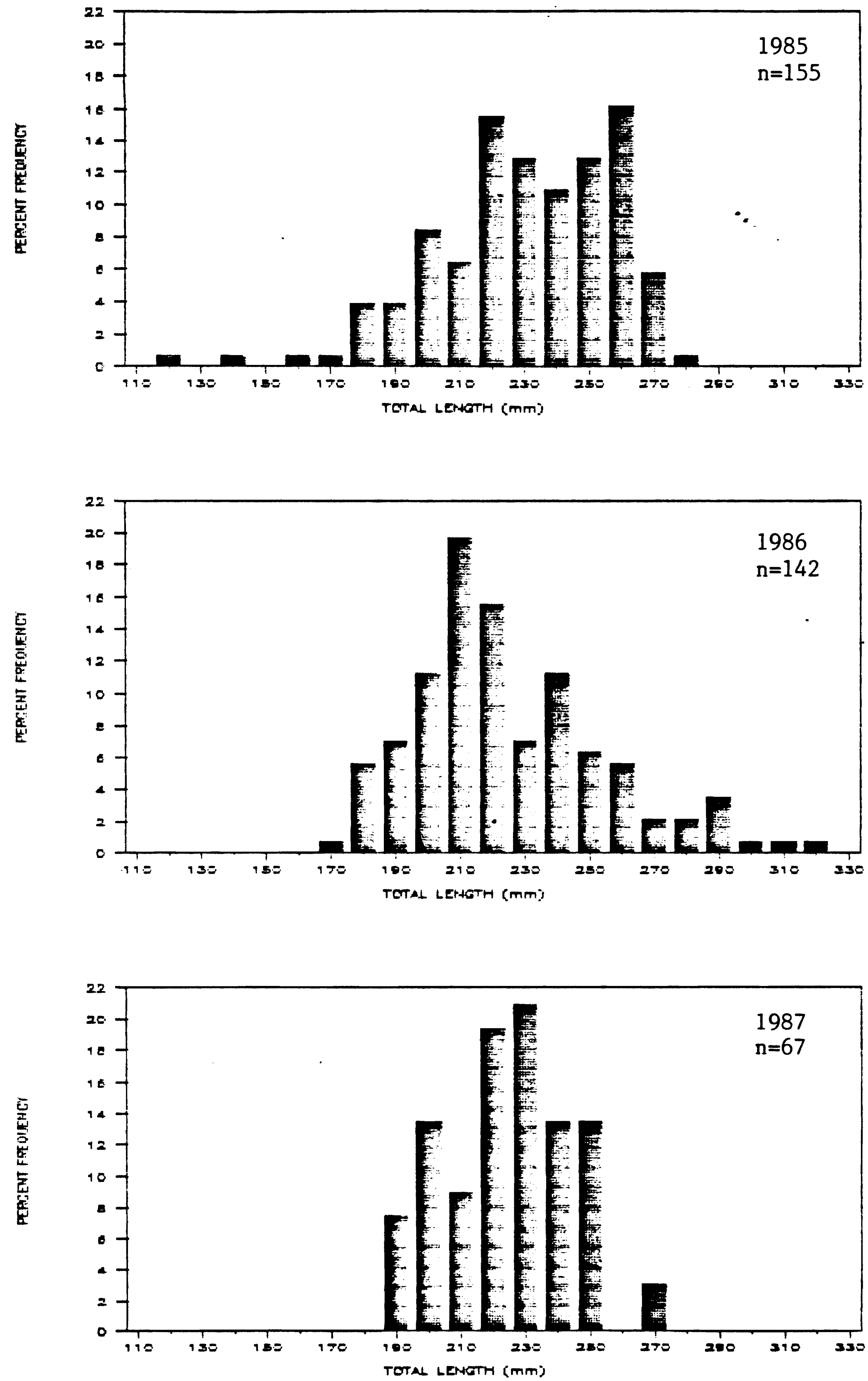



FIGURE 135. Size composition of squarespot rockfish from on-board observations of San Diego County commercial passenger fishing vessels.

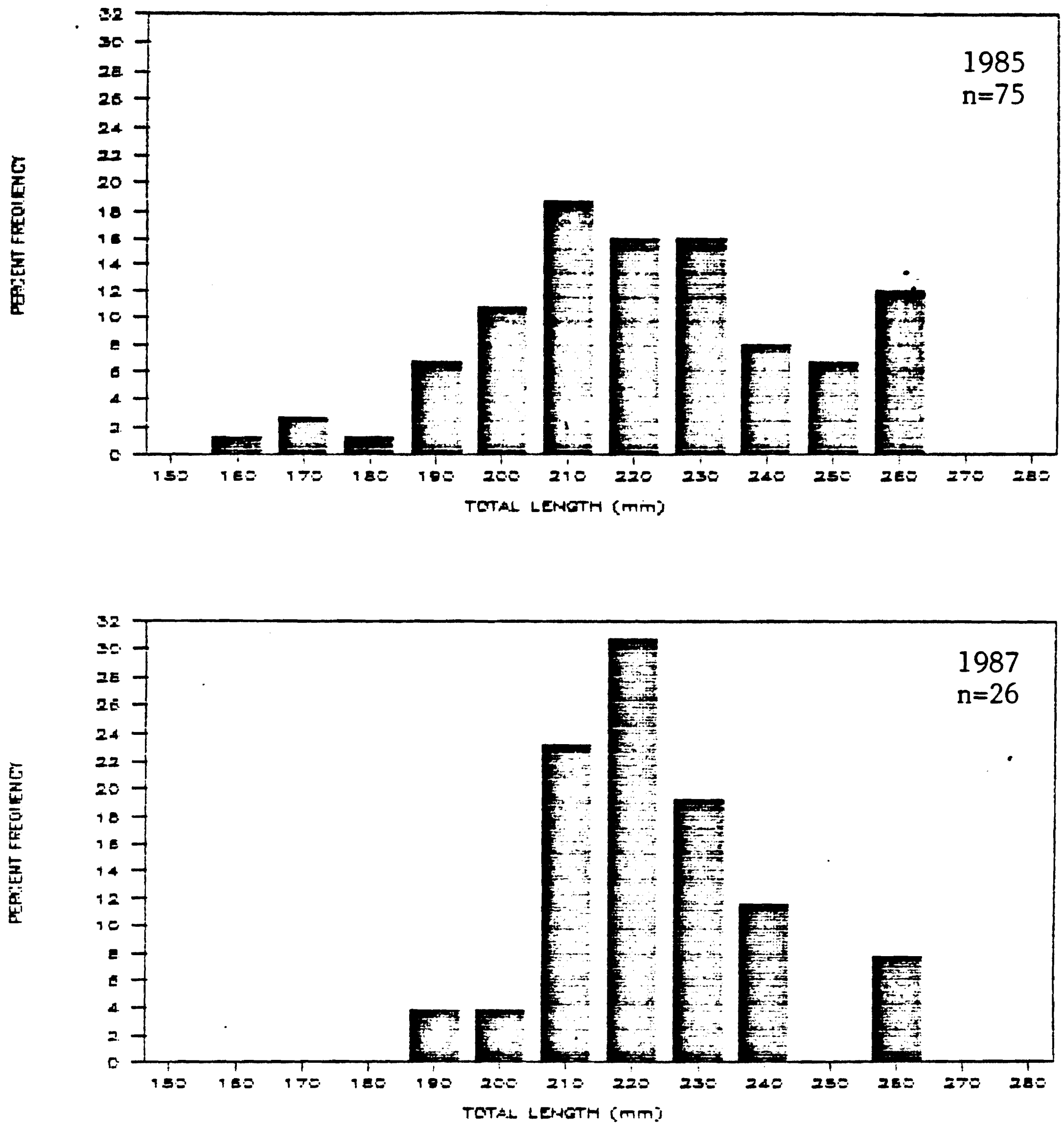



FIGURE 136. Size composition of squarespot rockfish from on-board observations of Orange County commercial passenger fishing vessels.

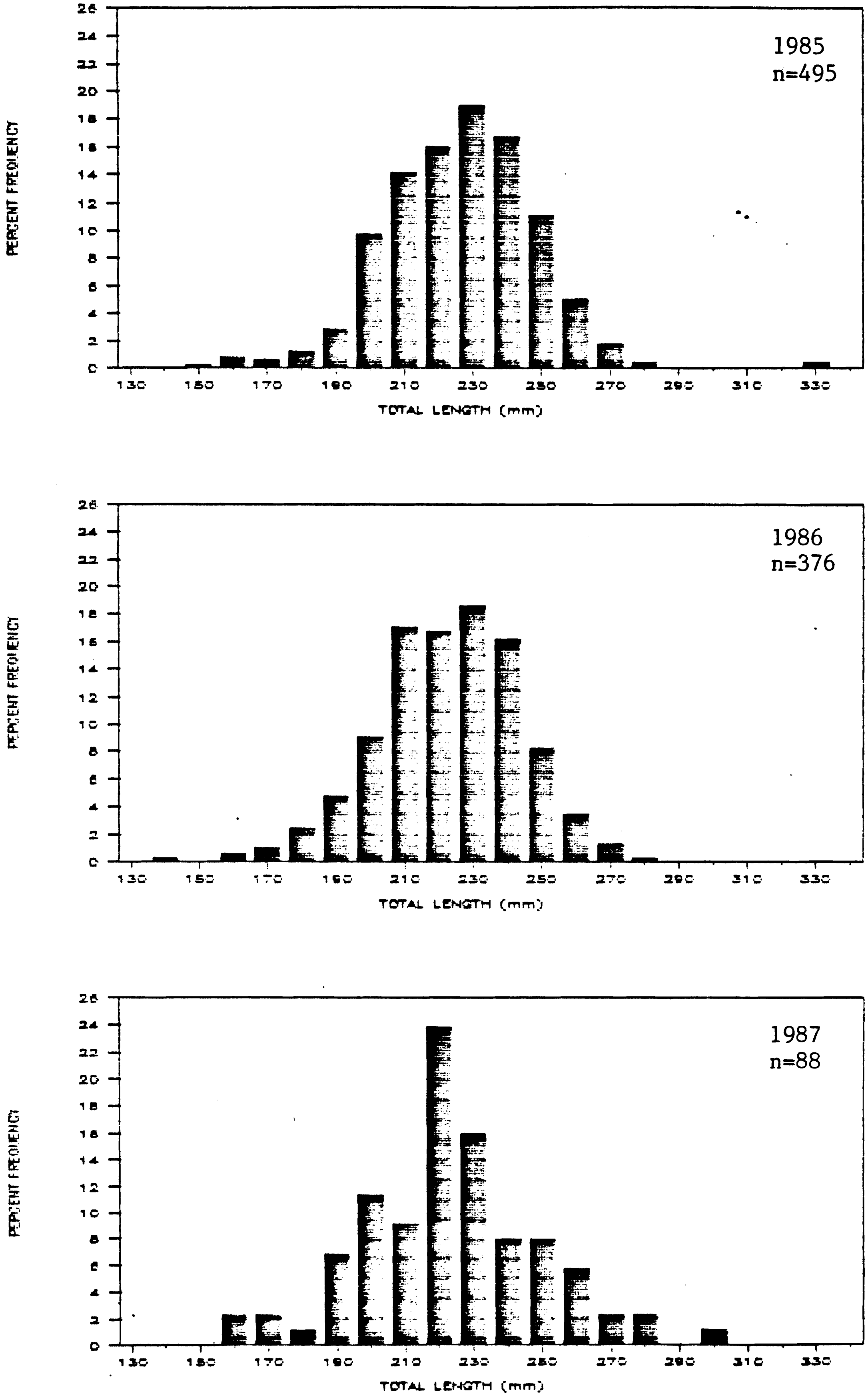



FIGURE 137. Size composition of squarespot rockfish from on-board observations of Los Angeles County commercial passenger fishing vessels.

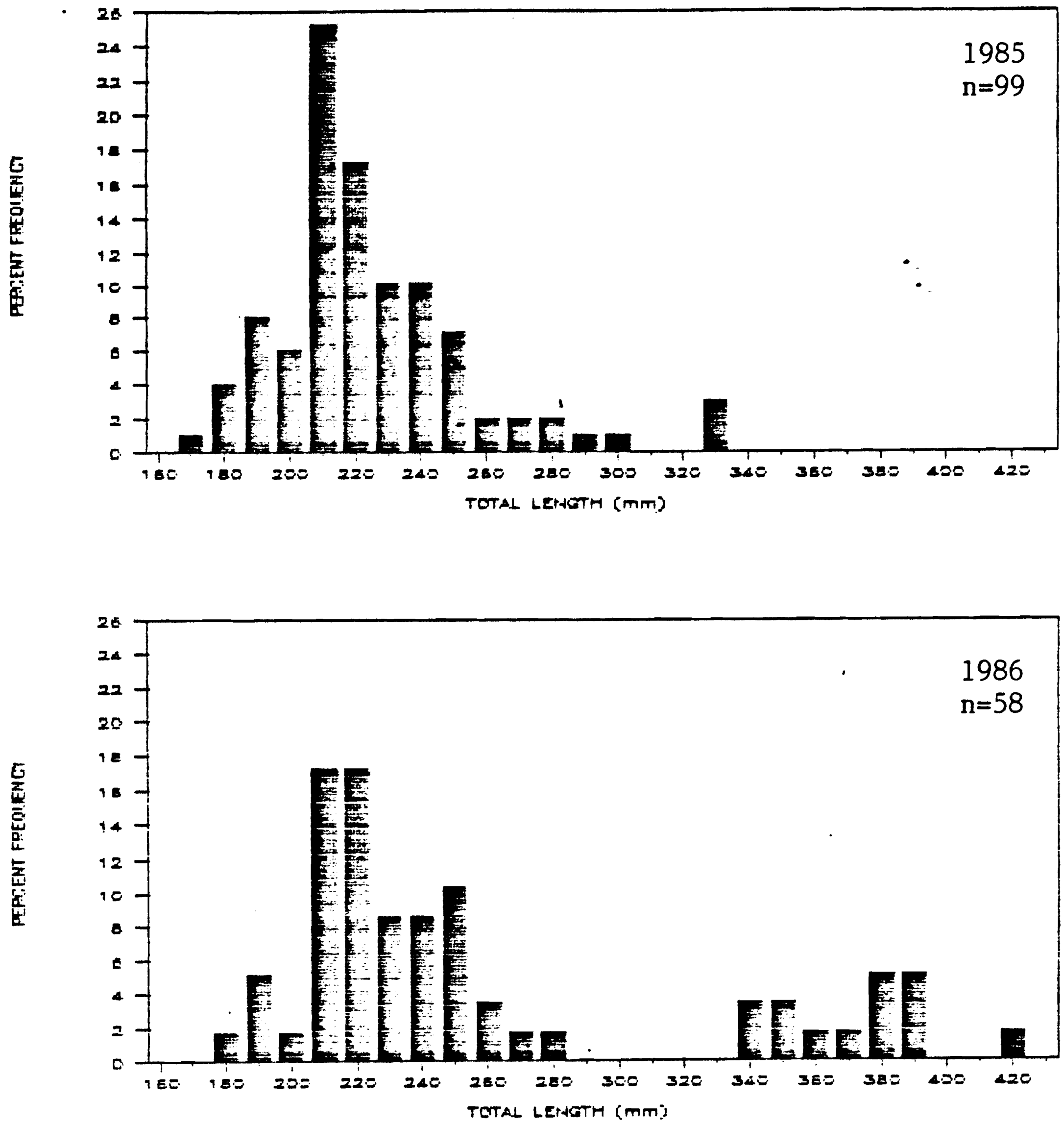



FIGURE 138. Size composition of squarespot rockfish from on-board observations of Ventura County commercial passenger fishing vessels.

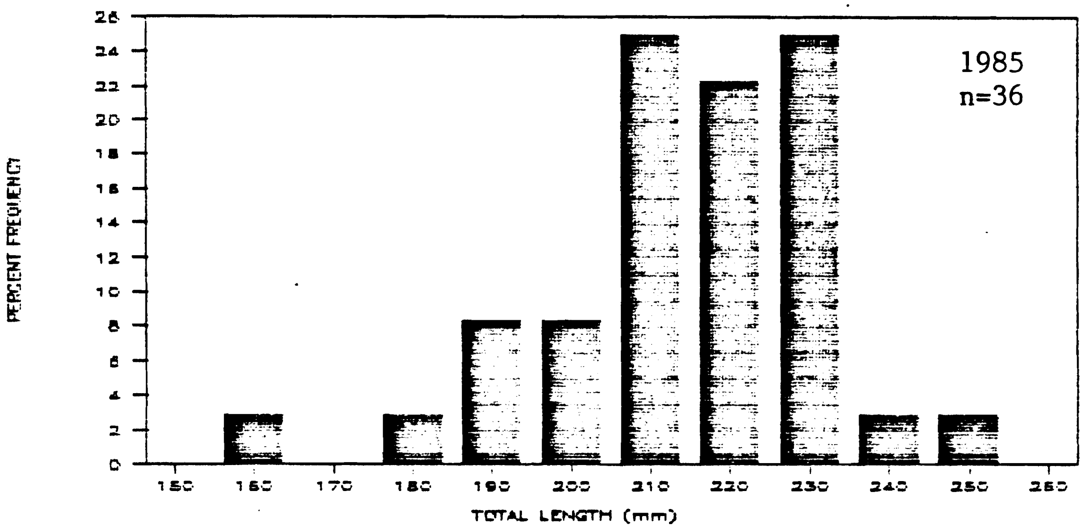



FIGURE 139. Size composition of squarespot rockfish from on-board observations of Santa Barbara County commercial passenger fishing vessels.

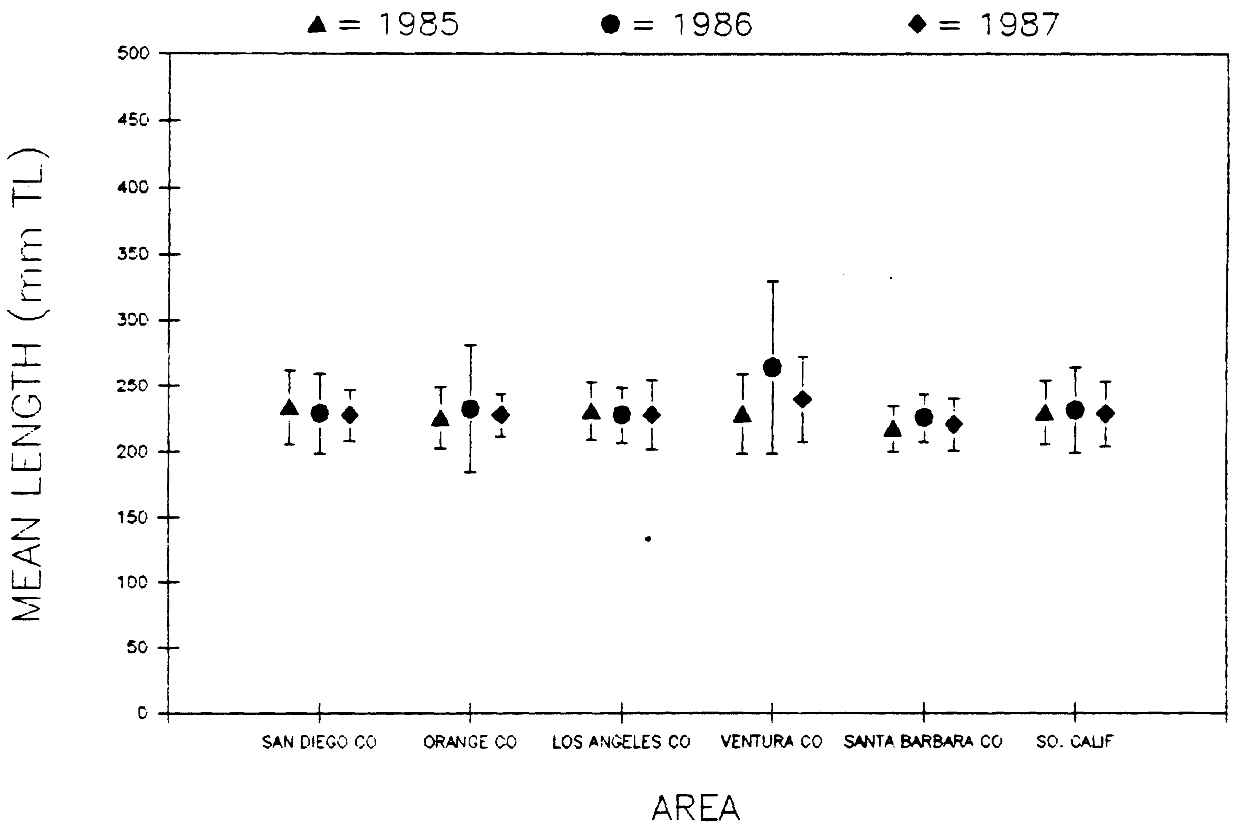



FIGURE 140. Mean lengths and standard deviations of squarespot rockfish measured on board southern California commercial passenger fishing vessels.

Based on our survey results, we do not feel that additional sport fish regulations are needed to protect squarespot rockfish, except as they apply to the rockfish group.

## Starry Rockfish (Scorpaenidae)

### Catch Estimates

Southern California. Starry rockfish is a small- to moderate-size rockfish species [maximum size = 460 mm (18 in.)] that lives in deep-water habitats (Eschmeyer, et al. 1983). Total catch estimates decreased from 42,752 fish ± 4,275 in 1985 to 24,721 ± 5,686 in 1987 (Table 45). Starry rockfish was the fifth ranked species at 4.7% in the rockfish catch (Table 30). Collins and Crooke (unpublished manuscript) reported starry rockfish total catch estimates ranging from 18,011 ± 2,389 in 1976 to 25,812 ± 3,037 in 1978. It was the 13th ranking rockfish species (1.3% frequency of occurrence) in their survey.

The monthly total catch distributions did not display clear, recurring seasonal patterns from year to year (Figure 141). In 1985 the highest catches of starry rockfish occurred in December, while the 1986 and 1987 December catches were among the lowest monthly catches in each respective year. The highest starry rockfish catches occurred in January and May in 1986, and in April in 1987.

Counties. San Diego, Los Angeles, and Ventura counties had the highest annual starry rockfish total catches (Table 45).

### Size Composition

Southern California. The starry rockfish length frequency plots do not display clearly defined length modes (Figure 142), and seem to encompass age group 5 through at least age group 15 (MacGregor 1987).

TABLE 45. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of Starry Rockfish from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| AREA | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 11,365 | 20 | 8,136 | 16 | 5,390 | 19 | 651 | 46 | 527 | 34 | 111 | 60 | 12,016 | 20 | 8,664 | 15 | 5,501 | 19 |
| Orange County | 2,330 | 37 | 498 | 40 | 156 | 58 | 116 | 58 | 0 | 0 | 58 | 99 | 2,446 | 36 | 498 | 40 | 214 | 63 |
| Los Angeles County | 11,031 | 12 | 8,408 | 24 | 8,465 | 56 | 1,931 | 27 | 1,116 | 24 | 745 | 70 | 12,962 | 11 | 9,523 | 22 | 9,210 | 52 |
| Ventura County | 13,026 | 20 | 15,143 | 26 | 7,291 | 29 | 68 | 59 | 171 | 99 | 26 | 98 | 13,094 | 20 | 15,313 | 26 | 7,317 | 29 |
| Santa Barbara County | 2,172 | 49 | 1,247 | 52 | 2,479 | 69 | 62 | 49 | 14 | 96 | 0 | 0 | 2,233 | 48 | 1,261 | 51 | 2,479 | 69 |
| Southern California | 39,923 | 10 | 33,431 | 14 | 23,782 | 23 | 2,829 | 22 | 1,828 | 20 | 939 | 57 | 42,752 | 10 | 35,259 | 13 | 24,721 | 23 |

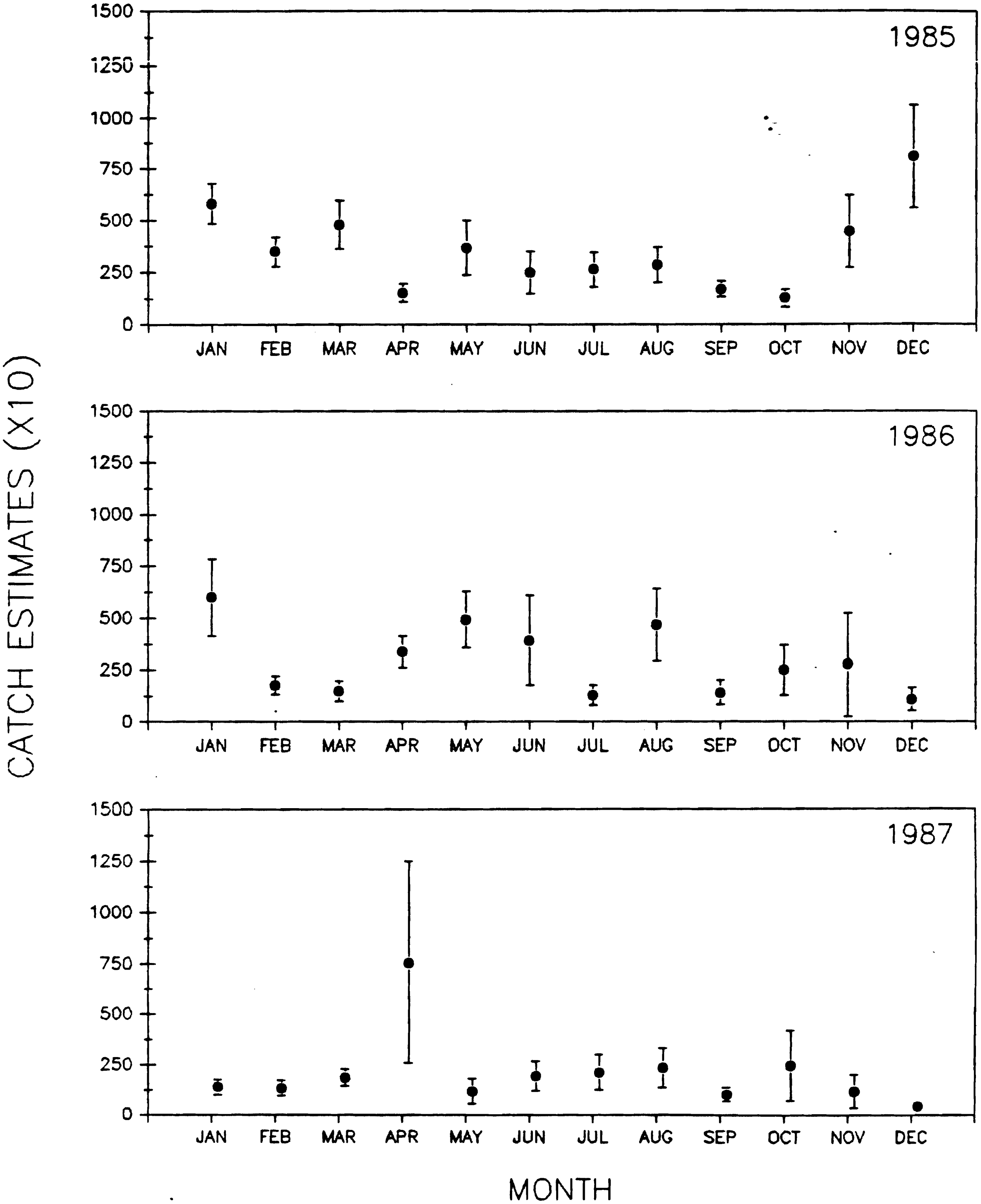



FIGURE 141. Monthly total catch estimates (number of fish) and standard deviations of starry rockfish from on-board observations of southern California commercial passenger fishing vessels.

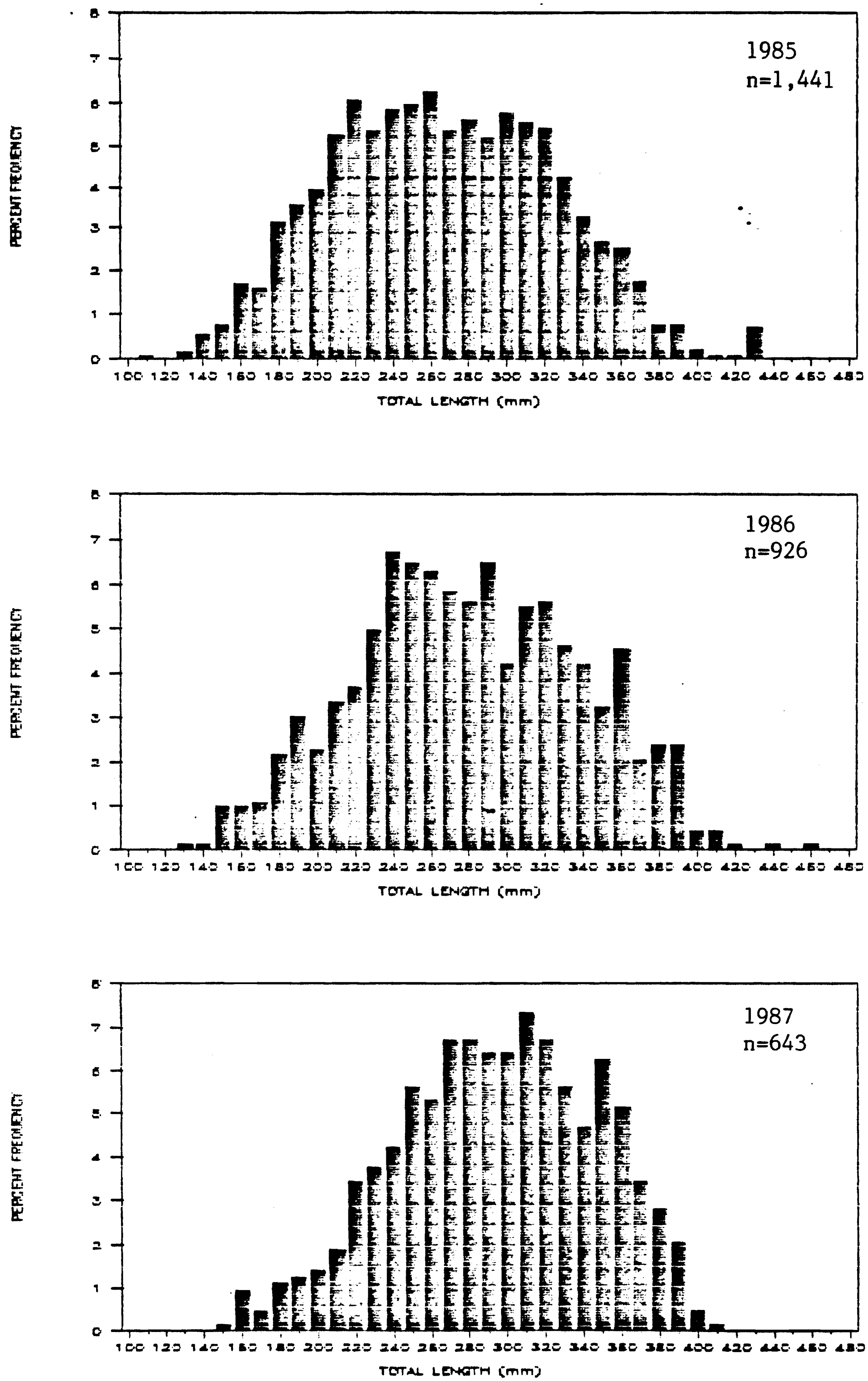



FIGURE 142. Size composition of starry rockfish from on-board observations of southern California commercial passenger fishing vessels.

Counties. MacGregor's (1987) length at age relationships were used to define length frequency patterns for starry rockfish from each county. The San Diego length plots have multiple modes, with 1980 year class starry rockfish [220 to 229 mm (8.7 to 9.0 in.) in 1985] composing a large portion of the catch in each year (Figure 143). There was only sufficient data for a 1985 Orange County plot (Figure 144). It reveals two modal groups, one representing 3-year-old, 1982 year class, fish [190 to 199 mm (7.5 to 7.8. in.)], and the second mode delineating 7-year-old, 1978 year class, starry rockfish [270 to 279 mm (10.6 to 11.0 in.)]. The Los Angeles County length frequency distributions are dominated by 1980 year class starry rockfish that became a major part of the 1985 through 1987 catches (Figure 145). The Ventura County plots display modes which are composed of multiple, overlapping year classes, ranging from 210 to 369 mm (8.3 to 14.5 in.), and representing major portions of the catches in each of the 3 years (Figure 146). Age classes 6 through 13 are represented in the defined modal ranges (MacGregor 1987). The Santa Barbara County plots have length modes that represent older, larger starry rockfish than those of other counties (Figure 147). The modal length groups range from 290 to 389 mm (11.4 to 15.3 in.), representing 9- to 14-year-old fish.

Mean lengths suggest a geographic cline in fish size, increasing from San Diego to Santa Barbara Counties (Figure 148). However, this may be due to an inverse function of the fishing pressure expended in these areas.

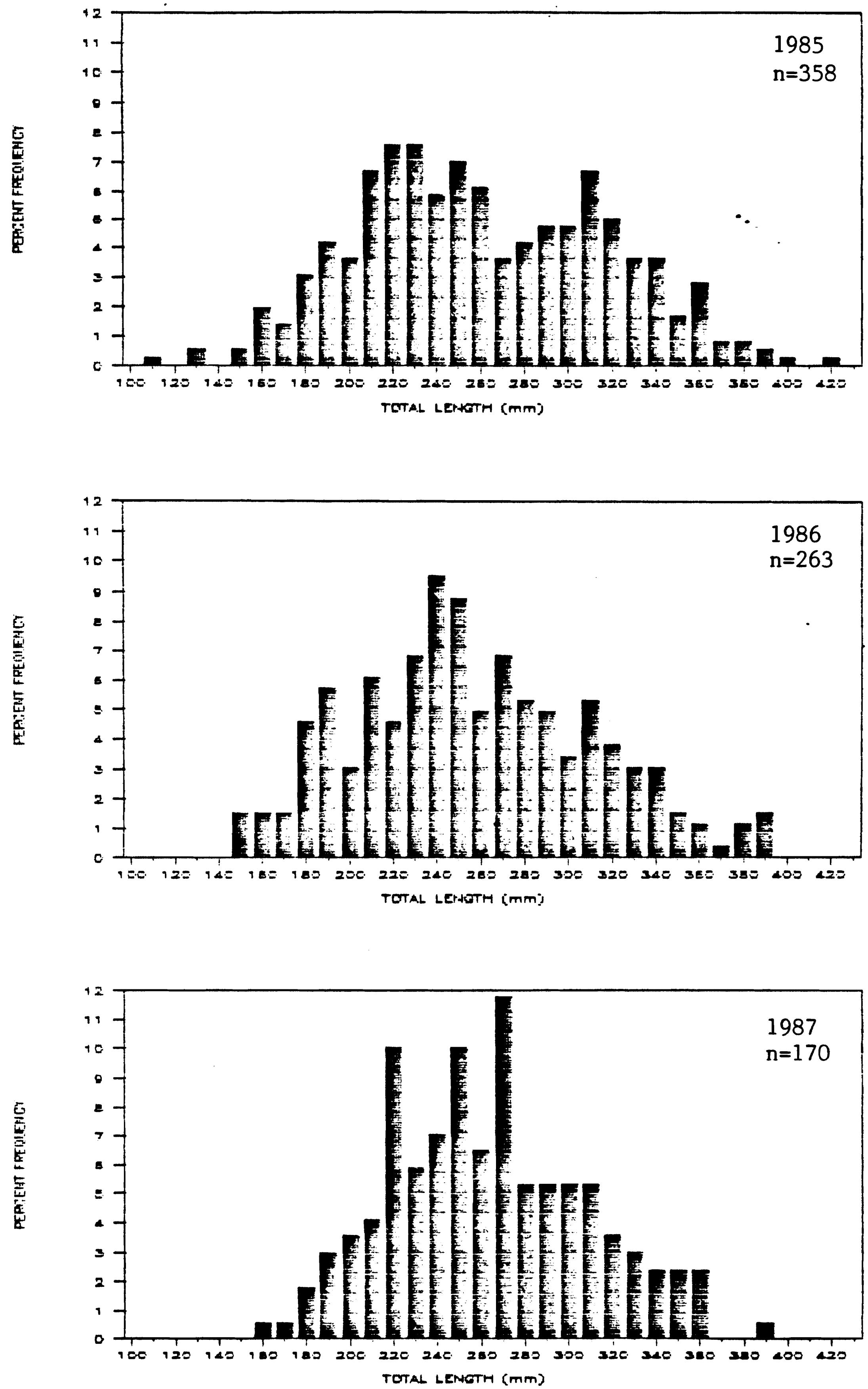



FIGURE 143. Size composition of starry rockfish from on-board observations of San Diego County commercial passenger fishing vessels.

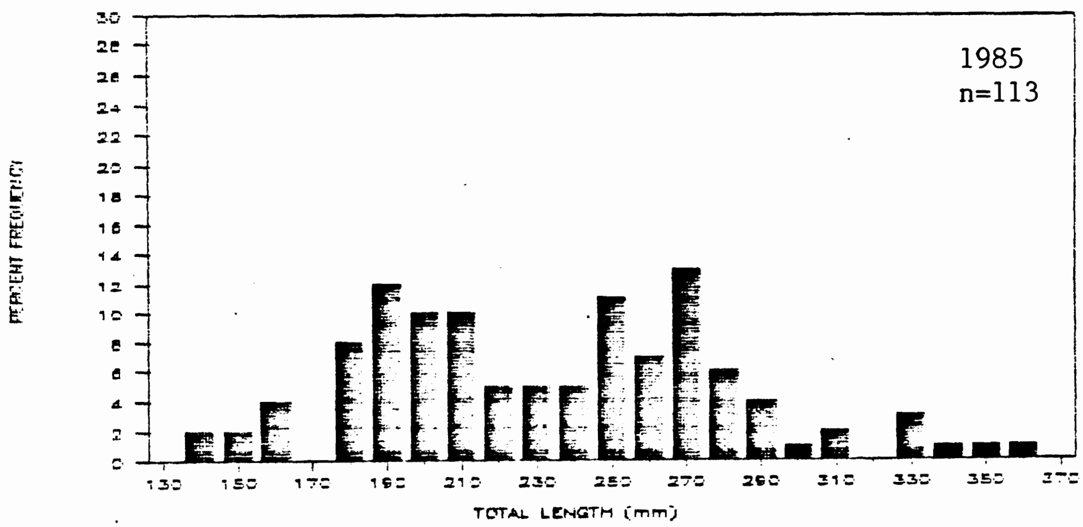



FIGURE 144. Size composition of starry rockfish from on-board observations of Orange County commercial passenger fishing vessels.

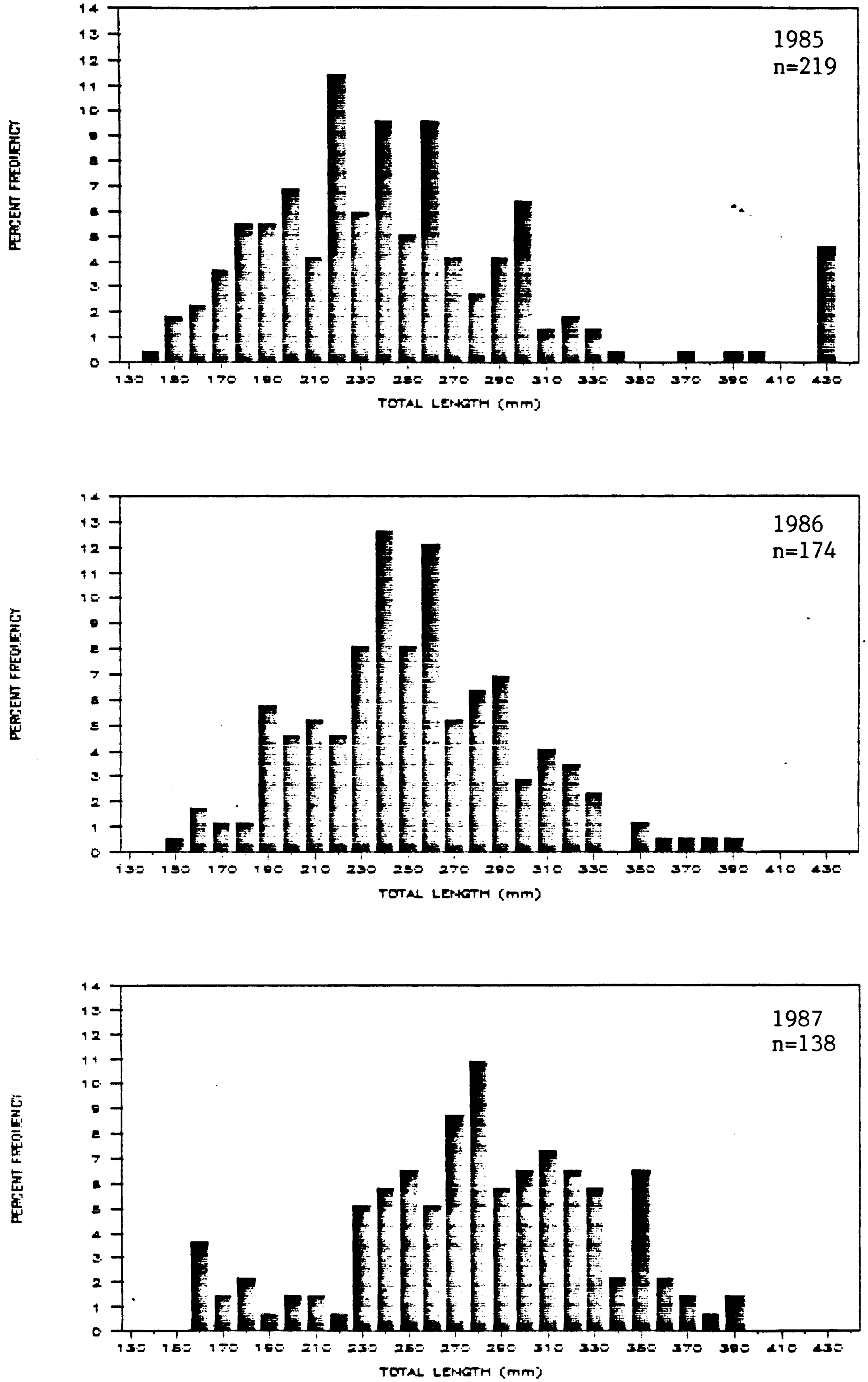



FIGURE 145. Size composition of starry rockfish from on-board observations of Los Angeles County commercial passenger fishing vessels.

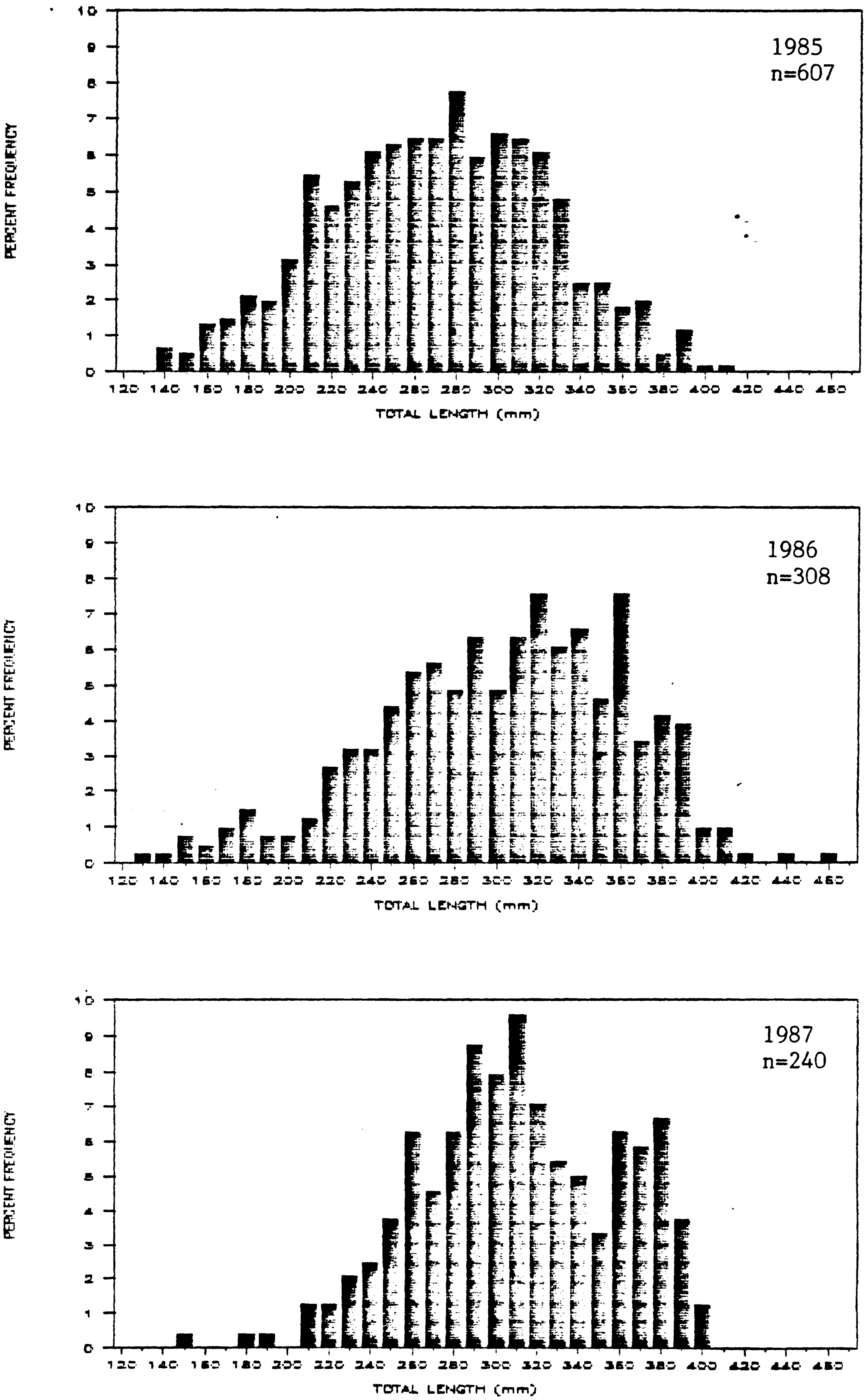



FIGURE 146. Size composition of starry rockfish from on-board observations of Ventura County commercial passenger fishing vessels.

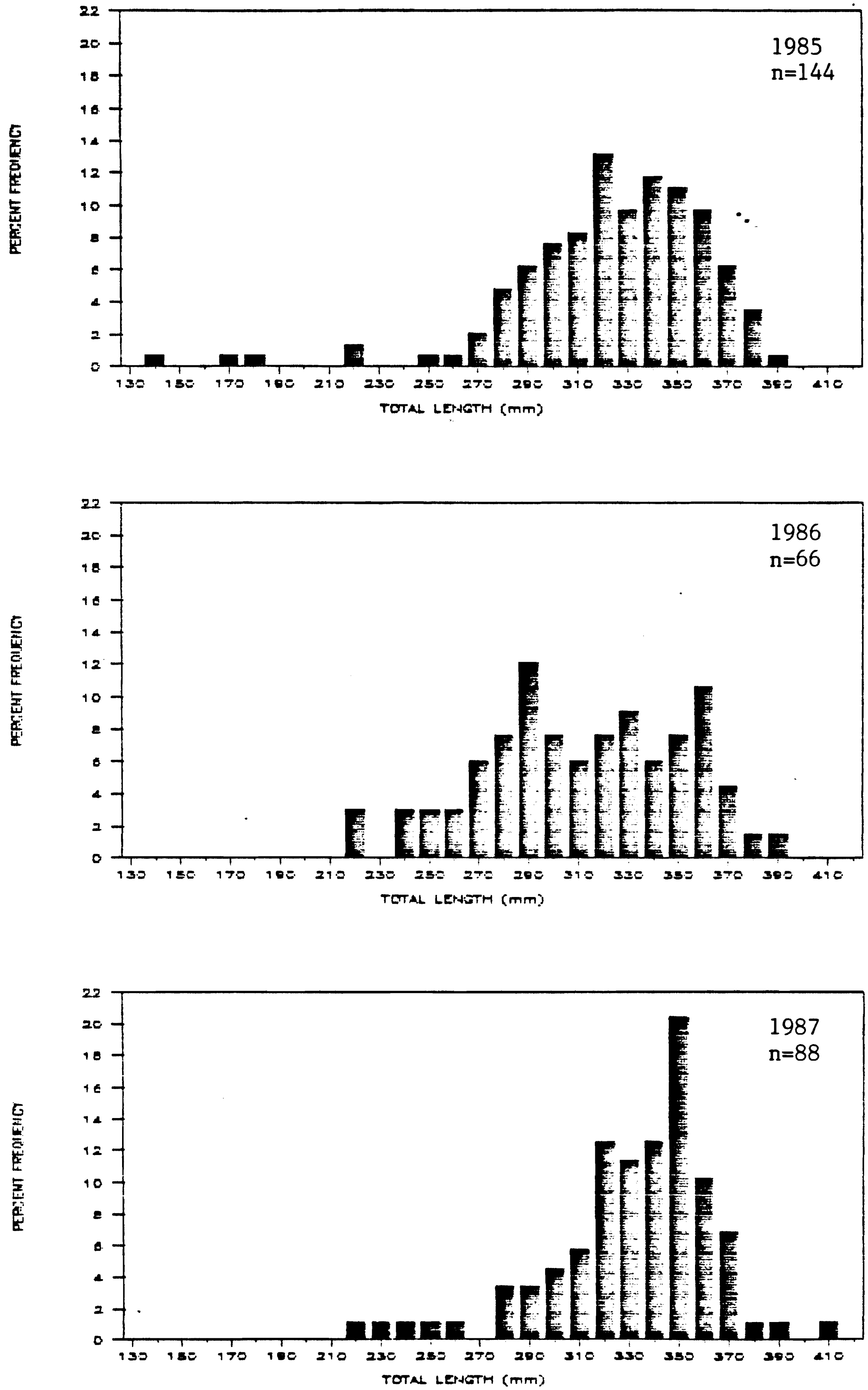



FIGURE 147. Size composition of starry rockfish from on-board observations of Santa Barbara County commercial passenger fishing vessels.

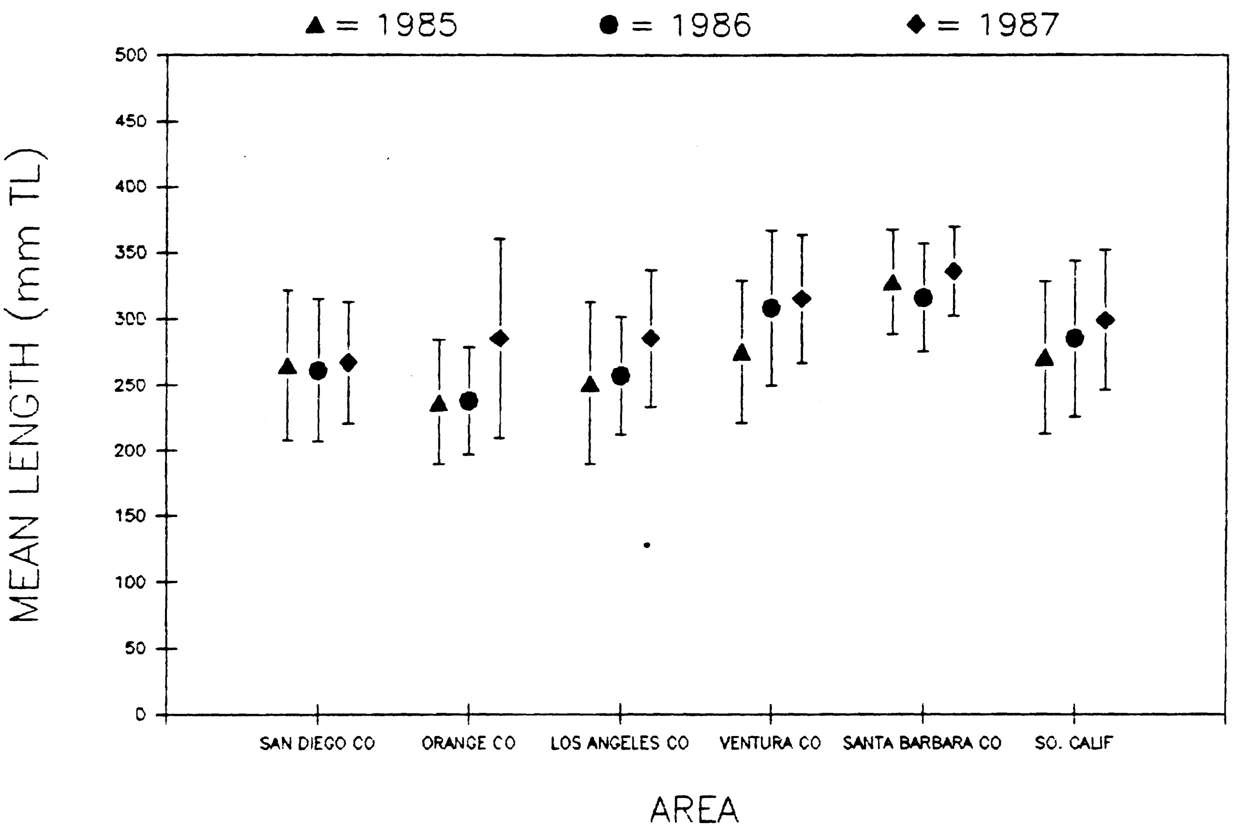



FIGURE 148. Mean lengths and standard deviations of starry rockfish measured on board southern California commercial passenger fishing vessels.

Management Recommendations

Starry rockfish are usually found in depths greater than 40 m (22 fm) in association with other demersal rockfish species. They are not usually targeted because of their small size, and are often caught in a mix along with other, larger species, such as vermilion rockfish and bocaccio.

Because the starry rockfish catch reflects a population composed of a wide range of age classes, and since catch levels have been relatively constant over the past 10 years, we feel the species has not been adversely affected by current levels of fishing. We do not recommend species-level regulatory protection at this time, except as it applies to the rockfish group.

## Vermilion Rockfish (Scorpaenidae)

### Catch Estimates

Southern California. Vermilion rockfish is considered a premium rockfish species by both sport and commercial fishermen; they are prized for the texture and flavor of their fillets. Our vermilion rockfish total catch estimates increased from 47,241 fish $\pm$ 8,976 in 1985 to 72,389 $\pm$ 9,411 in 1987 (Table 46). Collins and Crooke's (unpublished manuscript) vermilion rockfish total catch estimates ranged from 42,714 $\pm$ 5,312 in 1976 to 64,266 $\pm$ 12,352 in 1977. Those estimates placed vermilion rockfish fifth among their frequently taken rockfish species (3.5% frequency of occurrence). In our survey vermilion rockfish ranked third in species composition at 8.1% of the rockfish total catch (Table 30).

The total catch distribution of vermilion rockfish was quite variable over the 3 years surveyed (Figure 149). Catch peaks were in April and November in 1985, May and October in 1986, and February and June in 1987.

Counties. Los Angeles County had the largest portion of the southern California vermilion rockfish total catch, composing an average of 47% of the total catch. San Diego and Ventura county also had substantial vermilion rockfish total catches, composing an average of 19% and 21% of the southern California vermilion rockfish total catch, respectively.

TABLE 46. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of Vermilion Rockfish from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| AREA | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 4,229 | 17 | 13,097 | 28 | 14,684 | 25 | 54 | 71 | 459 | 30 | 250 | 45 | 4,283 | 17 | 13,557 | 27 | 14,934 | 25 |
| Orange County | 2,363 | 19 | 3,541 | 10 | 3,116 | 46 | 0 | 0 | 50 | 99 | 0 | 0 | 2,363 | 19 | 3,591 | 10 | 3,116 | 46 |
| Los Angeles County | 25,304 | 33 | 25,781 | 49 | 30,224 | 23 | 170 | 70 | 289 | 55 | 343 | 99 | 25,474 | 33 | 26,070 | 49 | 30,566 | 23 |
| Ventura County | 10,295 | 23 | 11,081 | 21 | 14,801 | 34 | 46 | 69 | 160 | 50 | 53 | 67 | 10,341 | 23 | 11,241 | 21 | 14,855 | 34 |
| Santa Barbara County | 4,752 | 40 | 686 | 35 | 8,883 | 27 | 27 | 68 | 21 | 98 | 36 | 72 | 4,780 | 40 | 2,007 | 35 | 8,919 | 27 |
| Southern California | 46,944 | 19 | 55,486 | 24 | 71,708 | 14 | 297 | 44 | 979 | 24 | 681 | 53 | 47,241 | 19 | 56,466 | 24 | 72,389 | 13 |

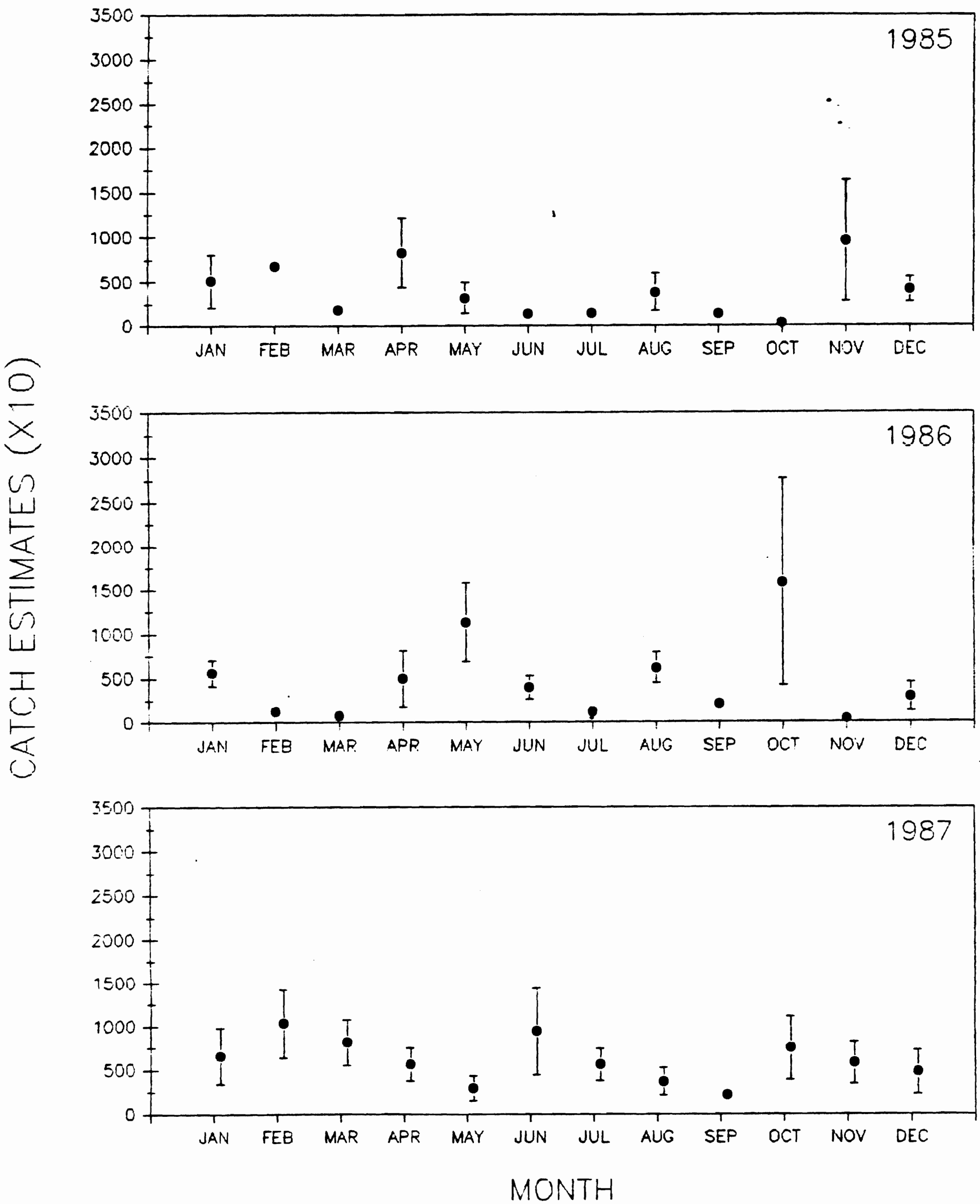



FIGURE 149. Monthly total catch estimates (number of fish) and standard deviations of vermilion rockfish from on-board observations of southern California commercial passenger fishing vessels.

## Size Composition

Southern California. The vermilion rockfish length frequency distributions display a trend toward the appearance of fewer modal groups in each succeeding year (Figure 150). By 1986, a modal group at 240 to 254 mm (9.4 to 10.0 in.), composed of 4-year-old fish, constituted a large portion of the catch sample (MacGregor 1987). These 1982 year class vermilion rockfish carried through to the next year, 1987, as the major modal group.

Counties. The pattern of vermilion rockfish length frequency distributions by county generally follow the trend seen in the southern California composite length frequency distributions (Figure 151 through 155). Vermilion rockfish greater than 360 mm (14 in.) and 10 years old were a diminishing segment of the sampled catch in each succeeding year.

Vermilion rockfish in Ventura and Santa Barbara counties were larger than those from the three southernmost counties (Figure 156). This may have been due to the ability of CPFV's from complexes in these two counties to fish areas of the northern Channel Islands that supported relatively unexploited populations of vermilion rockfish. The length frequency distributions for Ventura and Santa Barbara counties show concentrations of large, older [$\geq$400 mm (16.0 in.)] vermilion rockfish that did not appear elsewhere in the same modal quantities (Figures 154 and 155).

## Management Recommendations

Vermilion rockfish are highly prized by CPFV anglers, and made up a larger portion of the CPFV rockfish catch during our study than they did during Collins and Crooke's (unpublished manuscript) study. Our

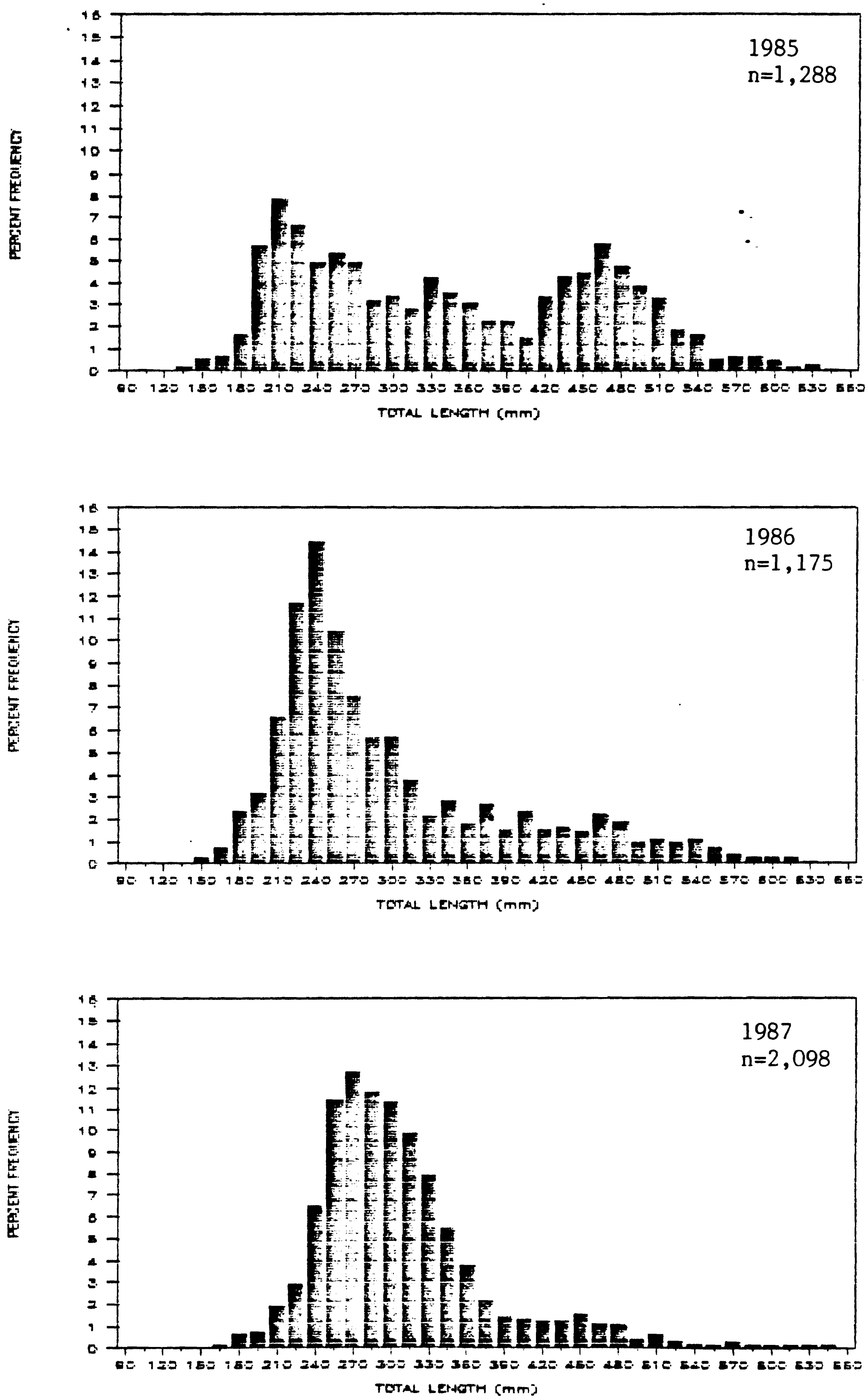



FIGURE 150. Size composition of vermilion rockfish from on-board observations of southern California commercial passenger fishing vessels.

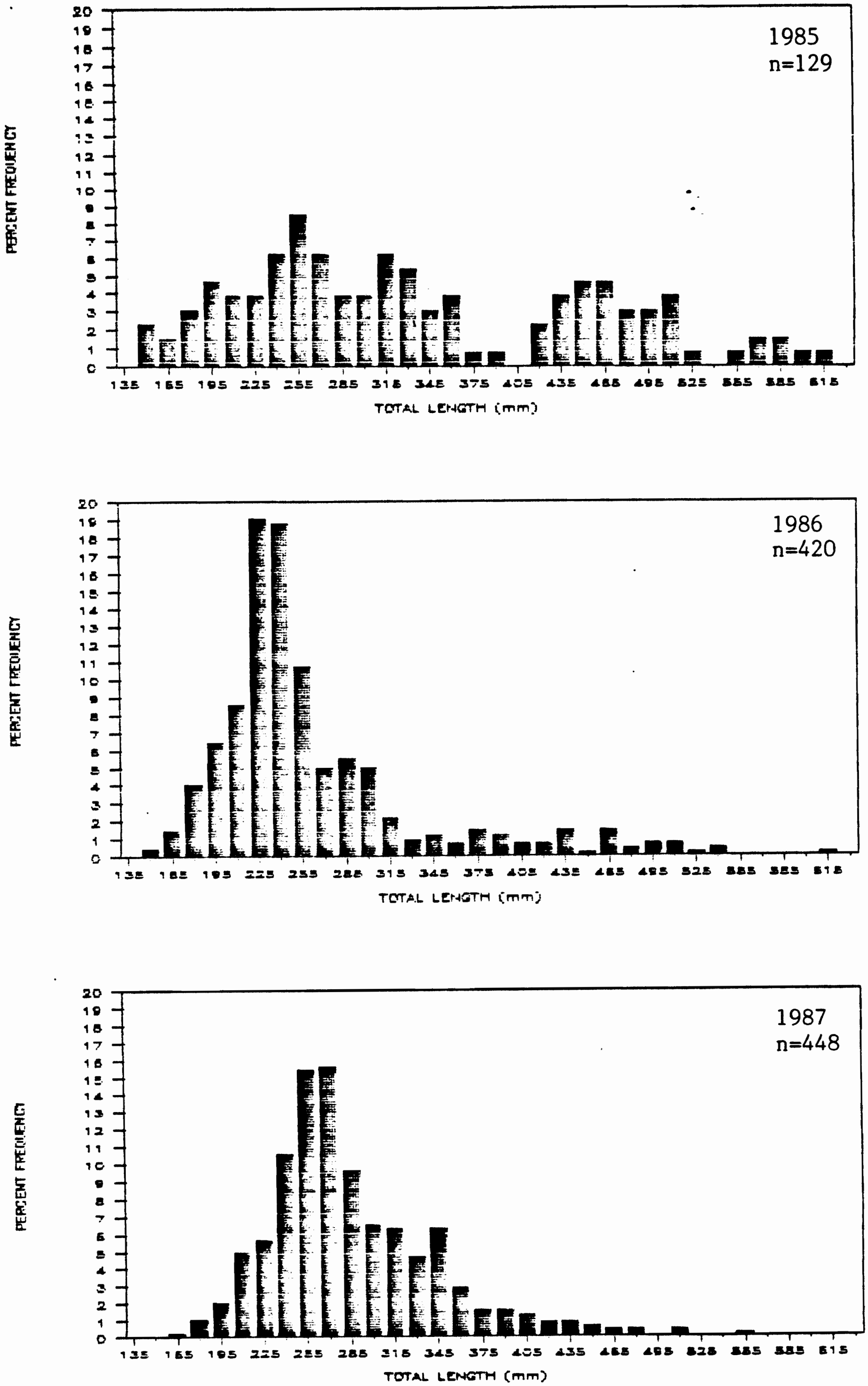



FIGURE 151. Size composition of vermilion rockfish from on-board observations of San Diego County commercial passenger fishing vessels.

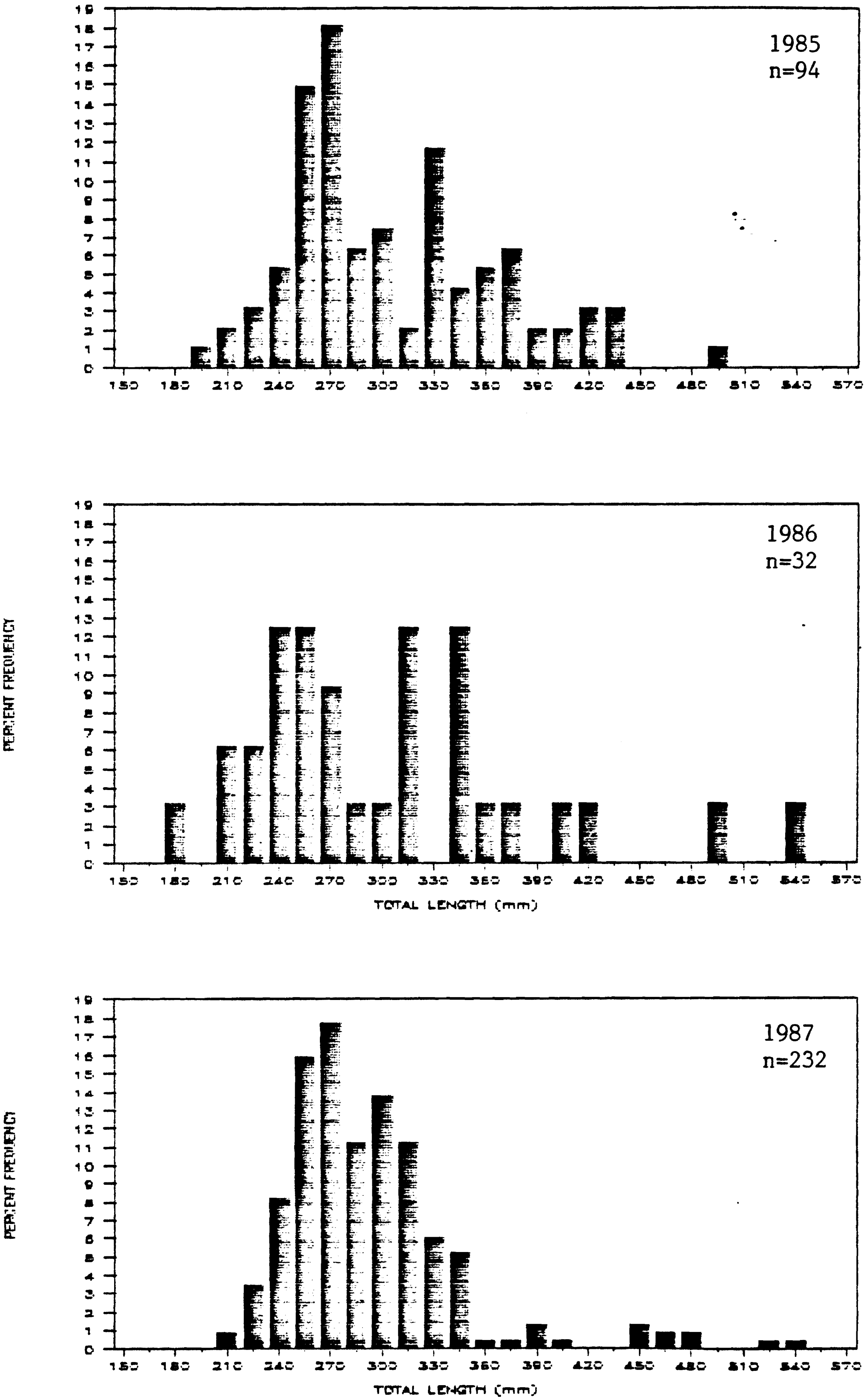



FIGURE 152. Size composition of vermilion rockfish from on-board observations of Orange County commercial passenger fishing vessels.

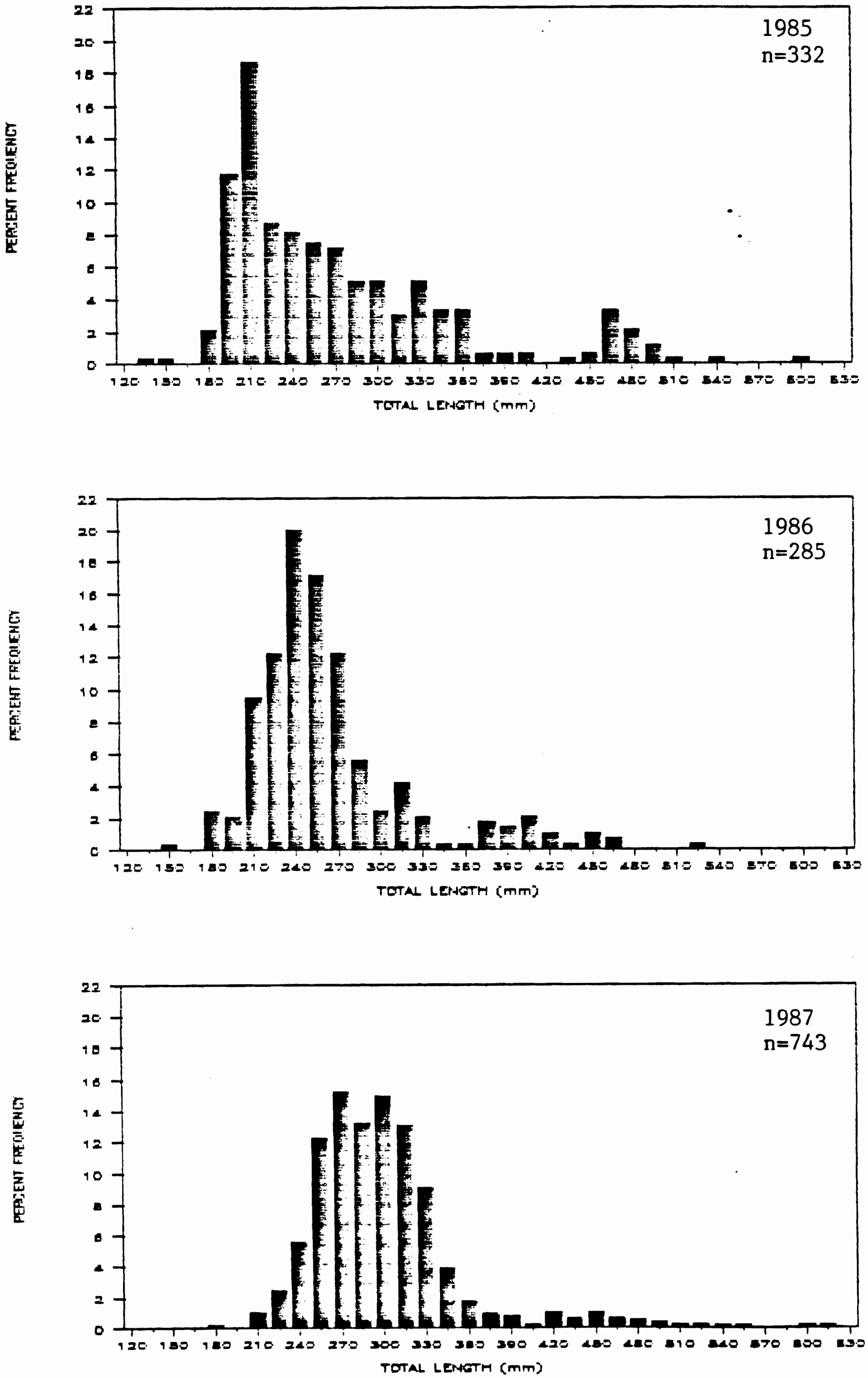
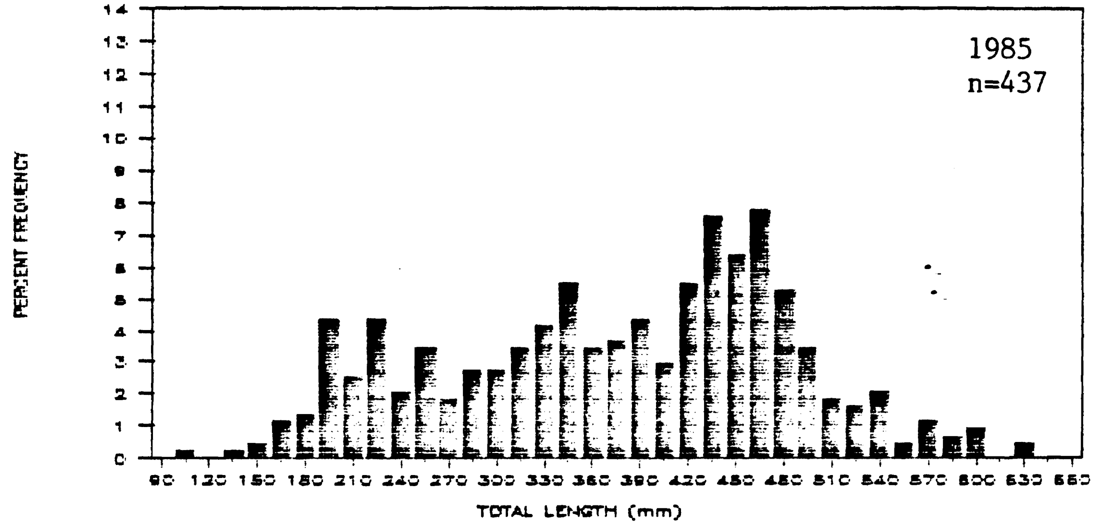
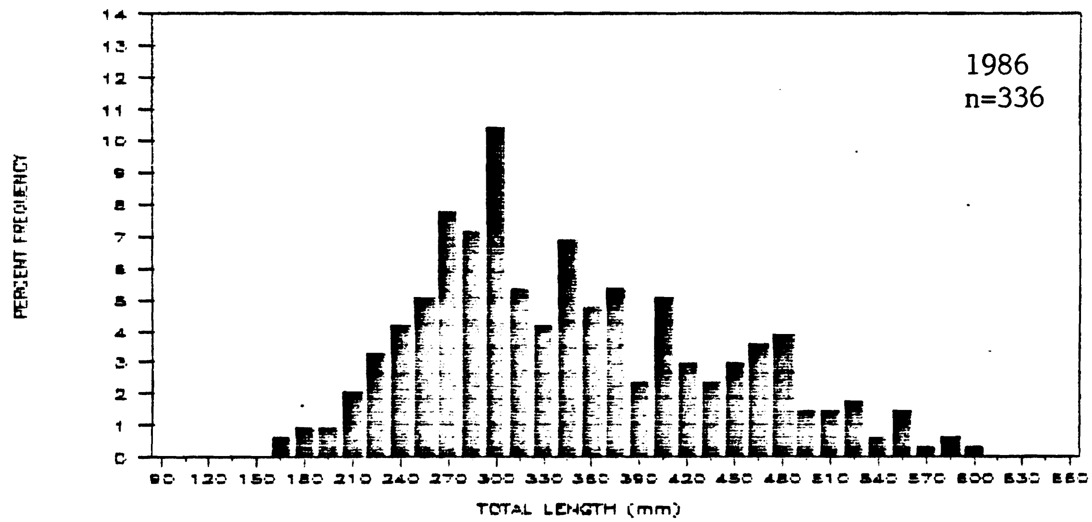



FIGURE 153. Size composition of vermilion rockfish from on-board observations of Los Angeles County commercial passenger fishing vessels.



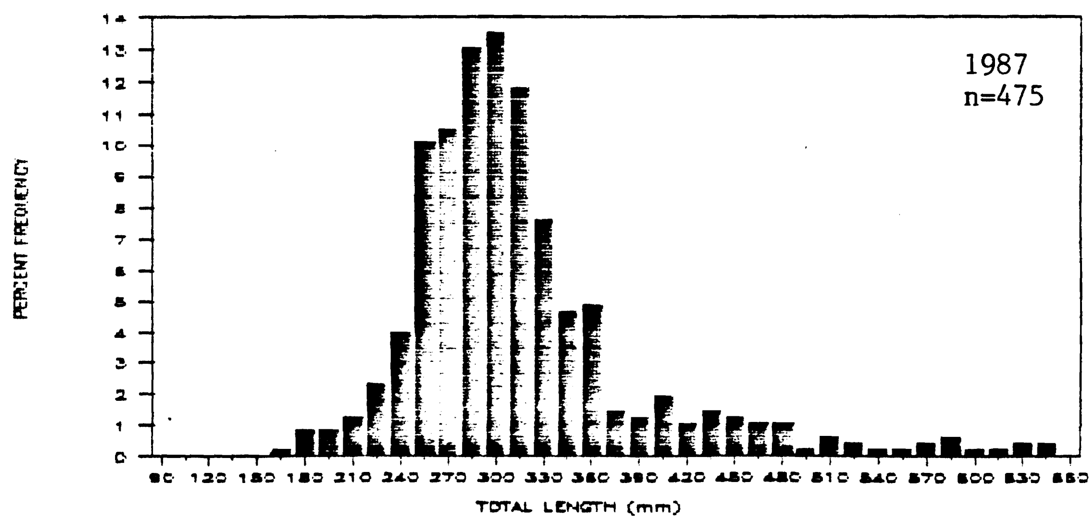




FIGURE 154. Size composition of vermilion rockfish from on-board observations of Ventura County commercial passenger fishing vessels.

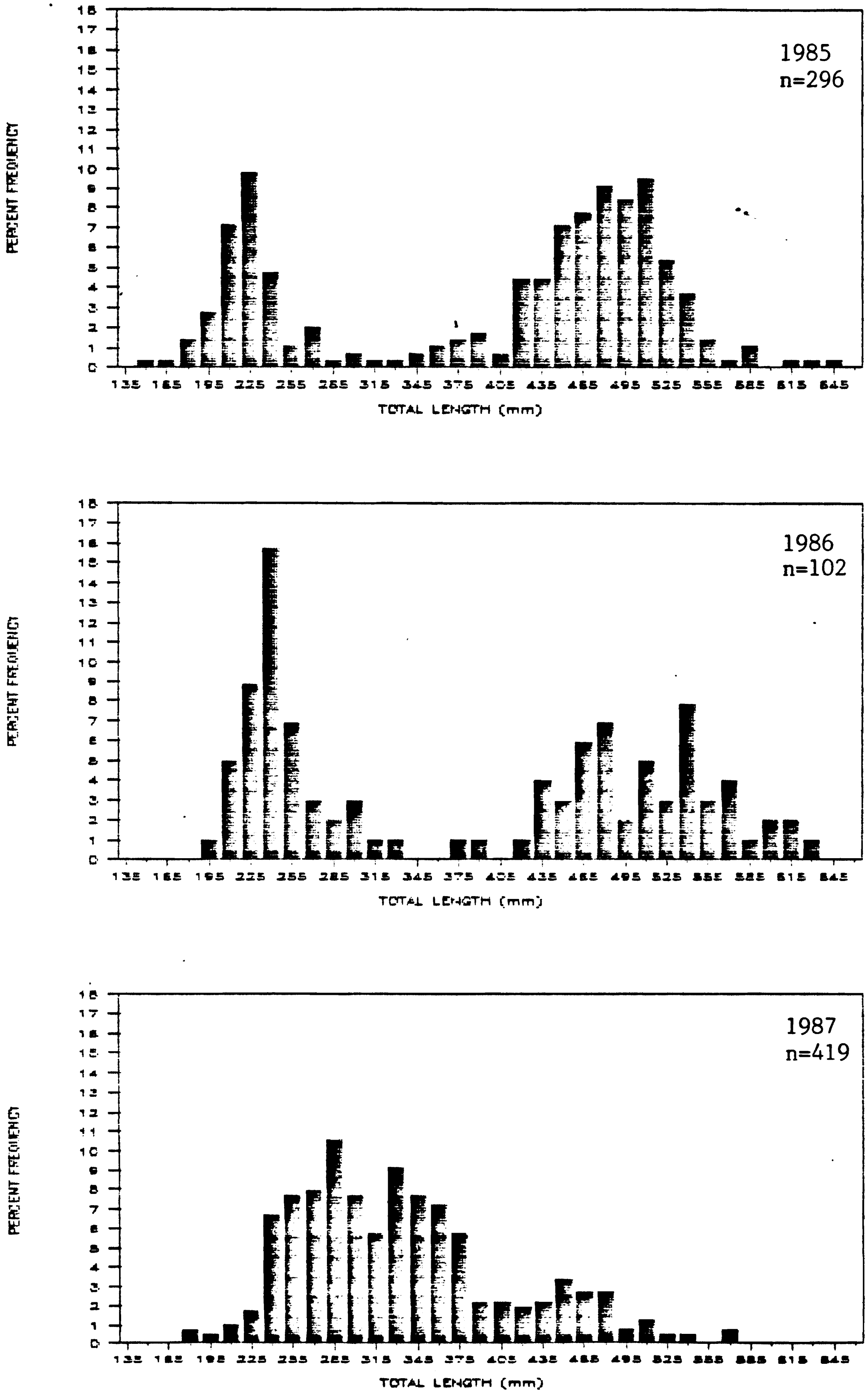



FIGURE 155. Size composition of vermilion **rockfish** from on-board observations of Santa Barbara County commercial passenger fishing vessels.

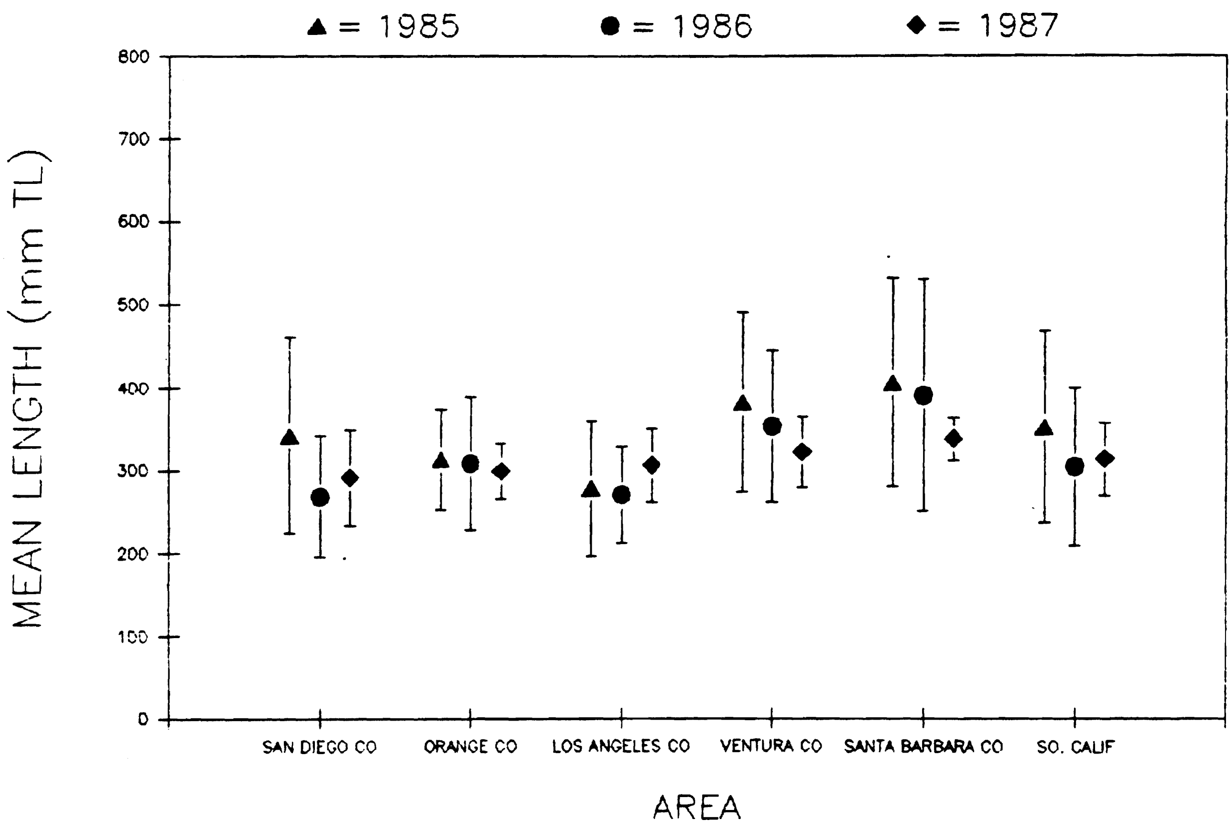



FIGURE 156. Mean lengths and standard deviations of vermilion rockfish measured on board southern California commercial passenger fishing vessels.

data indicate that the vermilion rockfish catch is supported by a relatively small number of year classes, and there is not the steady-state recruitment available, as observed in 1975 through 1978. Although the estimated catch of vermilion rockfish rose each year of our survey, several years of poor recruitment could precipitate a decline in the catch.

We recommend that the magnitude and population age structure of the annual vermilion rockfish catches be closely monitored. Any trend that includes declining catch estimates and/or a narrowing of the age group structure of harvested fish should be taken as an indication that management options, in addition to those that apply to the rockfish group, should be developed and implemented.

Widow Rockfish (Scorpaenidae)

Catch Estimates

Southern California. Widow rockfish, a pelagic, mid-water-schooling rockfish species, has been the object of a large commercial trawl fishery in central and northern California since 1980 (Wilkins 1986). In southern California widow rockfish is a moderately important species in the CPFV fishery.

Our widow rockfish total catch estimates ranged from 2,235 fish ± 604 in 1985 to 14,421 ± 6,922 in 1987 (Table 47). It was the 21st ranked rockfish, composing 1% of the rockfish estimated total catch (Table 30). In Collins and Crooke's CPFV survey (unpublished manuscript) widow rockfish total catch estimates ranged from of 22,730 ± 8,101 in 1976 to 36,320 ± 10,618 in 1978. They were the eighth-ranked rockfish species, composing 2.0% (frequency of occurrence) of the 1975 to 1978 rockfish catches.

The total catch distribution of widow rockfish over the 3 years of our study did not display a clearly recurring catch pattern (Figure 157). In 1985 the highest monthly widow rockfish total catches occurred in the spring and winter (March and November-December); the 1986 catch peak occurred in January, and the 1987 catch peak occurred in April.

Counties. Ventura County had the highest estimated widow rockfish total catches each year, followed closely by Santa Barbara County (Table 47). The two counties, combined, were the source of 84% of the southern California widow rockfish total catch.

TABLE 47. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of Widow Rockfish from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| AREA | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 0 | 0 | 28 | 98 | 50 | 96 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28 | 98 | 50 | 96 |
| Orange County | 53 | 98 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 53 | 98 | 0 | 0 | 0 | 0 |
| Los Angeles County | 144 | 99 | 581 | 80 | 253 | 77 | 31 | 98 | 0 | 0 | 0 | 0 | 175 | 83 | 581 | 80 | 253 | 77 |
| Ventura County | 1,190 | 31 | 4,390 | 58 | 7,188 | 89 | 0 | 0 | 0 | 0 | 0 | 0 | 1,190 | 31 | 4,390 | 58 | 7,188 | 89 |
| Santa Barbara County | 806 | 56 | 959 | 61 | 6,931 | 39 | 13 | 96 | 21 | 98 | 0 | 0 | 819 | 55 | 980 | 61 | 6,931 | 39 |
| Southern California | 2,192 | 28 | 5,958 | 45 | 14,421 | 48 | 43 | 75 | 21 | 98 | 0 | 0 | 2,235 | 27 | 5,979 | 45 | 14,421 | 48 |

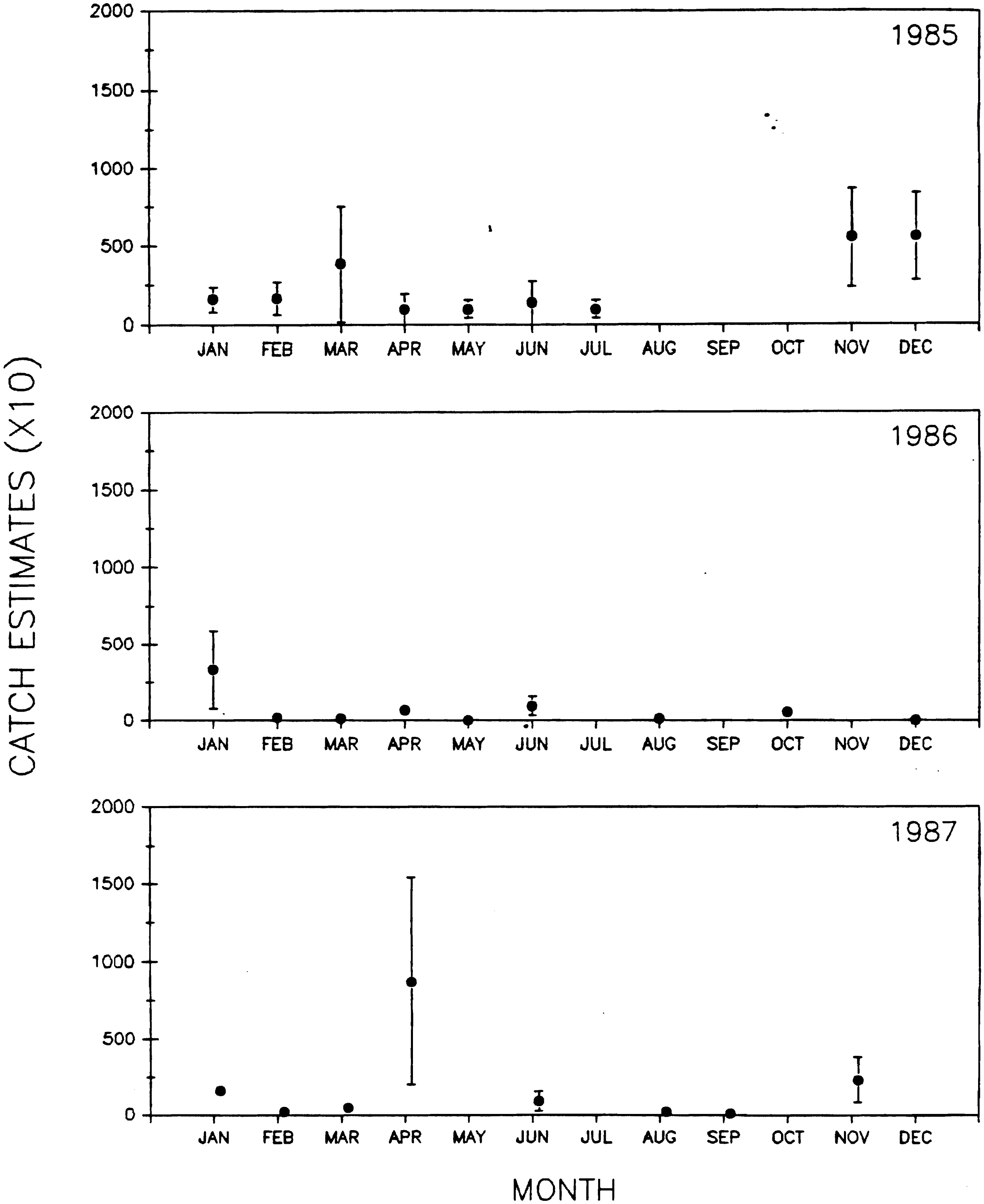



FIGURE 157. Monthly total catch estimates (number of fish) and standard deviations of widow rockfish from on-board observations of southern California commercial passenger fishing vessels.

## Size Composition

Southern California. The widow rockfish length frequency distributions (Figure 158) display an age structure dominated by age 6 [320 to 329 mm (12.5 to 12.9 in.)] and younger age classes (MacGregor 1987). In 1985 there was no clearly dominant length mode, and 3- to 6-year-old widow rockfish [230 to 329 mm (9.0 to 13.0 in.)] were all well represented in the frequency analysis. The 1986 plots have a bi-modal frequency distribution, with 4- and 7-year-old widow rockfish comprising the major modes [270 to 279 mm (10.6 to 11.0 in.) and 340 to 349 mm (13.4 to 13.7 in.) respectively]. In the 1987 length frequency plot, 5-year-old fish are dominant [290 to 299 mm (11.4 to 11.8 in.)], and older widow rockfish are almost completely absent from the analysis.

Counties. There were insufficient length data to plot for widow rockfish caught in San Diego, Orange, and Los Angeles counties. The length frequency plots for Ventura County display length modes representing 1979 year class widow rockfish (MacGregor 1987) in the 1985 and 1986 plots [ages 6 and 7; 320 to 329 mm (12.6 to 13.0 in.) and 340 to 349 mm (13.4 to 13.7 in.), respectively]. Widow rockfish of the 1982 year class [age 5; 290 to 299 mm (11.4 to 11.8 in.)] are prominent in the 1987 plot (Figure 159). In Santa Barbara County, prominent length modes represent 1982 year class widow rockfish in the 1985 and 1986 length frequency distributions [ages 3 and 4; 230 to 239 mm (9.0 to 9.5 in.) and 250 to 259 mm (9.8 to 10.2 in.), respectively], and 1983 year class widow rockfish [age 4; 240 to 249 mm (9.4 to 9.8 in.)] are prominent in the 1987 plot (Figure 160).

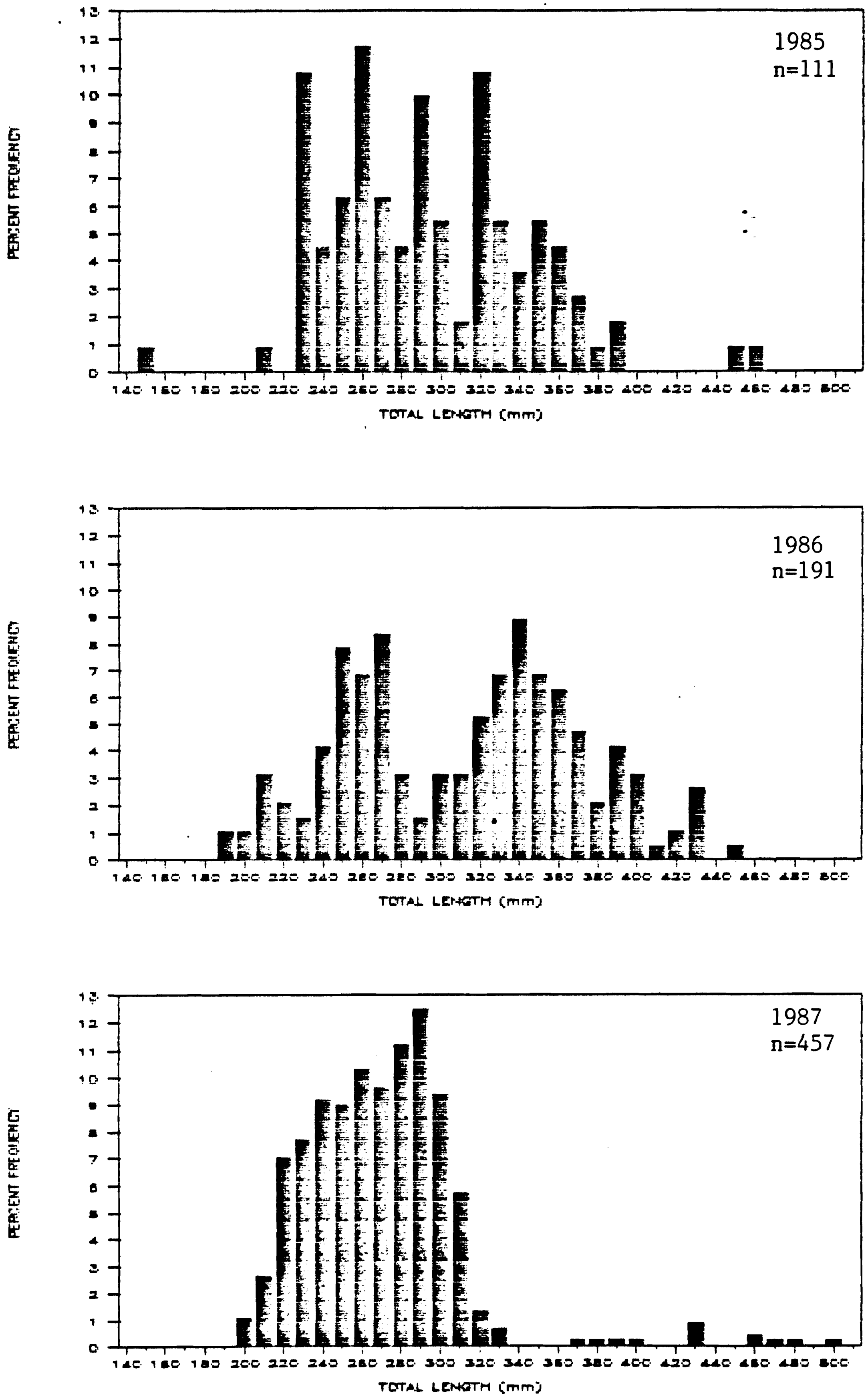



FIGURE 158. Size composition of widow rockfish from on-board observations of southern California commercial passenger fishing vessels.

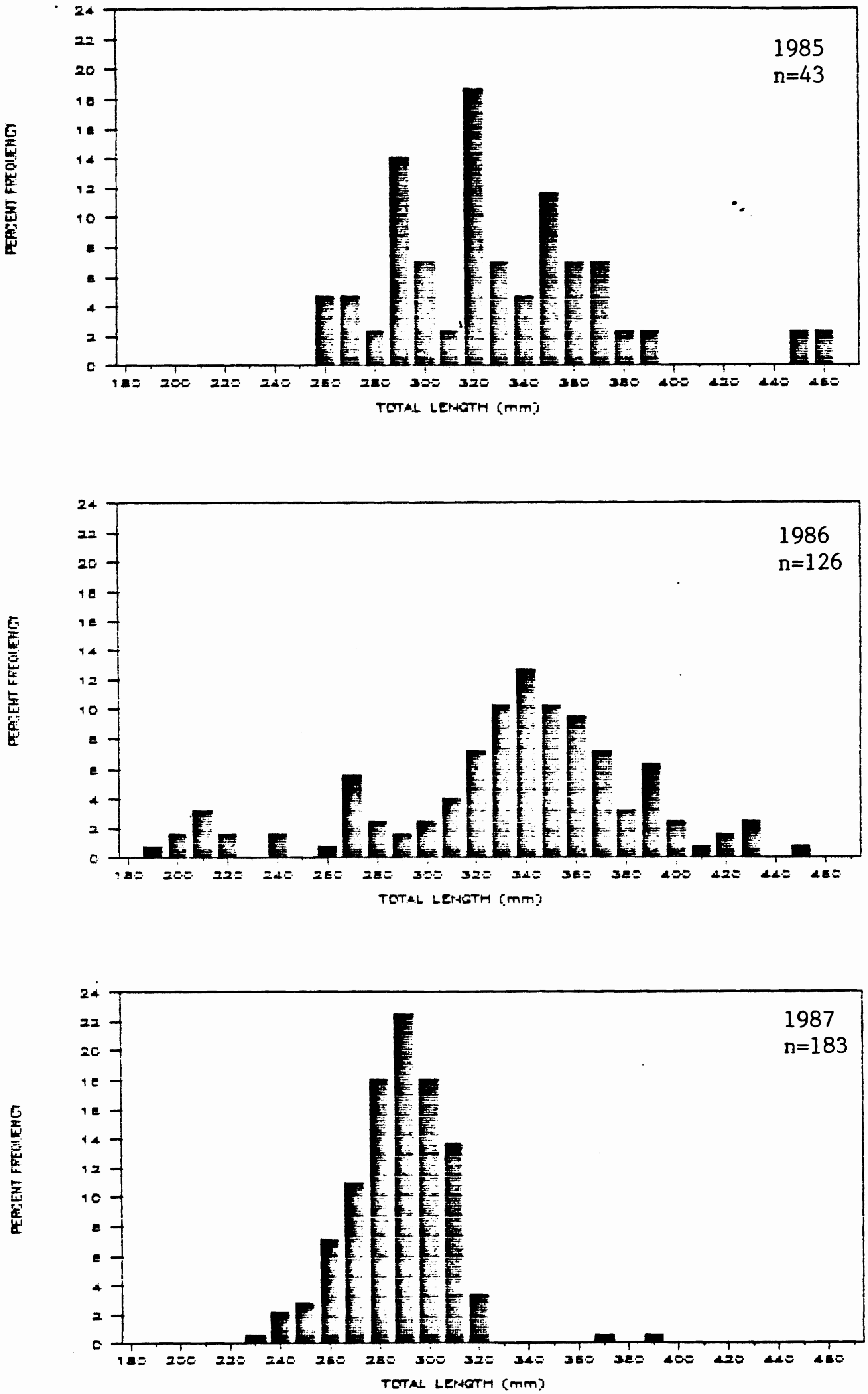



FIGURE 159. Size composition of widow rockfish from on-board observations of Ventura County commercial passenger fishing vessels.

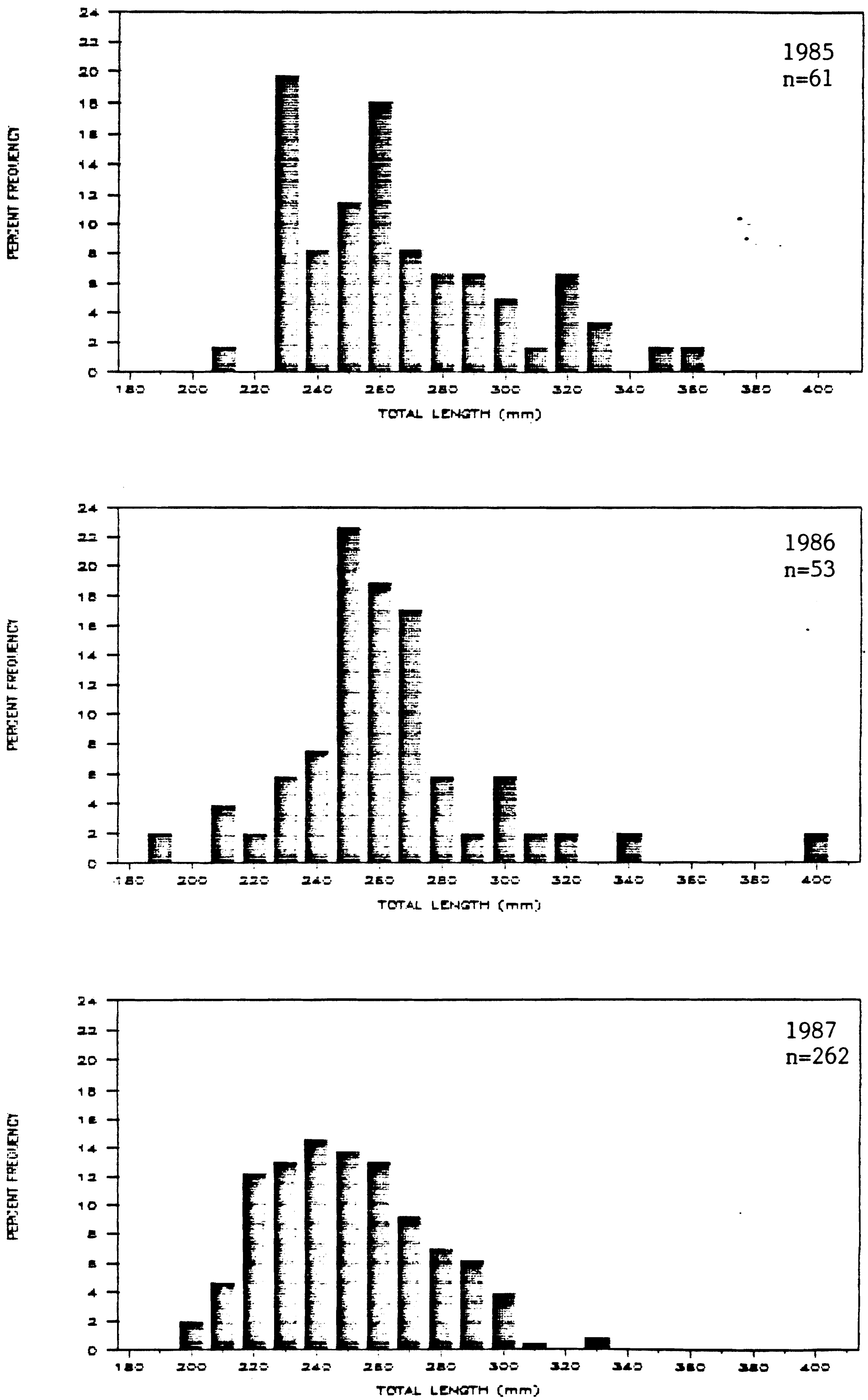



FIGURE 160. Size composition of widow rockfish from on-board observations of Santa Barbara County commercial passenger fishing vessels.

These cohorts were within the size and age ranges of widow rockfish that encompass the time of first and 50% sexual maturity (Echeverria 1987). First maturity in widow rockfish occurs at age 3 and 290 mm (11.4 in.), and 50% maturity occurs at age 5 and 370 mm (14.6 in.) in length.

The plot of widow rockfish mean lengths shows a south to north gradient, with larger fish caught in the south, and smaller fish in the north, over the 3 years surveyed (Figure 161). Much of the Santa Barbara County widow rockfish catch came from oil platform sites in 1986 and 1987 (Ally et al. 1988), and the subsurface structures of these sites apparently serve as the midwater habitat for schools of small, juvenile and sub-adult widow rockfish.

Management Recommendations

Widow rockfish were a minor constituent of the southern California CPFV catch in our survey, after having been ranked among the top 10 rockfish species in the 1975 through 1978 southern California CPFV catch (Collins and Crooke unpublished manuscript). North of Point Conception, widow rockfish CPFV total catches ranged up to 68,000 in 1977 (Monterey to Bodega Bay), but were considered to be a minor catch species at 5% of the rockfish catch (Cooperrider 1987). The commercial widow rockfish landings have ranged as high as 1.4 million fish in 1981, and the species was the most important rockfish species in the West Coast commercial catch. Currently, commercial catch quotas are in effect for widow rockfish in California, Oregon, and Washington (Anonymous 1988). In southern California, both the sport and commercial widow rockfish catch components are relatively minor

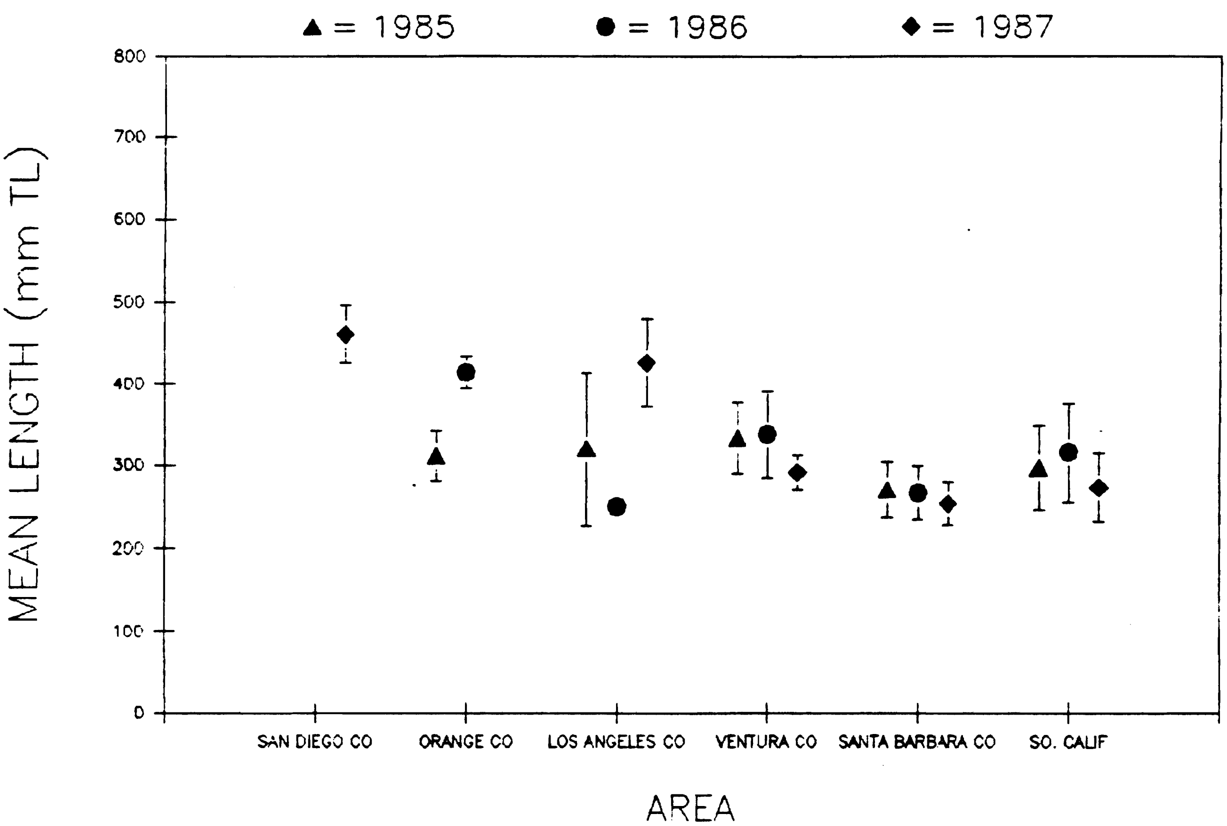



FIGURE 161. Mean lengths and standard deviations of widow rockfish measured on board southern California commercial passenger fishing vessels.

compared to the widow rockfish landings from the rest of the state.

Since the southern California CPFV widow rockfish total catch is such a minor component of the overall CPFV rockfish total catch, we do not feel that any species-specific regulatory protection is currently required, except as it applies to the rockfish group. If the widow rockfish harvest is greatly expanded, either through targeting by CPFV's or by the extension of the commercial widow rockfish fishery into southern California, then a review of management options would be appropriate.

## Barred Sand Bass (Serranidae)

### Catch Estimates

Southern California. According to our IRI, barred sand bass annually ranked as the third most important fish to the southern California CPFV fleet (Table 12). According to the CPFV logbook records, barred sand bass landings exceeded kelp bass landings in 1985 and 1987 for the first time since kelp bass and barred sand bass landings began being reported separately in 1961 (Mac Oliphant, California Department of Fish and Game, Marine Resources Division, pers. comm.). They accounted for 11% to 16% of all CPFV fish landings, 9% to 14% of all CPFV-released fish, and 10% to 15% of the CPFV total catch (Tables 13 and 48).

Estimated total catch of barred sand bass dropped slightly in 1986, but increased by 41% in 1987 (Table 48). One reason for the decrease in total catch in 1986 may have been the increased availability of kelp bass that year. Kelp bass catches were very high in 1986 and CPFV anglers probably directed their fishing effort away from barred sand bass to kelp bass. Estimated landings of barred sand bass increased 53% from 1985 to 1987 (Table 48). The estimated number of released barred sand bass dropped 23% from 1985 to 1986, then increased 26% from 1986 to 1987 (Table 48).

The ratio of kept to released barred sand bass rose from 1.7 to 1 in 1985, to 2.3 to 1 in 1986, to 2.7 to 1 in 1987. June through August was the time of peak total catches from 1985 through 1987 (Figure 162).

Estimated catches of barred sand bass have increased almost ten

TABLE 48. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of Barred Sand Bass from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| AREA | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 48,678 | 20 | 87,606 | 21 | 61,781 | 15 | 18,691 | 14 | 21,137 | 17 | 15,284 | 18 | 67,369 | 17 | 108,742 | 19 | 77,065 | 15 |
| Orange County | 79,532 | 21 | 74,005 | 16 | 153,981 | 18 | 54,998 | 18 | 40,897 | 20 | 47,088 | 13 | 134,531 | 18 | 114,902 | 15 | 201,069 | 17 |
| Los Angeles County | 177,975 | 13 | 157,751 | 15 | 217,616 | 14 | 105,210 | 15 | 75,742 | 19 | 98,870 | 14 | 283,185 | 12 | 233,493 | 15 | 316,486 | 13 |
| Ventura County | 8,176 | 43 | 2,620 | 42 | 46,115 | 32 | 1,640 | 37 | 859 | 47 | 14,256 | 35 | 9,816 | 41 | 3,480 | 38 | 60,371 | 32 |
| Santa Barbara County | 1,531 | 31 | 5,034 | 36 | 3,266 | 24 | 1,265 | 23 | 2,244 | 21 | 1,509 | 28 | 2,796 | 25 | 7,278 | 30 | 4,775 | 23 |
| Southern California | 315,893 | 9 | 327,016 | 10 | 482,758 | 9 | 181,804 | 10 | 140,879 | 12 | 177,007 | 9 | 497,697 | 9 | 467,895 | 10 | 659,766 | 9 |

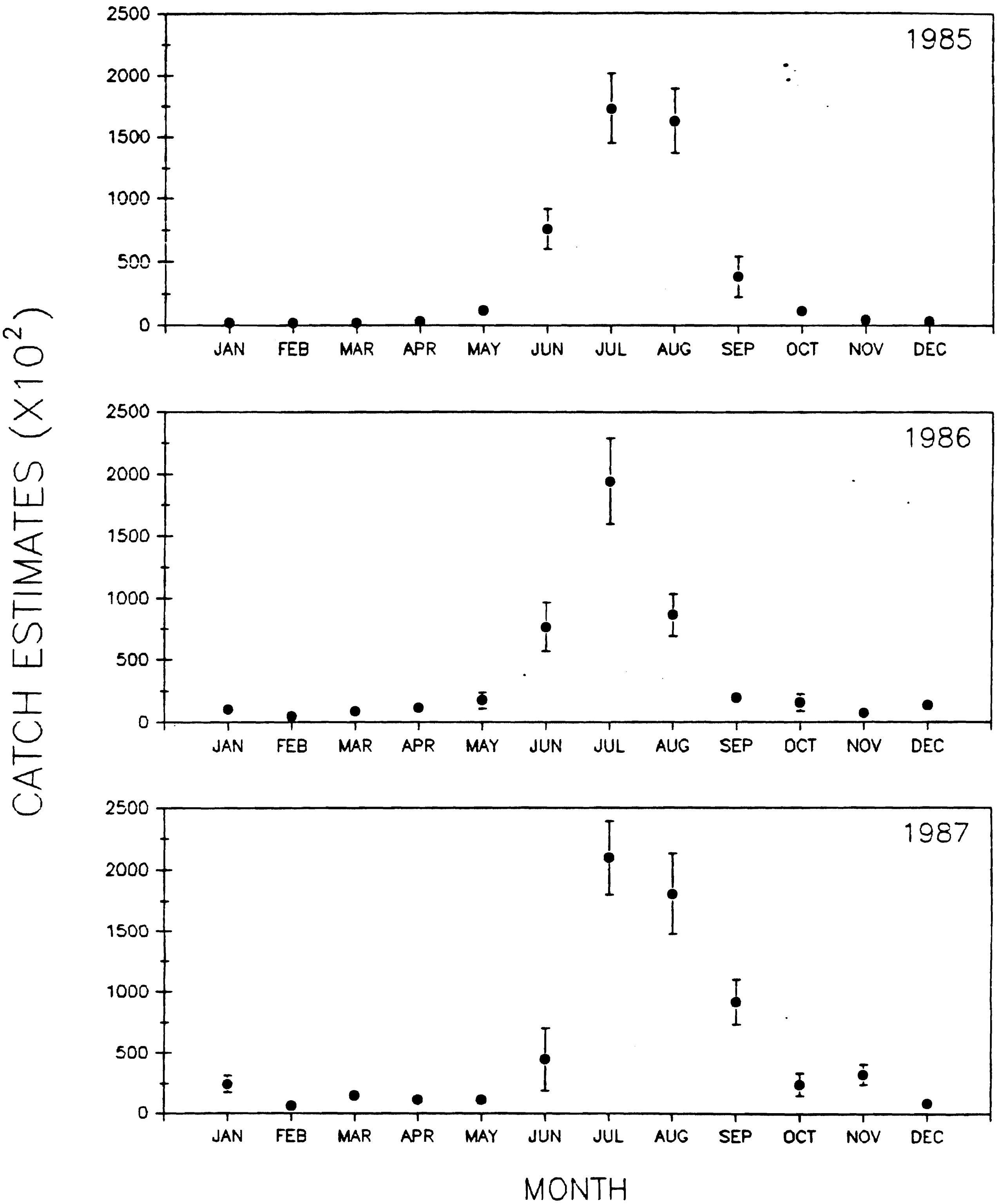



FIGURE 162. Monthly total catch estimates (number of fish) and standard deviations of barred sand bass from on-board observations of southern California commercial passenger fishing vessels.

fold since the time of Collins and Crooke's (unpublished manuscript) survey. The 1976 through 1978 estimated mean annual catch of legal size barred sand bass [$\geq$305 mm (12 in.)] increased from 44,634 fish $\pm$ 10,953 (Collins and Crooke unpublished manuscript) to our 3-year study's estimate of 355,726 $\pm$ 33,301; the estimated mean annual catch of short barred sand bass increased from 23,447 $\pm$ 7,273 (Collins and Crooke unpublished manuscript) to our 3-year study's estimate of 186,060 $\pm$ 19,119. According to surveyed CPFV skippers, the CPFV fleet has increased its fishing effort for barred sand bass since the 1970's. They cite the ease in which legal sand bass can be caught, and the relative scarcity of legal kelp bass as the major reasons for the increased effort toward barred sand bass. The ratio of legal to short barred sand bass increased from 1.4 to 1 in 1985, to 2.1 to 1 in 1986 to 2.3 to 1 in 1987. Collins and Crooke (unpublished manuscript) found that the ratio of legal to short barred sand bass was 3.7 to 1 in 1976, 4.7 to 1 in 1977, and 2.5 to 1 in 1978.

Counties. Los Angeles County had the highest annual total catches of barred sand bass from 1985 to 1987 (Table 48). It accounted for 48% to 57% of the total catch of barred sand bass in southern California; Orange County was next with 25% to 30%. Catch estimate trends by county for kept fish as well as for released fish were similar to that of total catch by county (Table 48).

Kept to released ratios increased from 1985 to 1986 in all counties except Ventura County. The ratios changed little from 1986 to 1987, except in Orange County, where they increased from 1.8 to 1 to 3.3 to 1. Ventura County had the highest kept to released ratio in

1985 with 5.0 to 1, and San Diego County had the highest in 1986 and 1987 with 4.1 to 1 and 4.0 to 1, respectively.

## Size Composition

Southern California. Annual mean lengths of kept barred sand bass for southern California changed little from 1985 to 1987 (Figure 163). Most of the kept barred sand bass were close to the minimum 305 mm (12 in.) size limit. The modal size class for kept barred sand bass was 310 to 314 mm (12.2 to 12.4 in.) in 1985 and 1986, and 315 to 319 mm (12.4 to 12.6 in.) in 1987 (Figure 164).

Barred sand bass, 305 to 329 mm (12.0 to 13.0 in.), annually made up 27% to 28% of all kept fish measured from 1985 to 1987. Barred sand bass 305 to 404 mm (12.0 to 15.9 in.) accounted for 73% to 77% of all measured fish. Fish 305 to 329 mm (12.0 to 13.0 in.) represent primarily two, possibly three year classes, while 305 to 404 mm (12.0 to 15.9 in.) fish represent primarily four, but possibly up to seven year classes (Diego Busatto, California Department of Fish and Game, Marine Resources Division, pers. comm.).

Kept barred sand bass less than the minimum size limit decreased from 10.2% to 7.2% of the annual CPFV barred sand bass landings from 1985 to 1987. Most of the kept sublegal barred sand bass were within 15 mm (0.6 in.) of the size limit (Figure 164). Barred sand bass less than 290 mm (11.4 in.) only made up 2.3% of the landings in 1985, 1.7% in 1986, and 1.0% in 1987. This suggests that inaccurate measuring, (by anglers and/or samplers), and/or fish shrinkage, and/or the temptation to keep a barely short barred sand bass, rather than mis-identifying the fish, or not knowing the minimum size regulations was/were responsible for most of the sublegal barred sand bass being kept by CPFV anglers.

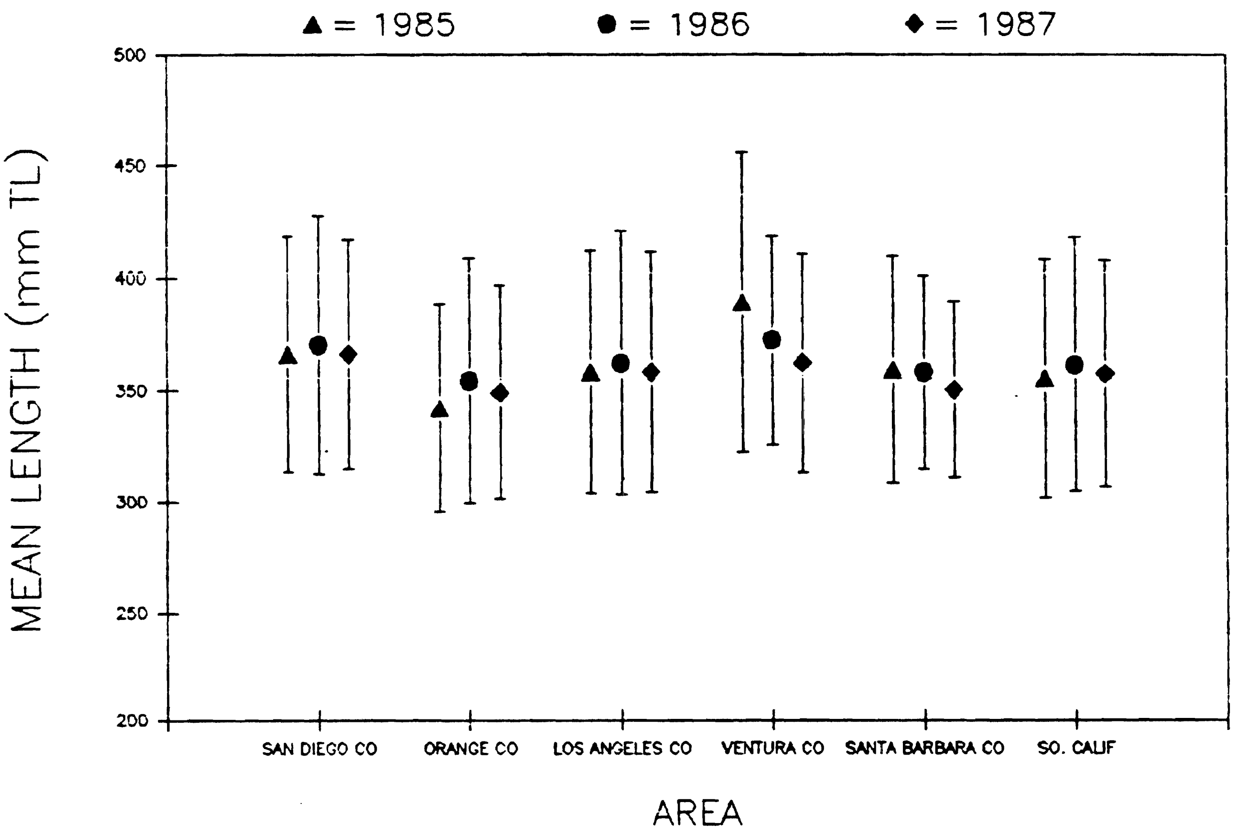



FIGURE 163. Mean lengths and standard deviations of kept barred sand bass measured on board southern California commercial passenger fishing vessels. Size limit = 305 mm (12 in.).

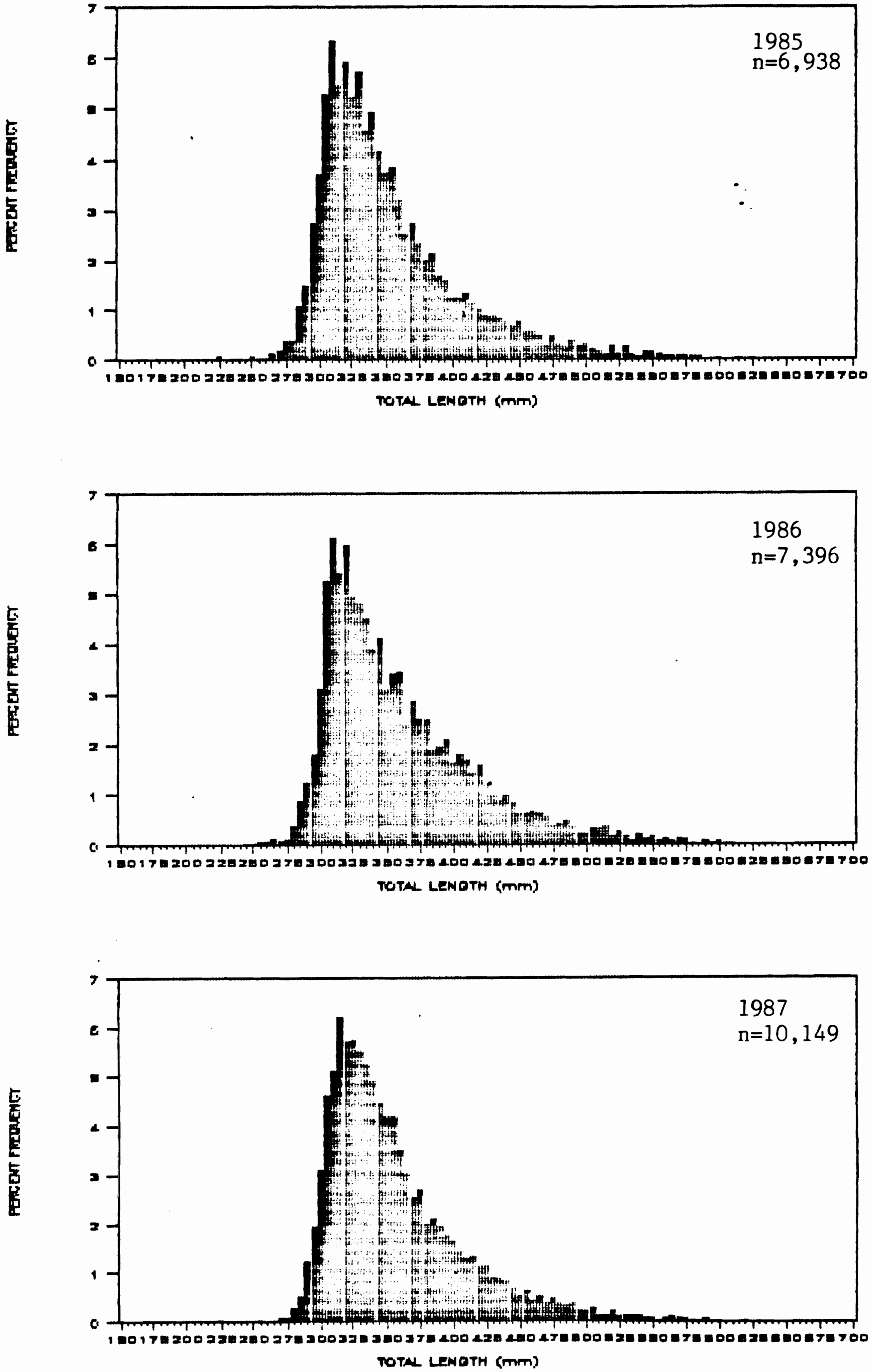



FIGURE 164. Size composition of kept barred sand bass from on-board observations of southern California commercial passenger fishing vessels. Size limit = 305 mm (12 in.).

Approximately 80% of the kept barred sand bass measured 290 to 404 mm (11.4 to 15.9 in.). The barred sand bass sport fishery is supported by several year classes, and most of the sublegal fish are released. Even though there could be reduced CPFV catches with poor recruitment from one or two year classes, it would probably take several years of low recruitment before a collapse in the population would occur. Because the kept-to-released ratio for barred sand bass was high from 1985 to 1987, and the percentage of sublegal fish kept was low, it is likely that there were sufficient numbers of legal barred sand bass to satisfy CPFV anglers.

However, one concern is that most of the fishing pressure takes place in shallow-water, sandy-bottom areas where barred sand bass congregate to spawn. We do not yet know if this adversely affects the barred sand bass resource. Also, the 305 mm (12 in.) minimum size limit for barred sand bass is actually based on data derived from Young's (1963) work on kelp bass. Young admitted that there was not enough data concerning barred sand bass, but said they probably had a similar or slightly faster growth rate than kelp bass. A current study shows that barred sand bass may reach the mimimum size limit a year younger than kelp bass (Diego Busatto, California Department of Fish and Game, Marine Resources Division, pers. comm).

The modal size classes of released barred sand bass were 280 to 284 mm (11.0 to 11.2 in.) in 1985, 285 to 289 mm (11.2 to 11.4 in.) in 1986, and 290 to 294 mm (11.4 to 11.6 in.) in 1987 (Figure 165). There was a decreasing number of fish caught less than 275 mm (10.8 in.) from 1985 to 1987 (Figure 165). This may have been due to a lower abundance

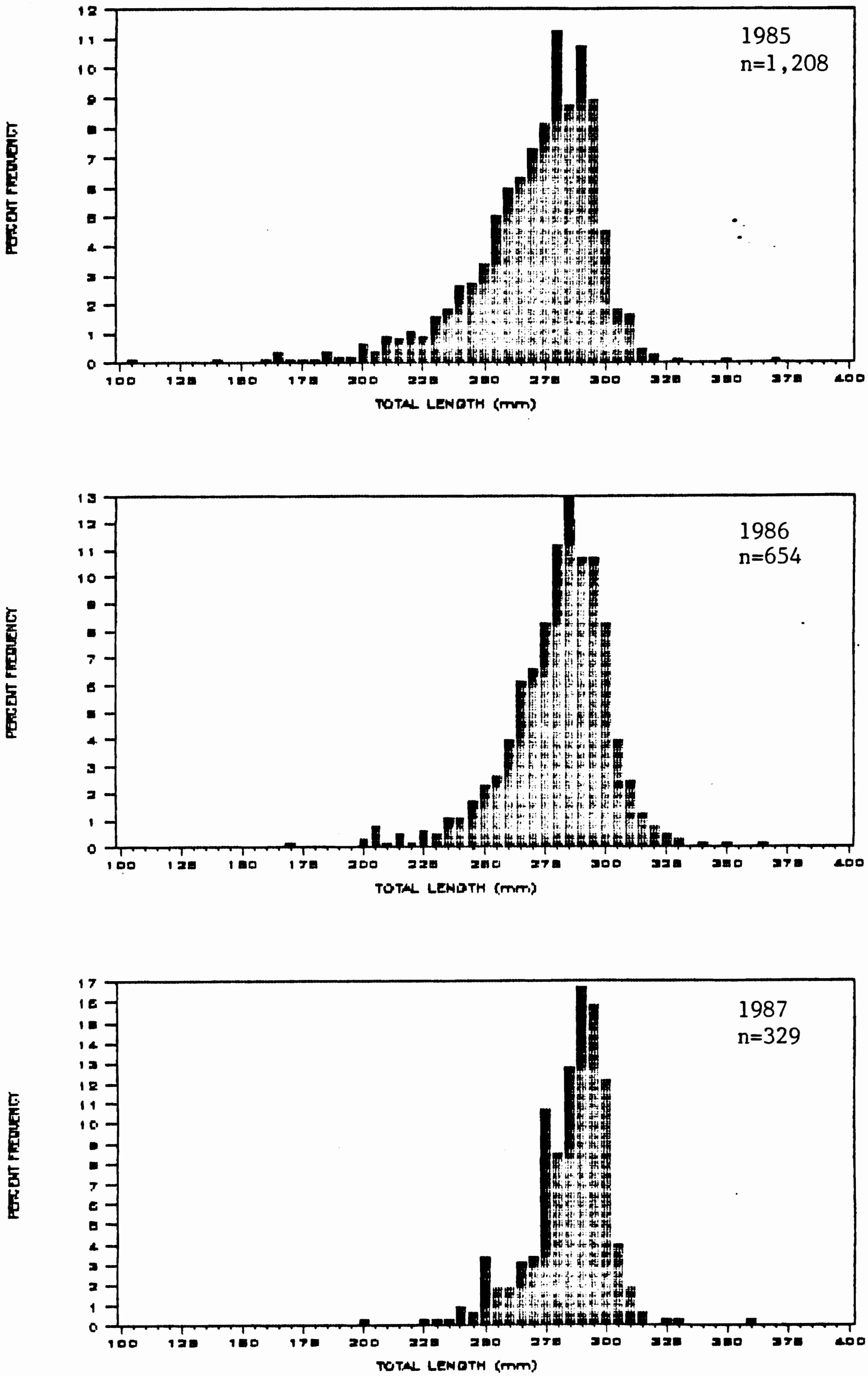



FIGURE 165. Size composition of released barred sand bass from on-board observations of southern California commercial passenger fishing vessels. Size limit = 305 mm (12 in.).

of these size fish, or, more likely, a decrease in the incidental take of these size fish in the later years, as evidenced by the increasing kept-to-released ratios from 1985 to 1987. Barred sand bass probably are not fully recruited into the CPFV fishery until they reach 255 to 279 mm (10.0 to 11.0 in.) in length.

Counties. Mean lengths of kept barred sand bass were largest in Ventura County in 1985 and 1986, and largest in San Diego County in 1987 (Figure 163). Orange County had the lowest mean lengths of kept barred sand bass from 1985 through 1987 (Figure 163). The mean length of kept barred sand bass decreased 27 mm (1.1 in.) in Ventura County from 1985 to 1987 (Figure 163). The other counties showed no notable trends.

Some differences in size compositions of kept barred sand bass among southern California counties were observed (Figures 166 to 170). Ventura County was the only county which had its highest frequency mode of measured kept fish in the 330 to 354 mm (13.0 to 13.9 in.) size range. In all other counties, 305 to 329 mm (12.0 to 13.0 in.) was the modal size class (Figures 166 to 170).

Sublegal barred sand bass accounted for 12.7% to 16.3% of the annual CPFV landings in Orange County, the highest rate among southern California counties. Los Angeles County had the next highest rate, 6.8% to 8.6%. Sublegal landings of barred sand bass decreased from 1985 to 1987 in San Diego, Orange, and Los Angeles counties. Ventura and Santa Barbara counties kept fewer sublegal barred sand bass in 1986 than 1985, but more in 1987 than 1985.

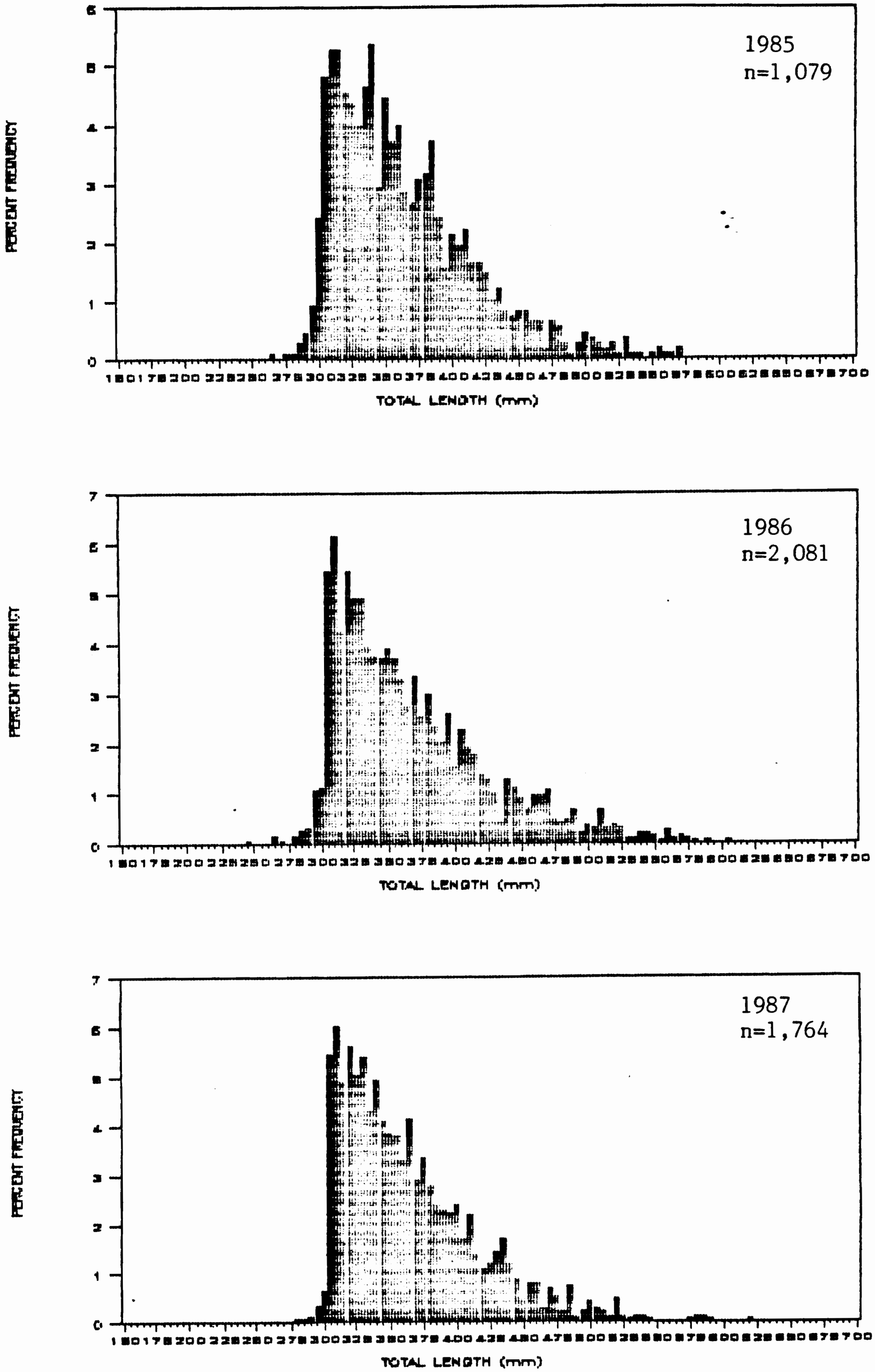



FIGURE 166. Size composition of kept barred sand bass from on-board observations of San Diego County commercial passenger fishing vessels. Size limit = 305 mm (12 in.).

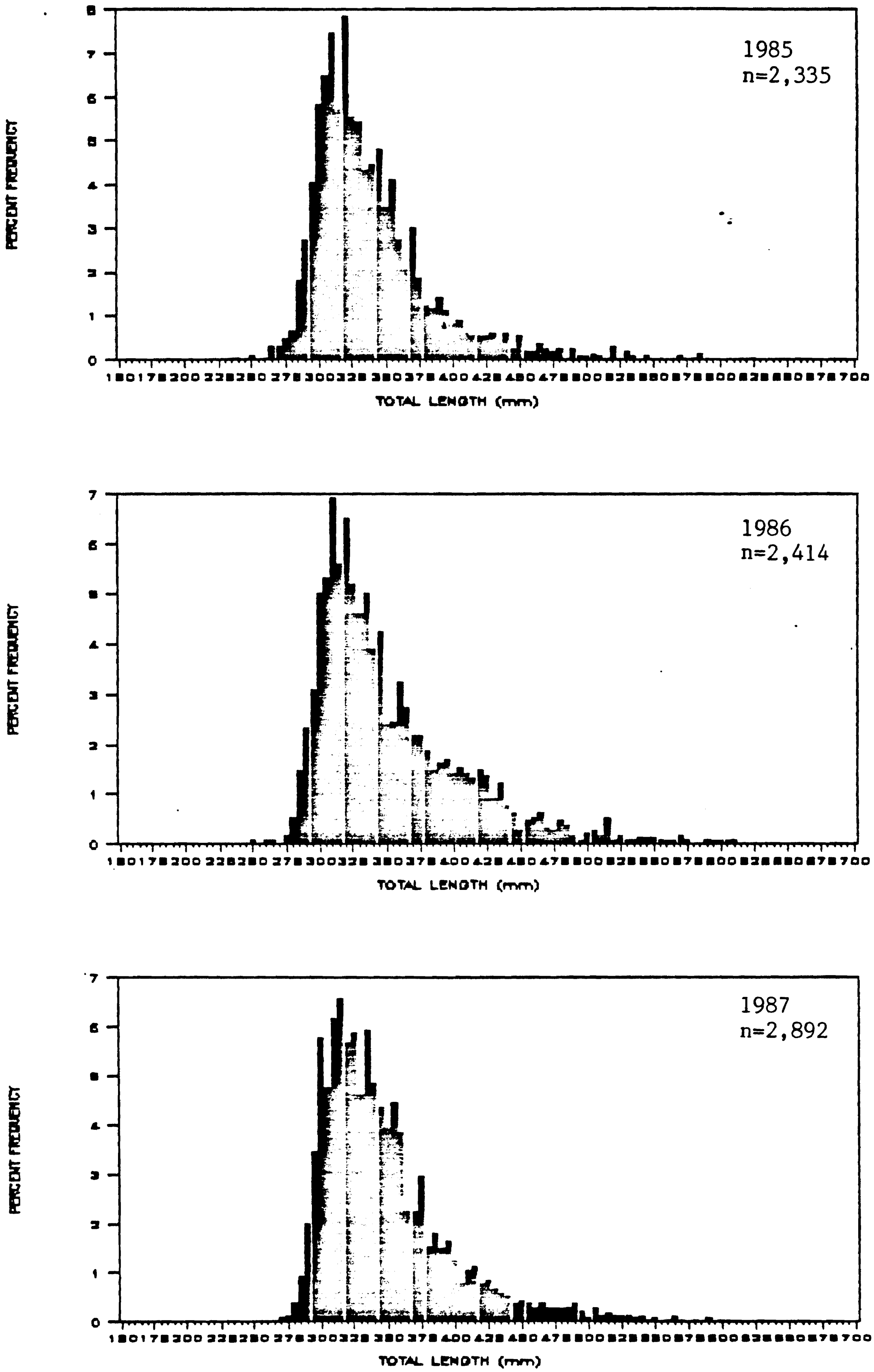



FIGURE 167. Size composition of kept barred sand bass from on-board observations of Orange County commercial passenger fishing vessels. Size limit = 305 mm (12 in.).

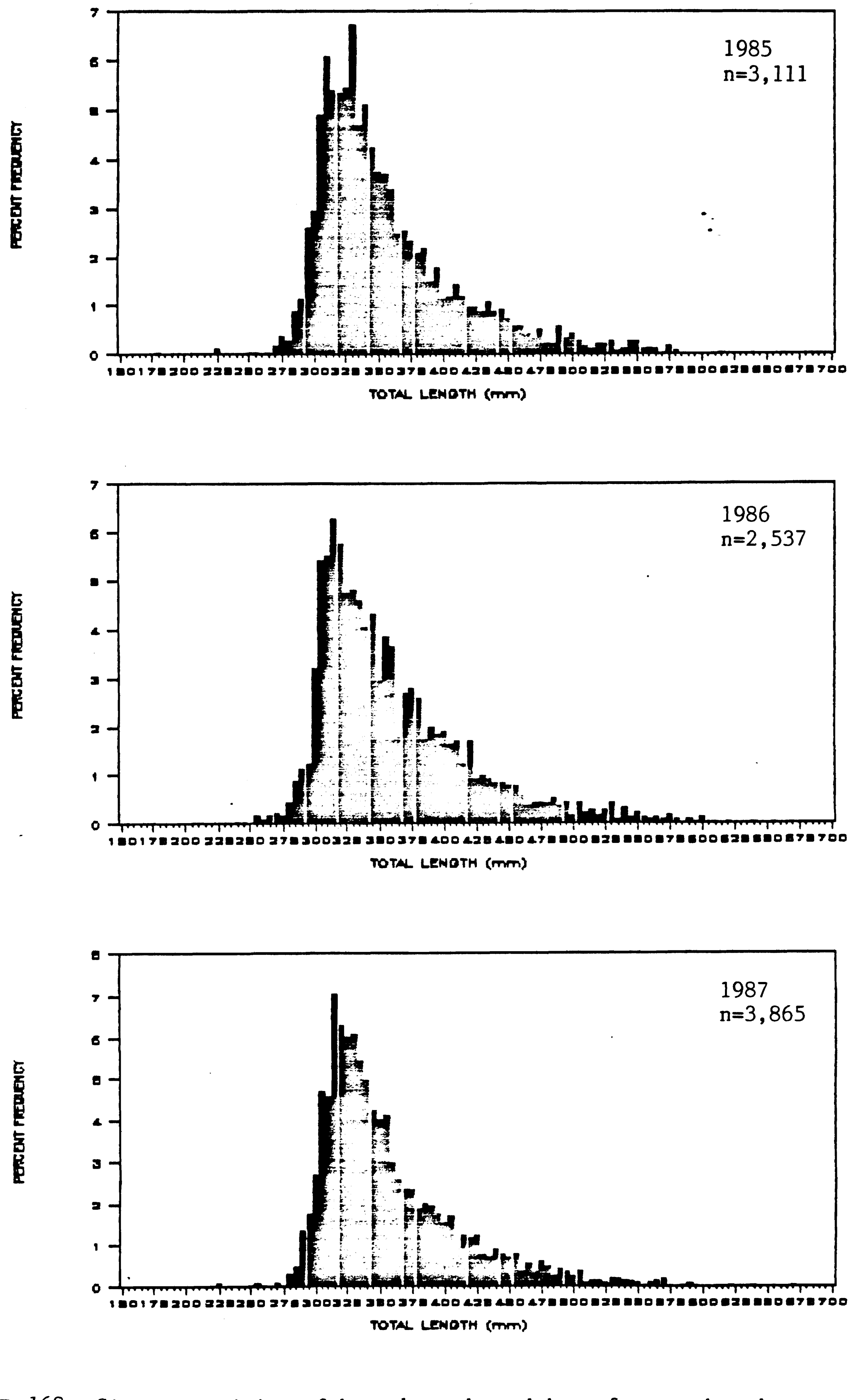



FIGURE 168. Size composition of kept barred sand bass from on-board observations of Los Angeles County commercial passenger fishing vessels. Size limit = 305 mm (12 in.).

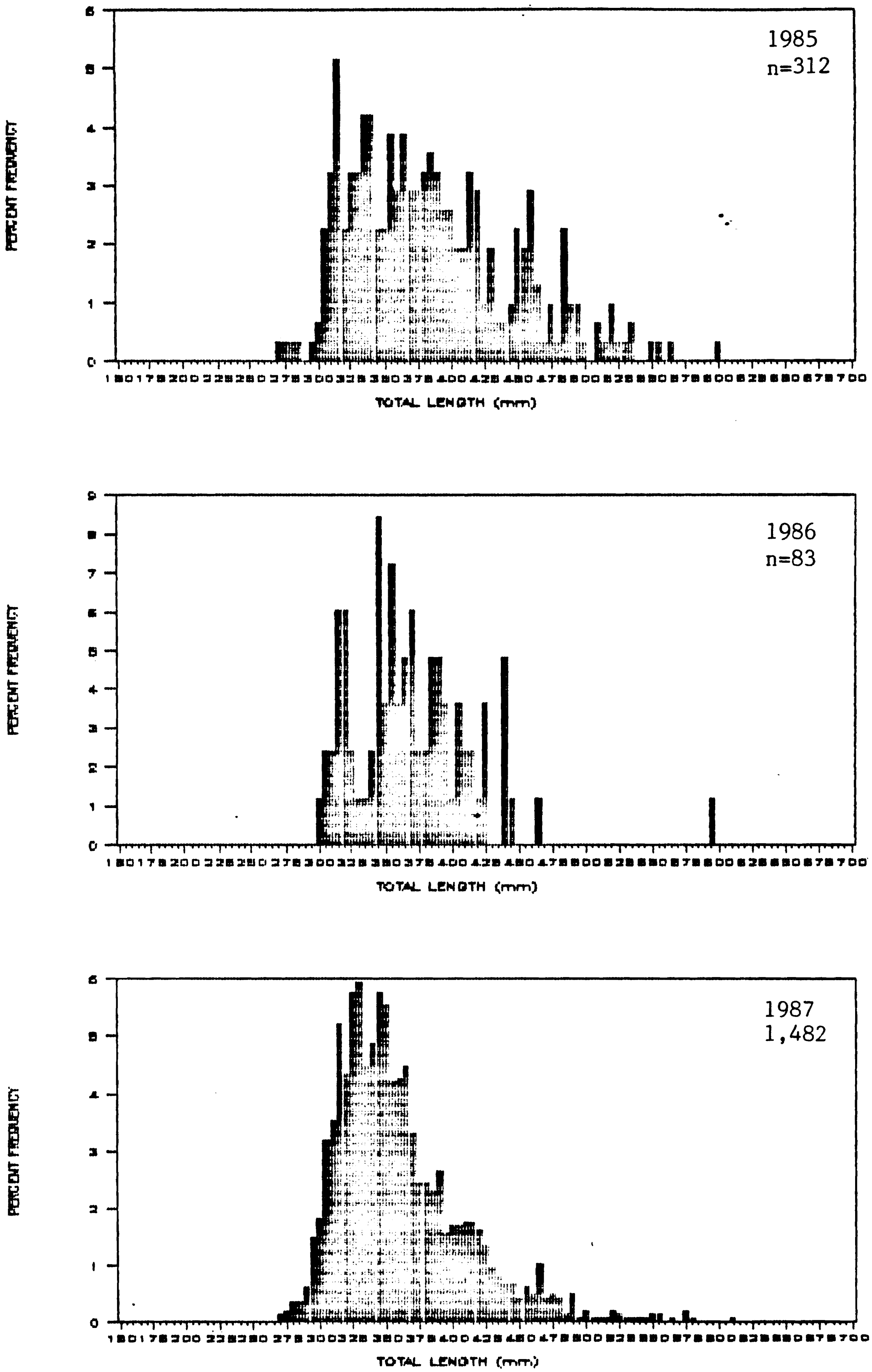



FIGURE 169. Size composition of kept barred sand bass from on-board observations of Ventura County commercial passenger fishing vessels. Size limit = 305 mm (12 in.).

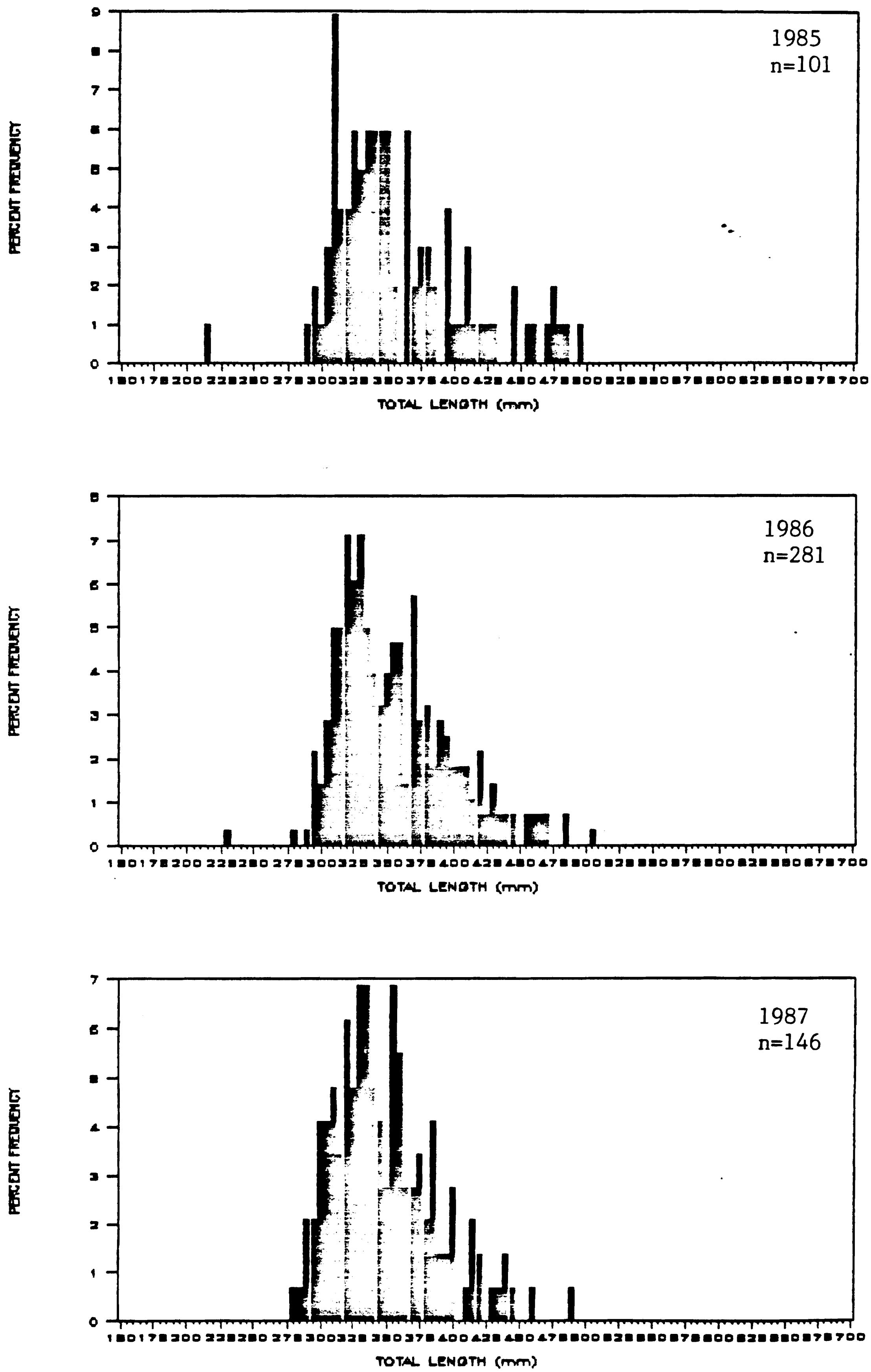



FIGURE 170. Size composition of kept barred sand bass from on-board observations of Santa Barbara County commercial passenger fishing vessels. Size limit = 305 mm (12 in.).

## Management Recommendations

We propose no management recommendations at this time, but we feel that the DFG needs to examine growth rates and maturation of barred sand bass to insure that the minimum size limit allows enough barred sand bass to spawn before being recruited into the sport fishery. The DFG should also determine how much time barred sand bass spend in spawning congregations, a time during which they are highly vulnerable to CPFV anglers. A current DFG barred sand bass tagging program designed to determine their movements and growth rates may shed light on these concerns.

## Giant Sea Bass (Serranidae)

### Catch Estimates

Southern California. Giant sea bass has been a prohibited species for both the sport and commercial fisheries in southern California since 1982 (an incidental take of one fish per landing of gill and trammel nets is currently in effect). In our survey we measured and counted giant sea bass that were caught and then released. Estimates of released giant sea bass ranged from 339 fish $\pm$ 139 in 1985 to 614 $\pm$ 184 in 1987 (Table 49). The catch-by-month distribution for giant sea bass did not display a clearly discernible catch pattern (Figure 171). However, we observed that the lowest giant sea bass catches were consistently made in the spring (April-June) and late winter (November-December).

Counties. The three southernmost counties, San Diego, Orange, and Los Angeles, contributed the greatest portion of the released giant sea bass catch. In 1987 all of the estimated 614 giant sea bass came from these counties.

### Size Composition

Southern California. Almost all the giant sea bass encountered in our survey were small, juvenile specimens, less than 670 mm (25 in.) long, and less than 4 years old [based on the length at age criteria described in Frey (1971)]. Too few fish were measured to perform a meaningful analysis. One larger giant sea bass, at 882 mm (34.7 in.) in length and 5 years of age, was measured at San Clemente Island in 1987. All the giant sea bass measured were well under the 1,219- to

TABLE 49. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of Giant Sea Bass from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| AREA | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 0 | 0 | 0 | 0 | 0 | 0 | 68 | 50 | 139 | 51 | 38 | 99 | 68 | 50 | 139 | 51 | 38 | 99 |
| Orange County | 0 | 0 | 0 | 0 | 0 | 0 | 32 | 98 | 50 | 99 | 178 | 52 | 32 | 98 | 50 | 99 | 178 | 52 |
| Los Angeles County | 0 | 0 | 0 | 0 | 0 | 0 | 213 | 60 | 344 | 48 | 399 | 38 | 213 | 60 | 344 | 48 | 399 | 38 |
| Ventura County | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 96 | 55 | 71 | 0 | 0 | 13 | 96 | 55 | 71 | 0 | 0 |
| Santa Barbara County | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 96 | 17 | 97 | 0 | 0 | 13 | 96 | 17 | 97 | 0 | 0 |
| Southern California | 0 | 0 | 0 | 0 | 0 | 0 | 339 | 41 | 604 | 31 | 614 | 30 | 339 | 41 | 604 | 31 | 614 | 30 |

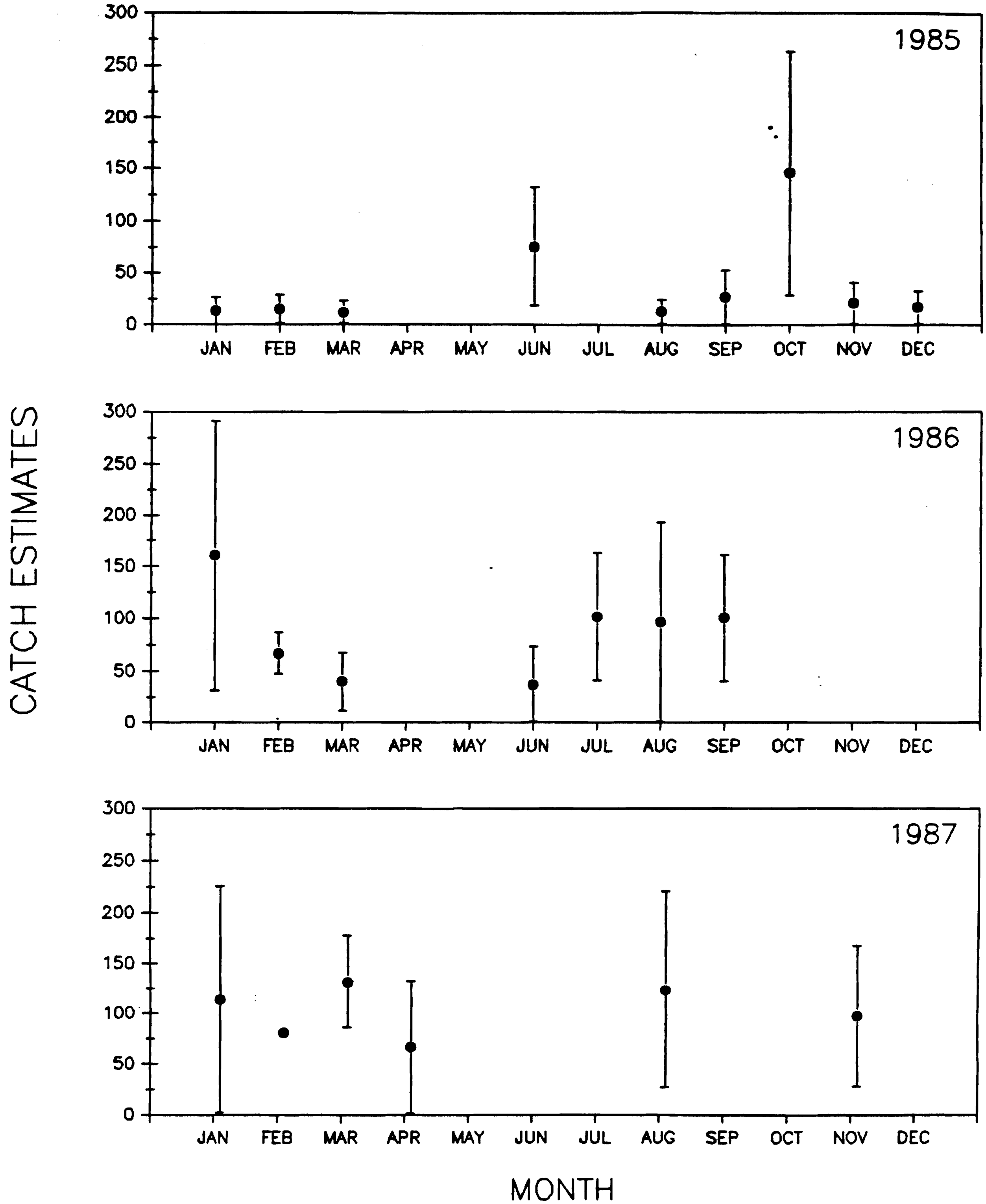



FIGURE 171. Monthly total catch estimates (number of fish) and standard deviations of giant sea bass from on-board observations of southern California commercial passenger fishing vessels.

1,397-mm (48- to 55-in.) size range (11- to 13-year age range) at which the species is sexually mature (Frey 1971).

Counties. Los Angeles County was the only county with sufficient length frequency data to analyze. The data showed considerable annual variation [over 200 mm (8 in.)] in giant sea bass mean lengths (Figure 172).

Management Recommendations

Giant sea bass range from the Gulf of California to Humboldt Bay, although they are rare north of Point Conception (Eschmeyer et al. 1983). The center of their range is off Baja California, where most of the pre-1982 sport and commercial catches originated. In southern California the adult population is concentrated around the offshore islands, including San Clemente, Santa Catalina, Santa Barbara, San Nicolas, Anacapa, and Santa Cruz Islands (Frey 1971).

According to Frey (1971), the commercial giant sea bass fishery in southern California peaked sometime before 1945. The CPFV fishery, comprised of only fish caught in Mexican waters since 1981, amounts to less than 200 giant sea bass per year, based on CPFV logbook data. In southern California, the complete prohibition for both sport and commercial fisheries should have greatly lowered the fishing mortality on all stocks of giant sea bass. Any enhancement of the stocks, however, would not become apparent for many years because of the lengthy reproductive cycle of giant sea bass.

An unknown quantity of giant sea bass is probably taken illegally each year by sport divers and private boat fishermen. Also, commercial set net fisheries take legal (allowable incidental catch) and, perhaps, illegal giant sea bass.

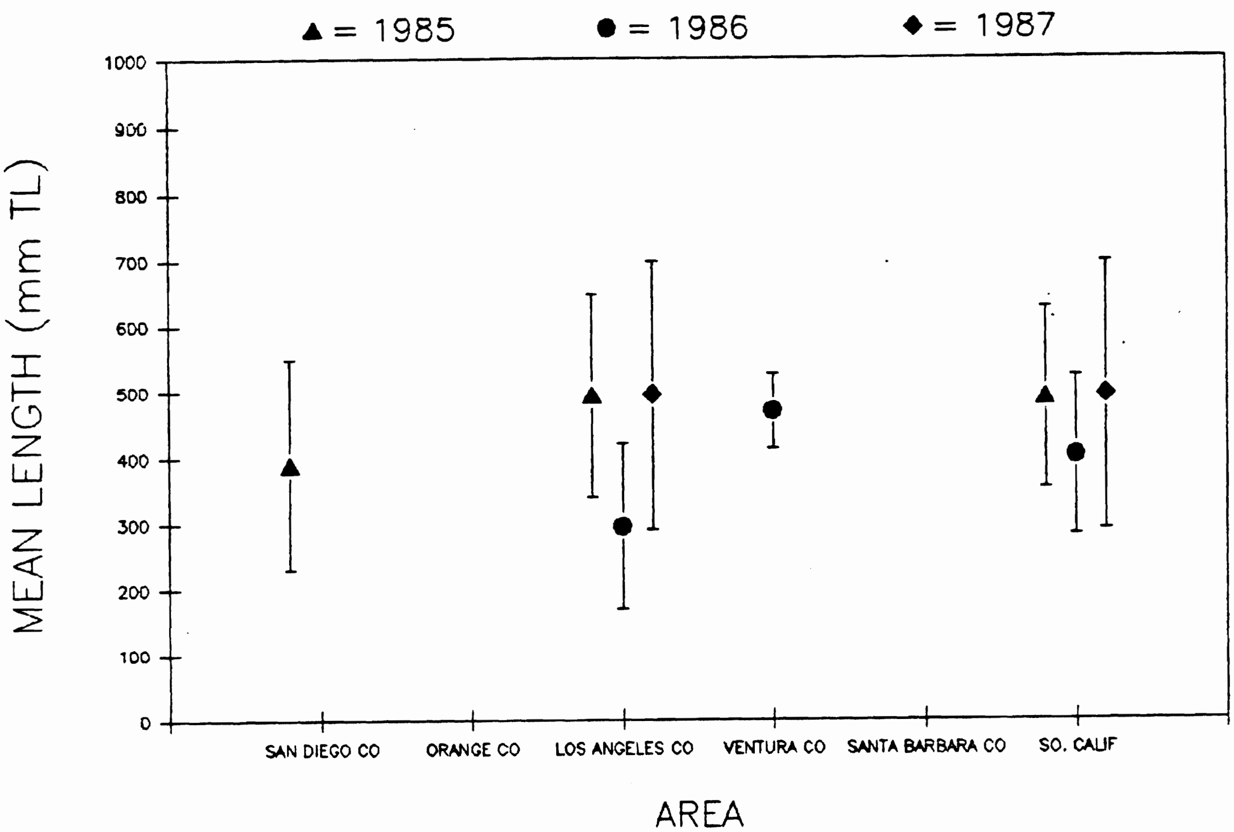



FIGURE 172. Mean lengths and standard deviations of giant sea bass measured on board southern California commercial passenger fishing vessels.

Proposed management recommendations would include a program to educate sport anglers in the identification of juvenile giant sea bass, and the necessity of and procedure for releasing them. In order to protect the adult populations, giant sea bass habitat and spawning areas should be identified and protected from the net fisheries that are likely to take them accidentally.

## Kelp Bass (Serranidae)

### Catch Estimates

Southern California. Kelp bass have long been one of the most important sport fishes to the southern California CPFV fleet. Young (1969) stated that CPFV landing operators ranked both kelp and barred sand basses the second most important species to the CPFV fleet. According to our IRI, from 1985 to 1987 kelp bass annually ranked as either the first or second most important species (Table 12). Kelp bass accounted for 11% to 17% of all CPFV fish landings, 25% to 33% of all fishes released, and 16% to 22% of the total catch of the CPFV fleet (Table 13).

The estimated total catch of kelp bass varied from year to year, with a large peak of over 1 million fish caught in 1986 (Table 50). Estimated catches of kept and released kelp bass showed a trend similar to that of total catch (Table 50). This pattern of variable catches is similar to the historical landing trends documented in the CPFV logbook records (Oliphant 1979; Best 1963; Calif. Dept. Fish and Game 1952). Whether the variability of the landings is due more to the availability of kelp bass, or yearly changes in the amount of fishing effort directed towards kelp bass, or some other reason, or a combination of factors is not known.

The ratio of kept to released kelp bass was 0.7 to 1 in 1985, 1.0 to 1 in 1986, and 1.3 to 1 in 1987.

June was the time of peak catches of kelp bass in all 3 years of the survey, but there also seemed to be a second peak between August and October (Figure 173).

TABLE 50. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of Kelp Bass from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| AREA | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 48,874 | 15 | 118,620 | 11 | 130,579 | 10 | 54,288 | 10 | 114,251 | 10 | 88,280 | 11 | 103,163 | 11 | 232,871 | 9 | 218,858 | 9 |
| Orange County | 34,015 | 19 | 68,998 | 18 | 69,277 | 17 | 82,148 | 16 | 102,056 | 17 | 58,549 | 16 | 116,163 | 16 | 171,054 | 16 | 127,827 | 15 |
| Los Angeles County | 126,832 | 13 | 160,257 | 12 | 93,453 | 16 | 174,119 | 13 | 205,047 | 13 | 93,033 | 12 | 300,951 | 12 | 365,304 | 12 | 186,485 | 13 |
| Ventura County | 37,275 | 22 | 136,797 | 11 | 94,774 | 13 | 21,296 | 15 | 77,338 | 11 | 53,904 | 15 | 58,571 | 17 | 214,134 | 10 | 148,677 | 13 |
| Santa Barbara County | 9,227 | 18 | 21,408 | 14 | 17,626 | 19 | 11,755 | 24 | 23,184 | 22 | 12,941 | 24 | 20,982 | 19 | 44,591 | 17 | 30,567 | 20 |
| Southern California | 256,223 | 8 | 506,080 | 6 | 405,709 | 6 | 343,606 | 8 | 521,875 | 7 | 306,706 | 6 | 599,829 | 7 | 1,027,955 | 6 | 712,415 | 6 |

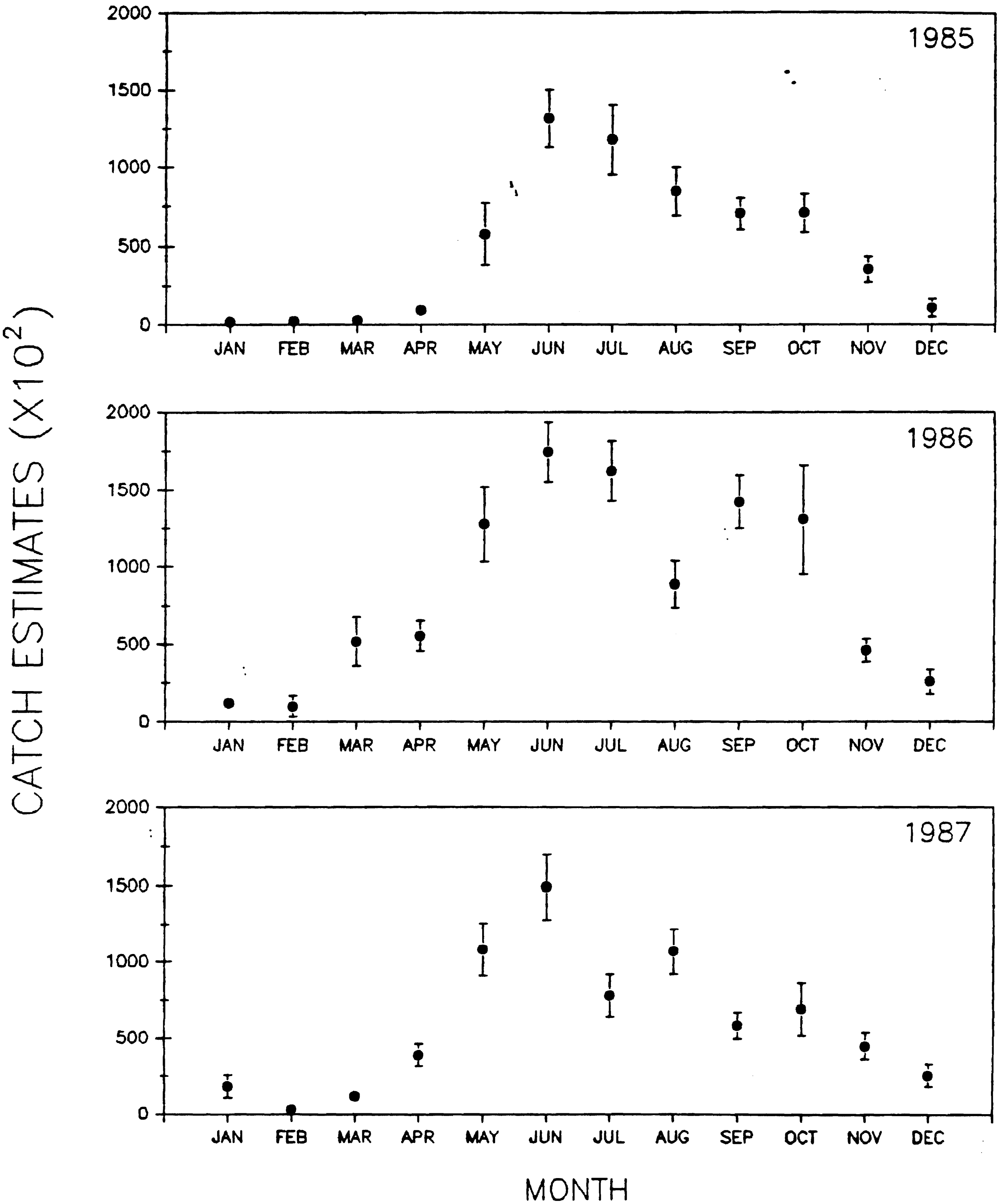



FIGURE 173. Monthly total catch estimates (number of fish) and standard deviations of kelp bass from on-board observations of southern California commercial passenger fishing vessels.

Estimated total catches of kelp bass have increased since the time of Collins and Crooke's (unpublished manuscript) survey. The 1976 through 1978 estimated mean annual catch of legal size kelp bass [$\geq$305 mm (12 in.)] increased from 271,812 fish $\pm$ 27,224 (Collins and Crooke unpublished manuscript) to our 3-year study's estimate of 354,921 $\pm$ 23,034; the estimated mean annual catch of short kelp bass increased from 191,846 $\pm$ 20,111 (Collins and Crooke unpublished manuscript) to our 3-year study's estimate of 412,033 $\pm$ 29,783. The ratio of legal to short kelp bass was 0.7 to 1 in 1985, 0.8 to 1 in 1986, and 1.1 to 1 in 1987. Collins and Crooke's (unpublished manuscript) ratio of legal to short kelp bass was 4.5 to 1 in 1976, 1.6 to 1 in 1977, and 0.8 to 1 in 1978.

Counties. All counties showed an increase in kelp bass total catch from 1985 to 1986, followed by a decrease in total catch in 1987 (Table 50). Los Angeles County had the highest estimated total catch in 1985 and 1986, while San Diego County had the highest in 1987 (Table 50). Los Angeles County's contribution toward the southern California total catch dropped from 50% in 1985 to 26% in 1987. Conversely, San Diego County's contribution increased from 17% in 1985 to 31% in 1987. Catch estimate trends by county for kept as well as for released fish were similar to that of total catch by county (Table 50).

Kept-to-released ratios for kelp bass increased in all counties from 1985 to 1987, except in Ventura County, where they remained the same. However, Ventura County had the highest kept-to-released ratio at 1.8 to 1; while Orange County had the lowest in 1985 and 1986 at 0.4 to 1 and 0.7 to 1, respectively; and Los Angeles County, the lowest in 1987 at 1.0 to 1. The increase in the kept-to-released ratios may indicate (i) the emergence of strong year classes reaching legal size in such numbers as to increasingly satisfy angler demand for legal-sized fish, and/or (ii) reduced recruitment.

Size Composition

Southern California. Annual mean lengths of kept kelp bass for southern California changed little during 1985 to 1987 (Figure 174). Most of the kept bass were close to the minimum 305-mm (12-in.) size limit (Figure 175). The modal size class for kept kelp bass was 310 to 314 mm (12.2 to 12.4 in.) in 1985 and 1986, and 305 to 309 mm (12.0 to 12.2 in.) in 1987 (Figure 175).

Kelp bass 305 to 329 mm (12.0 to 13.0 in.) annually made up 31% to 34% of all kept kelp bass measured from 1985 to 1987. Kelp bass 305 to 404 mm (12.0 to 15.9 in.) accounted for 76% to 79% of all measured kelp bass. According to Young (1963), the 305 to 329 mm (12.0 to 13.0 in.) range represents primarily two, possibly three year classes, while that of 305 to 404 mm (12.0 to 15.9 in.) represents primarily four, but possibly up to seven year classes.

Kept kelp bass less than the minimum size limit decreased from 11.9% to 10.9% of the annual CPFV kelp bass landings from 1985 to 1987. Most of the kept sublegal kelp bass were within 15 mm (0.6 in.) of the size limit. Kelp bass less than 290 mm (11.4 in.) made up only 2.7% of the measured kept bass in 1985, 2.6% in 1986, and 1.8% in 1987. This suggests that inaccurate measuring (by anglers and/or samplers), and/or fish shrinkage, and/or the temptation to keep a barely short kelp bass, rather than mis-identifying the fish or not knowing the minimum size regulations, was/were responsible for most of the sublegal kelp bass being kept by CPFV anglers.

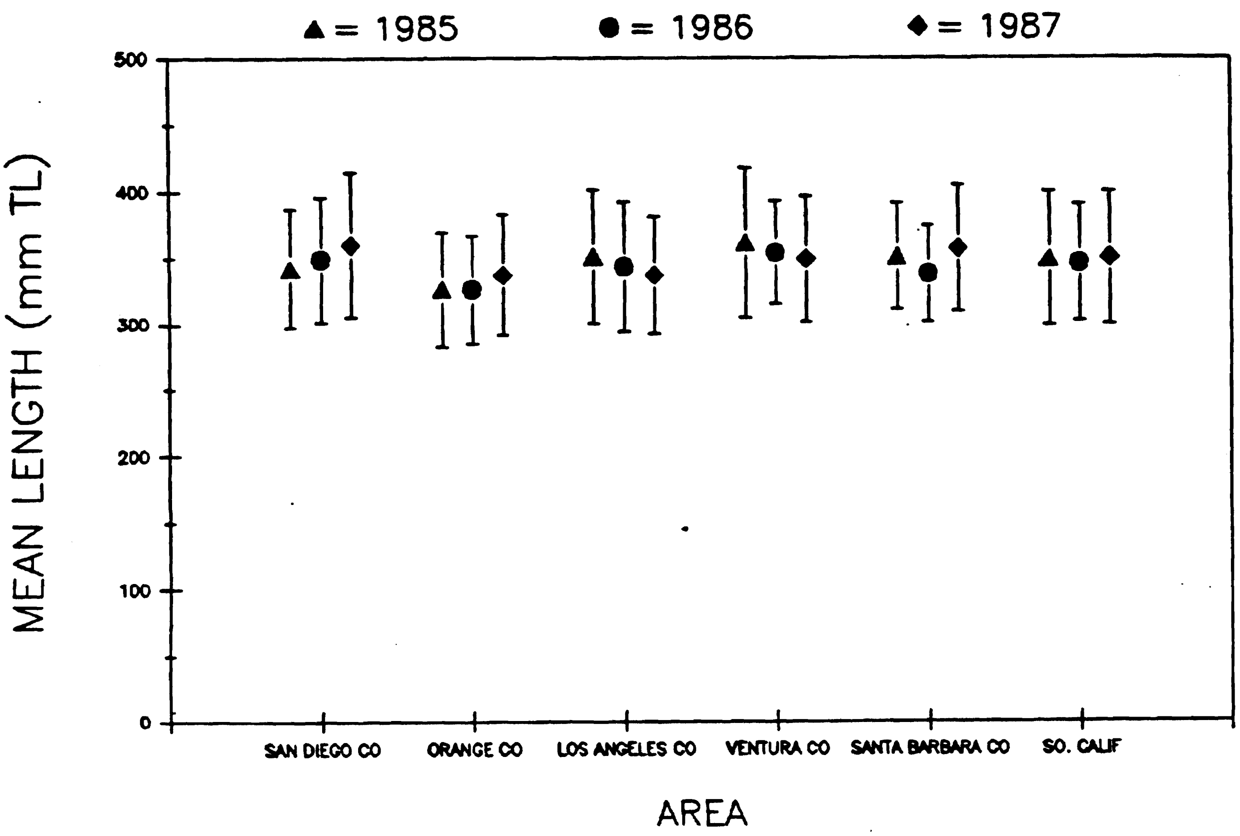



FIGURE 174. Mean lengths and standard deviations of kept kelp bass measured on board southern California commercial passenger fishing vessels. Size limit = 305 mm (12 in.).

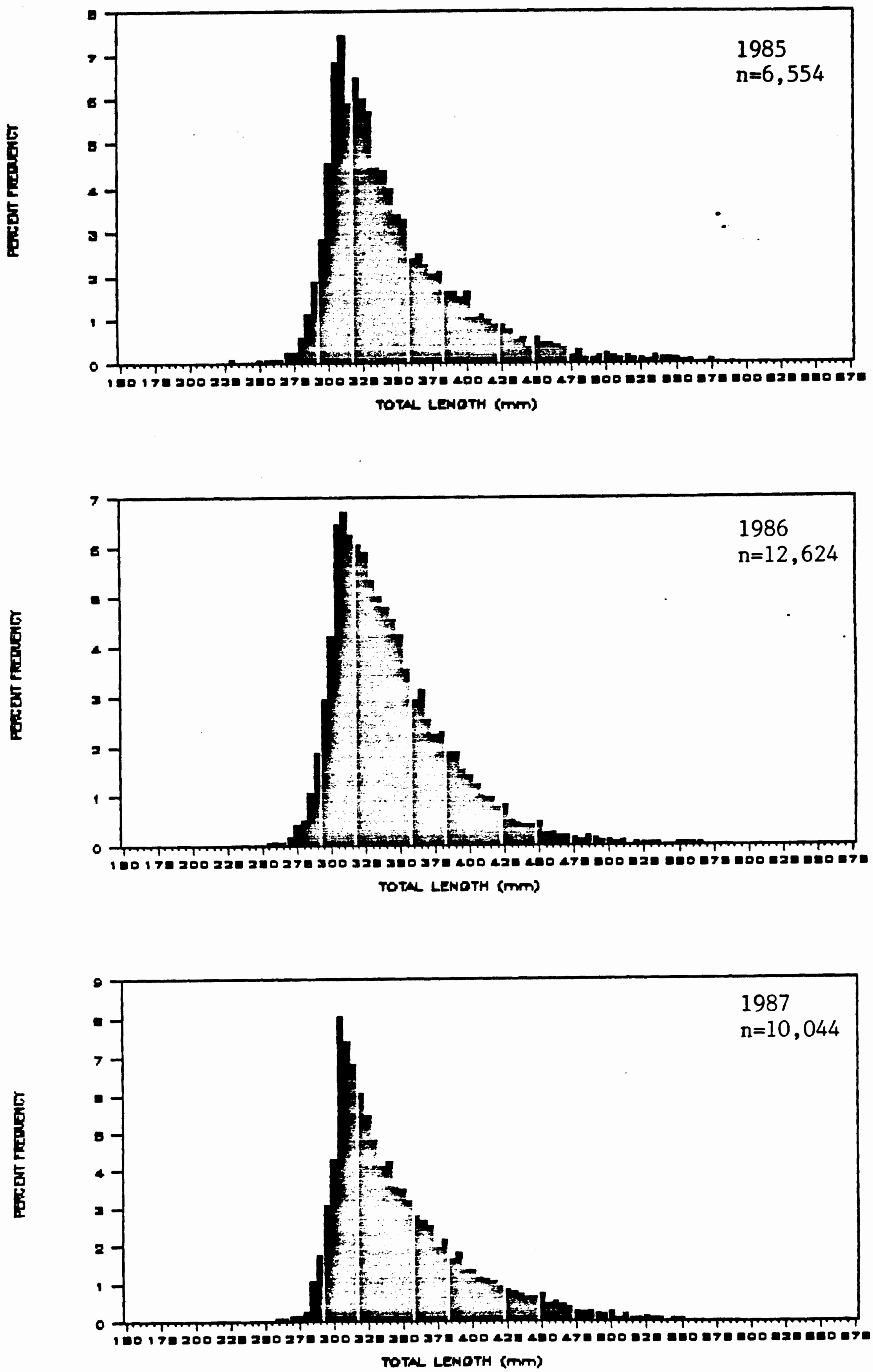



FIGURE 175. Size composition of kept kelp bass from on-board observations of southern California commercial passenger fishing vessels. Size limit = 305 mm (12 in.).

Over 85% of the kept kelp bass measured between 290 to 404 mm (11.4 to 15.9 in.). It appears that a stable spawning potential is being maintained because many year classes support the kelp bass sport fishery and most sublegal fish are released. Even though there could be substantially reduced CPFV catches [especially among the 305- to 329-mm (12- to 13-in.) fish] with poor recruitment from one or two year classes, it would likely take several years of low recruitment before a collapse in the population would occur.

The modal size class of released kelp bass was 280 to 284 mm (11.4 to 11.6 in.) in 1985 and 1986, and 290 to 294 mm (11.4 to 11.6 in.) in 1987 (Figure 176). Kelp bass are probably not fully recruited into the CPFV fishery until they are 255 to 279 mm (10.0 to 11.0 in.) in length. Peak catches of released kelp bass probably occur at the above size due to bait selectivity.

Counties. Kept kelp bass from Ventura and San Diego counties had larger mean lengths than those of any other southern California county (Figure 174). Orange County kelp bass had the smallest mean length of any southern California county (Figure 174). Mean lengths increased slightly each year in San Diego County, but decreased slightly in Los Angeles and Ventura counties (Figure 174).

Length frequency analyses for kept kelp bass and released kelp bass by county exhibited similar patterns to those of southern California as a whole (Figures 177 to 186).

Sublegal kelp bass accounted for 23.1% to 30.6% of the annual CPFV kelp bass landings in Orange County, by far the highest rate among southern California counties. Los Angeles County had the next highest

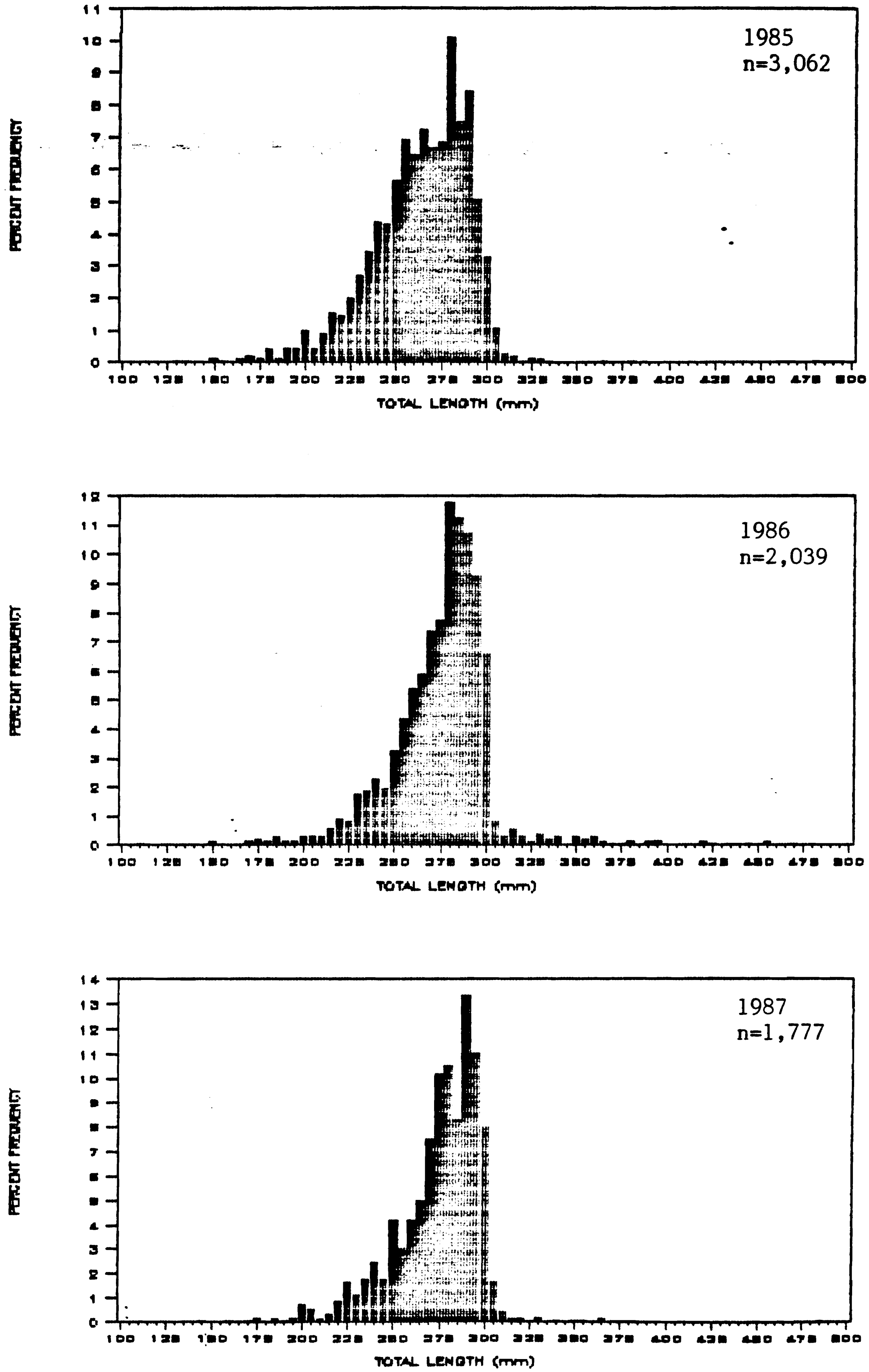



FIGURE 176. Size composition of released kelp bass from on-board observations of southern California commercial passenger fishing vessels. Size limit = 305 mm (12 in.).

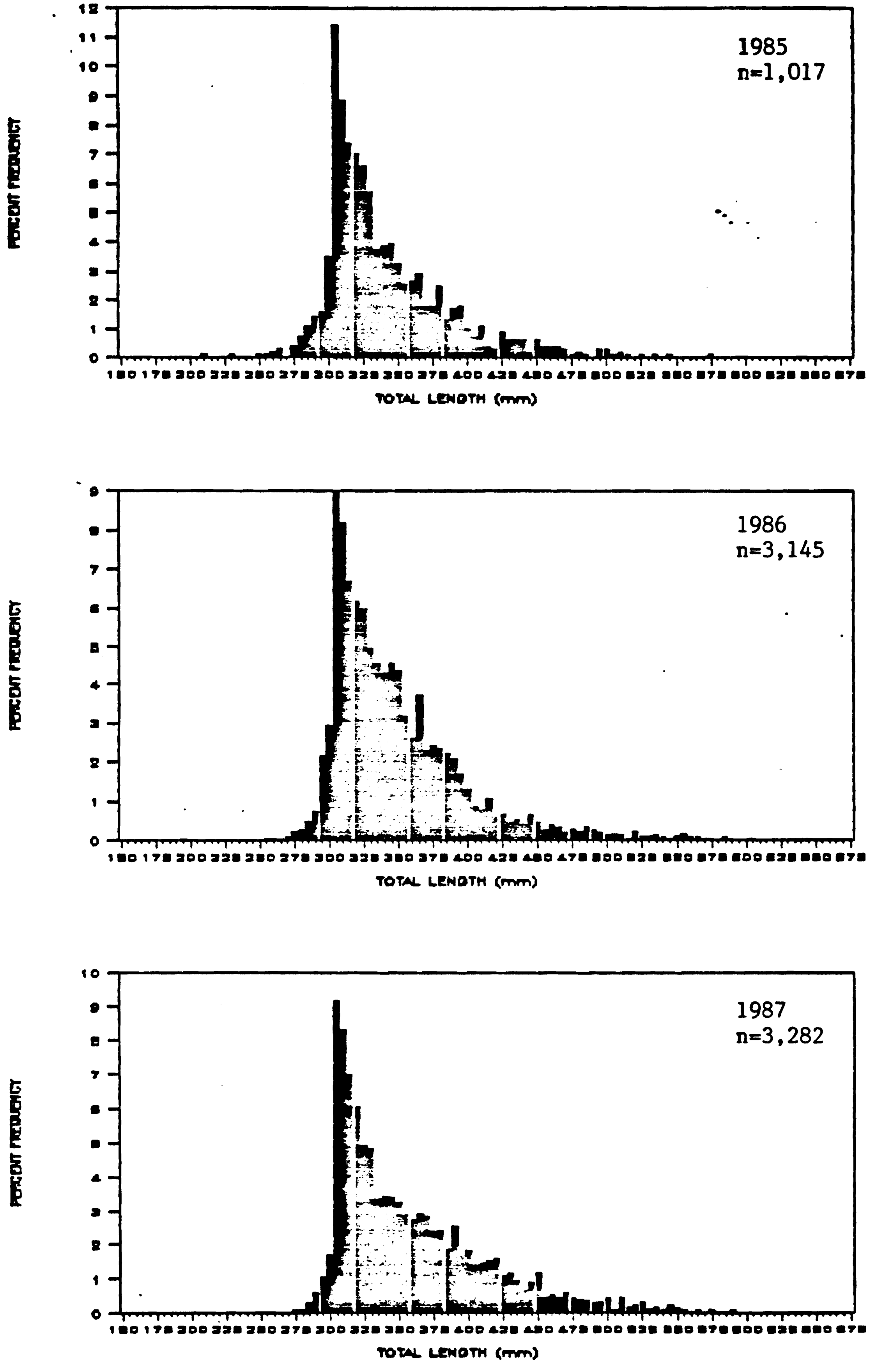



FIGURE 177. Size composition of kept kelp bass from on-board observations of San Diego County commercial passenger fishing vessels. Size limit = 305 mm (12 in.).

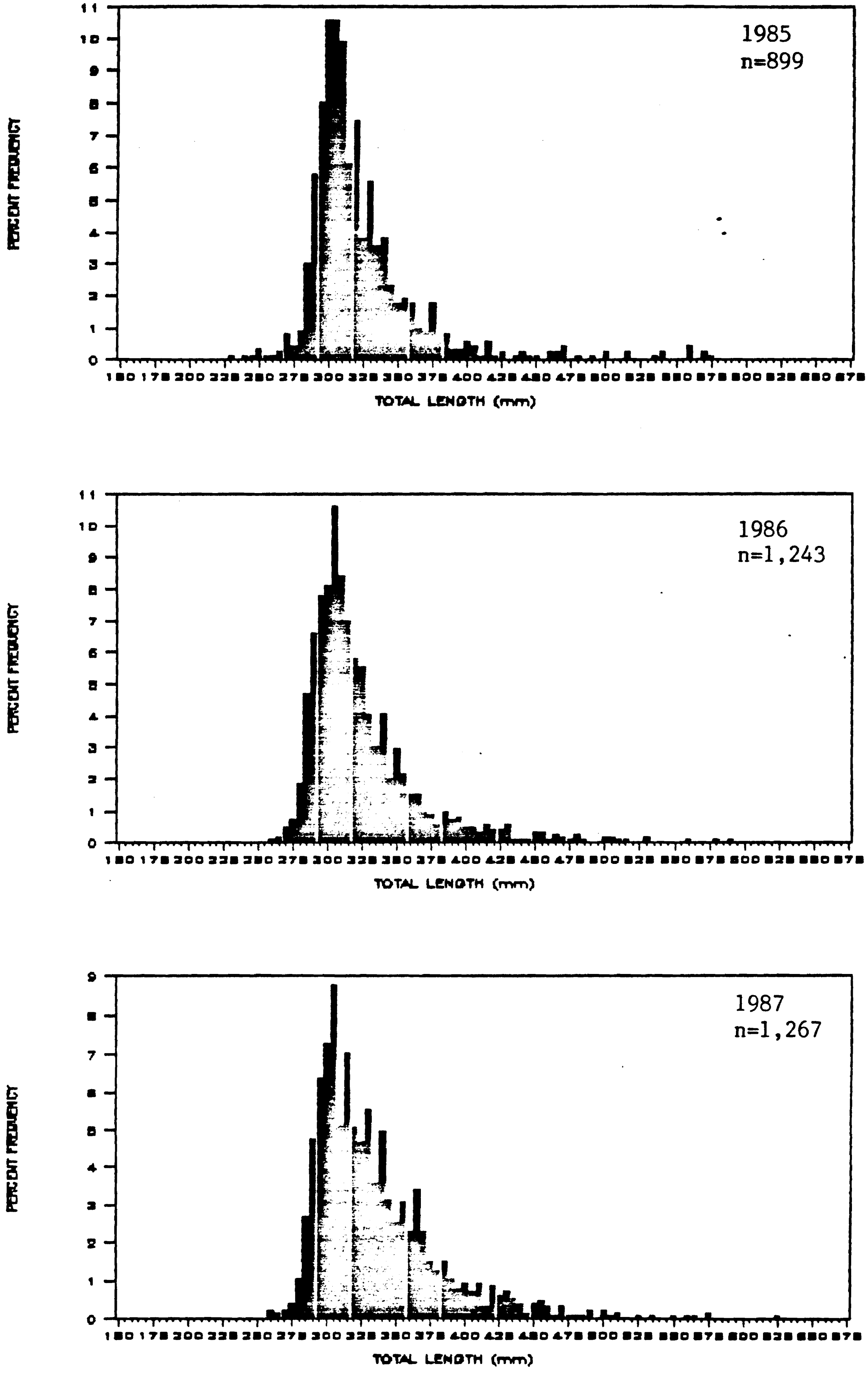



FIGURE 178. Size composition of kept kelp bass from on-board observations of Orange County commercial passenger fishing vessels. Size limit = 305 mm (12 in.).

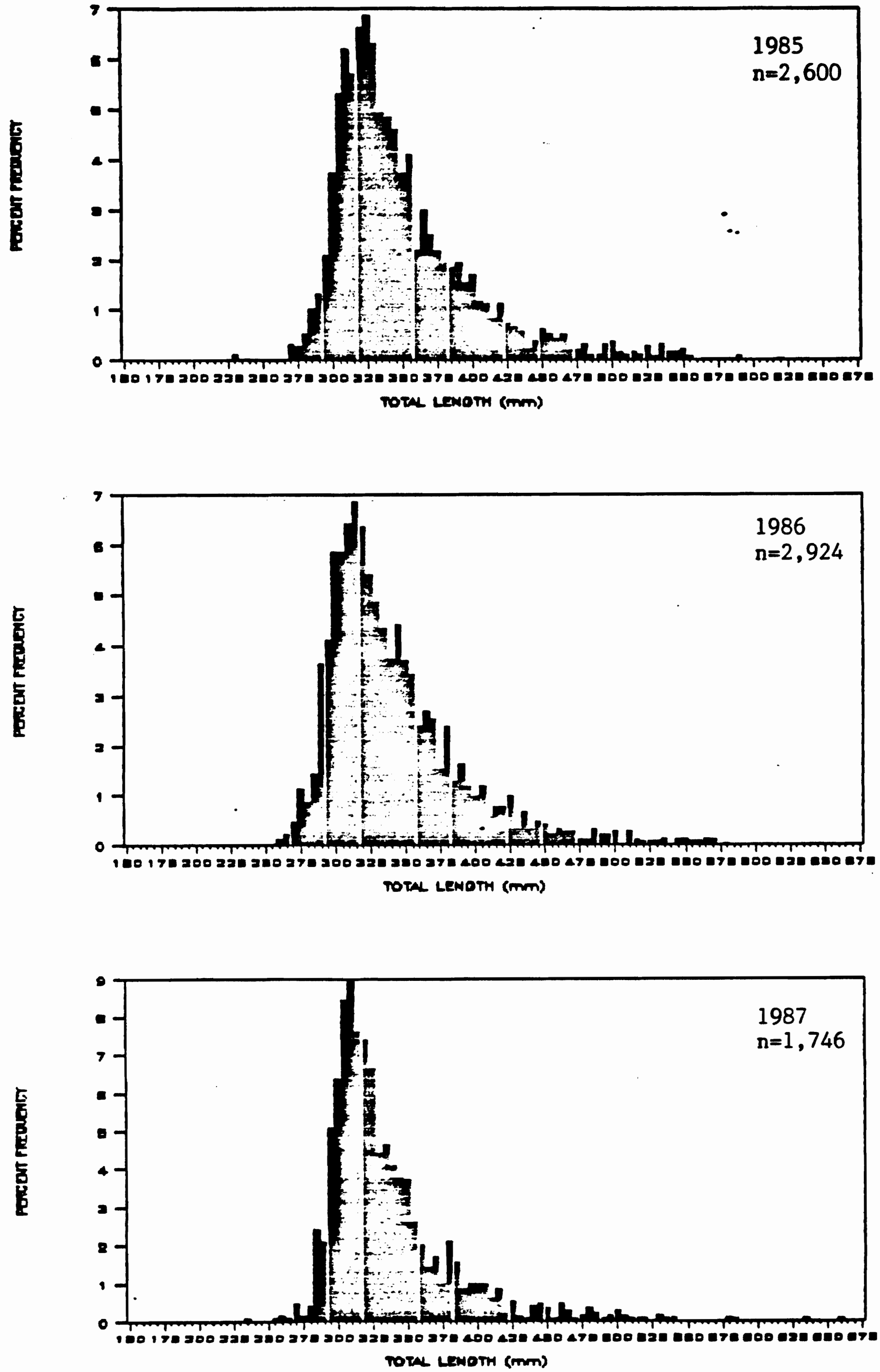



FIGURE 179. Size composition of kept kelp bass from on-board observations of Los Angeles County commercial passenger fishing vessels. Size limit = 305 mm (12 in.).

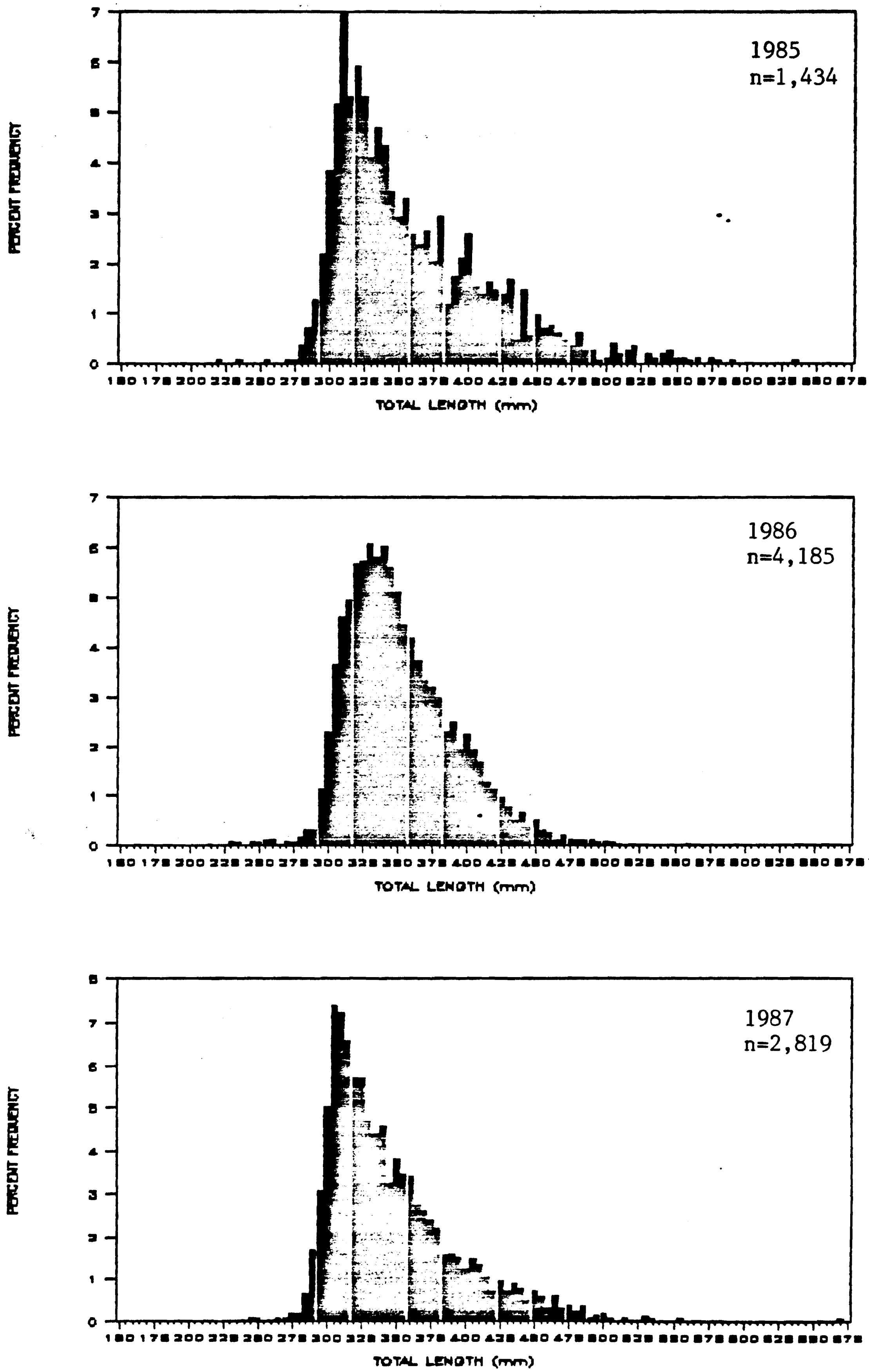



FIGURE 180. Size composition of kept kelp bass from on-board observations of Ventura County commercial passenger fishing vessels. Size limit = 305 mm (12 in,).

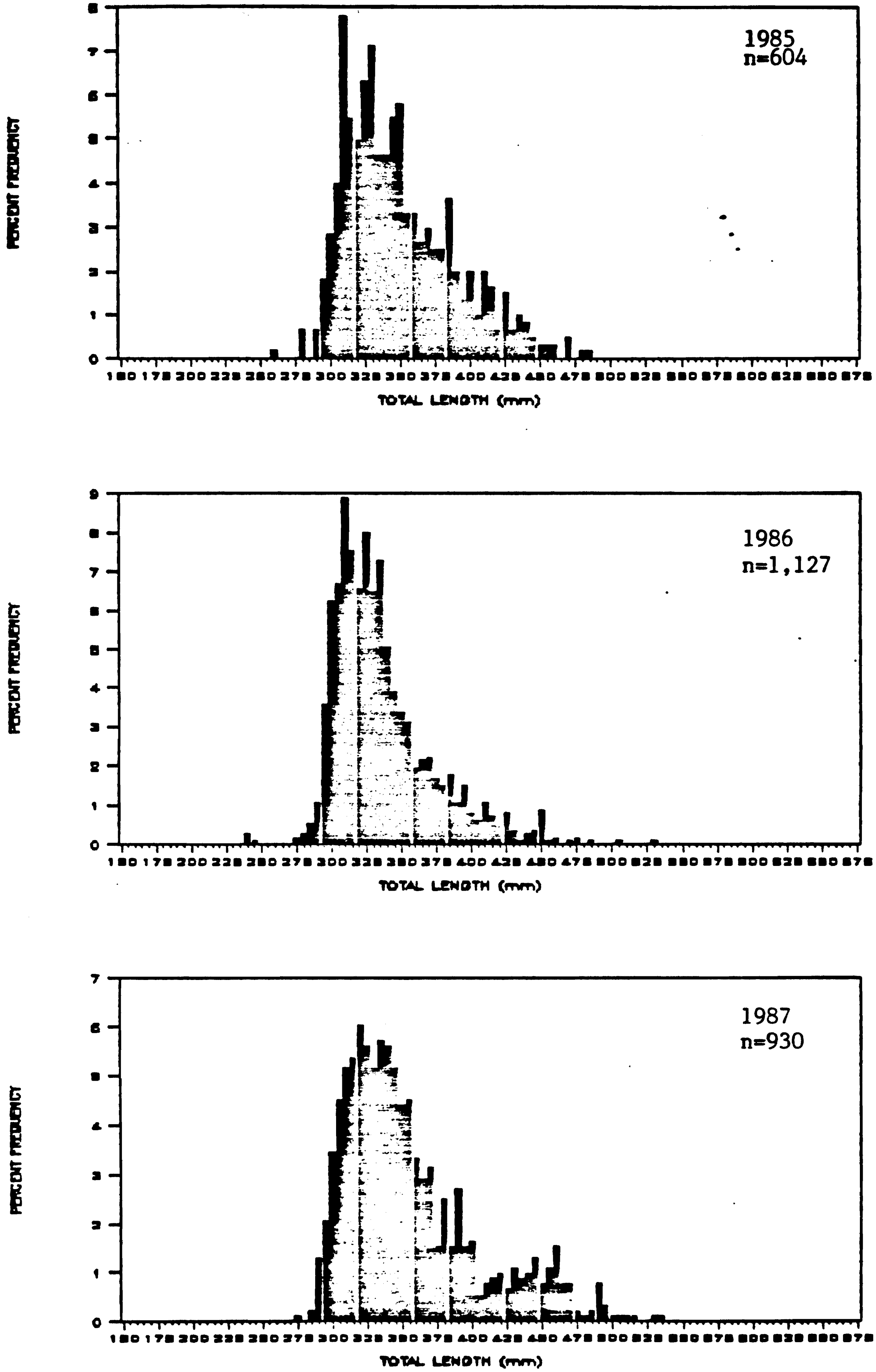



FIGURE 181. Size composition of kept kelp bass from on-board observations of Santa Barbara County commercial passenger fishing vessels. Size limit = 305 mm (12 in.).

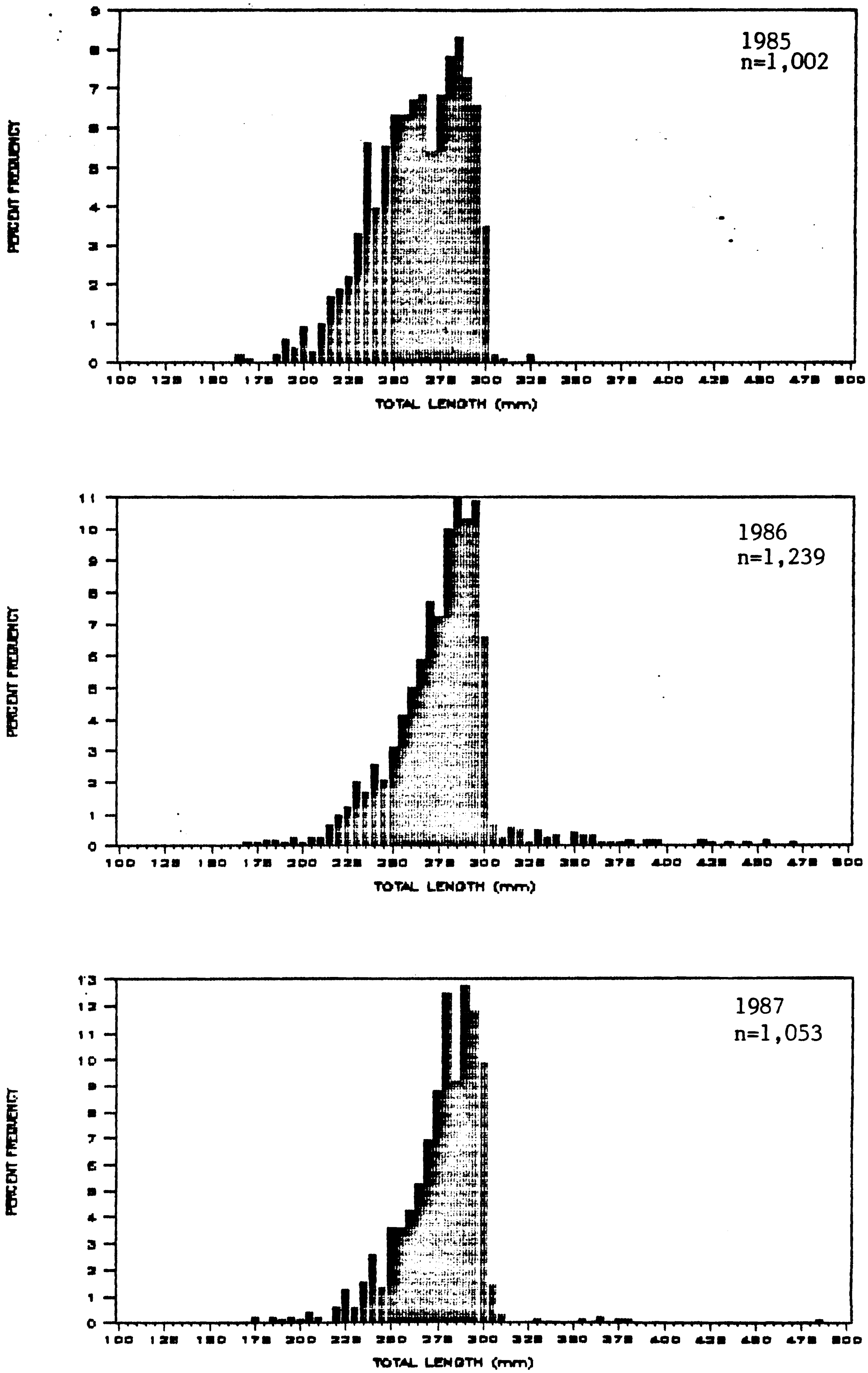



FIGURE 182. Size composition of released kelp bass from on-board observations of San Diego County commercial passenger fishing vessels. Size limit = 305 mm (12 in.).

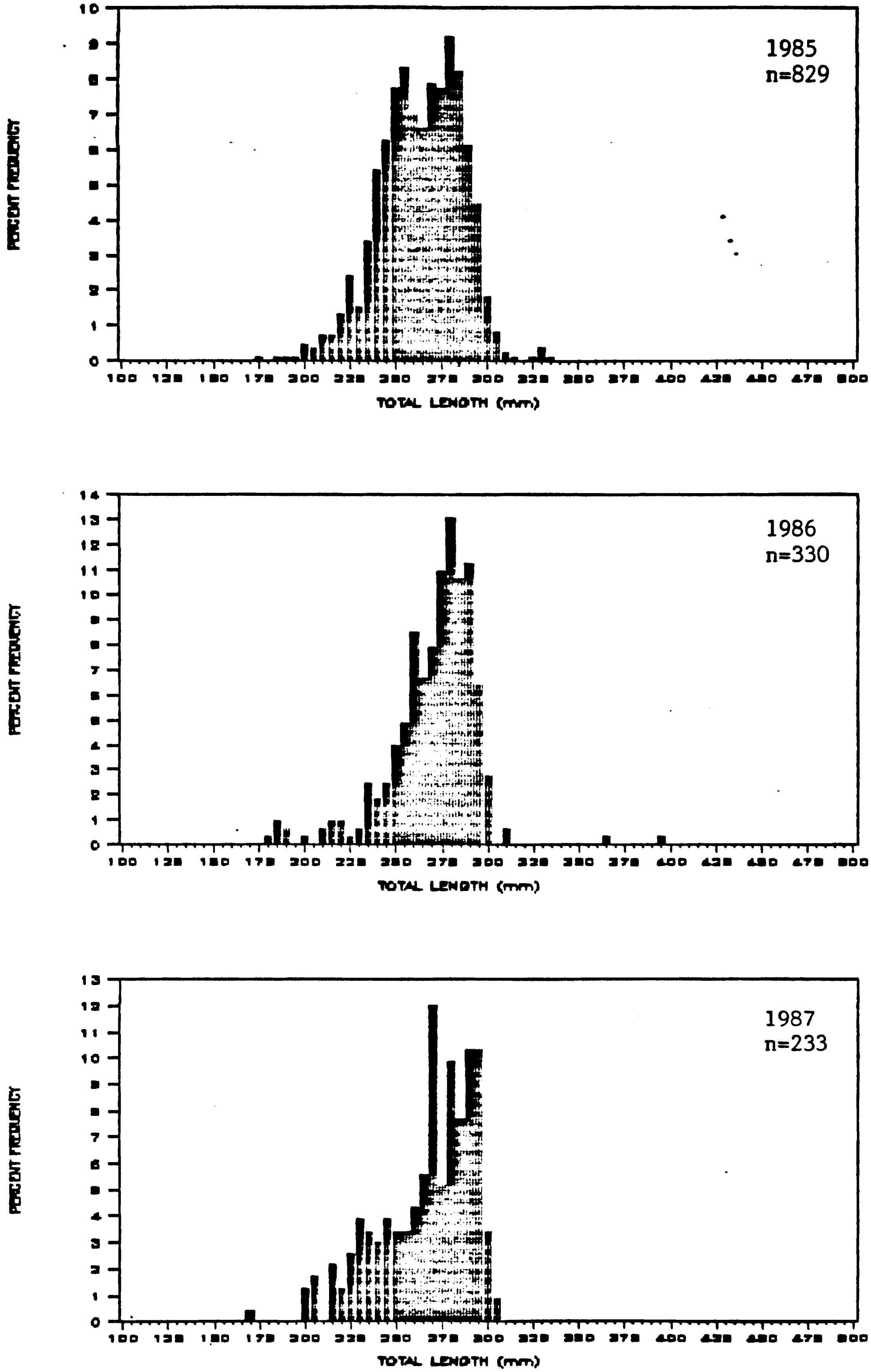



FIGURE 183. Size composition of released kelp bass from on-board observations of Orange County commercial passenger fishing vessels. Size limit = 305 mm (12 in.).

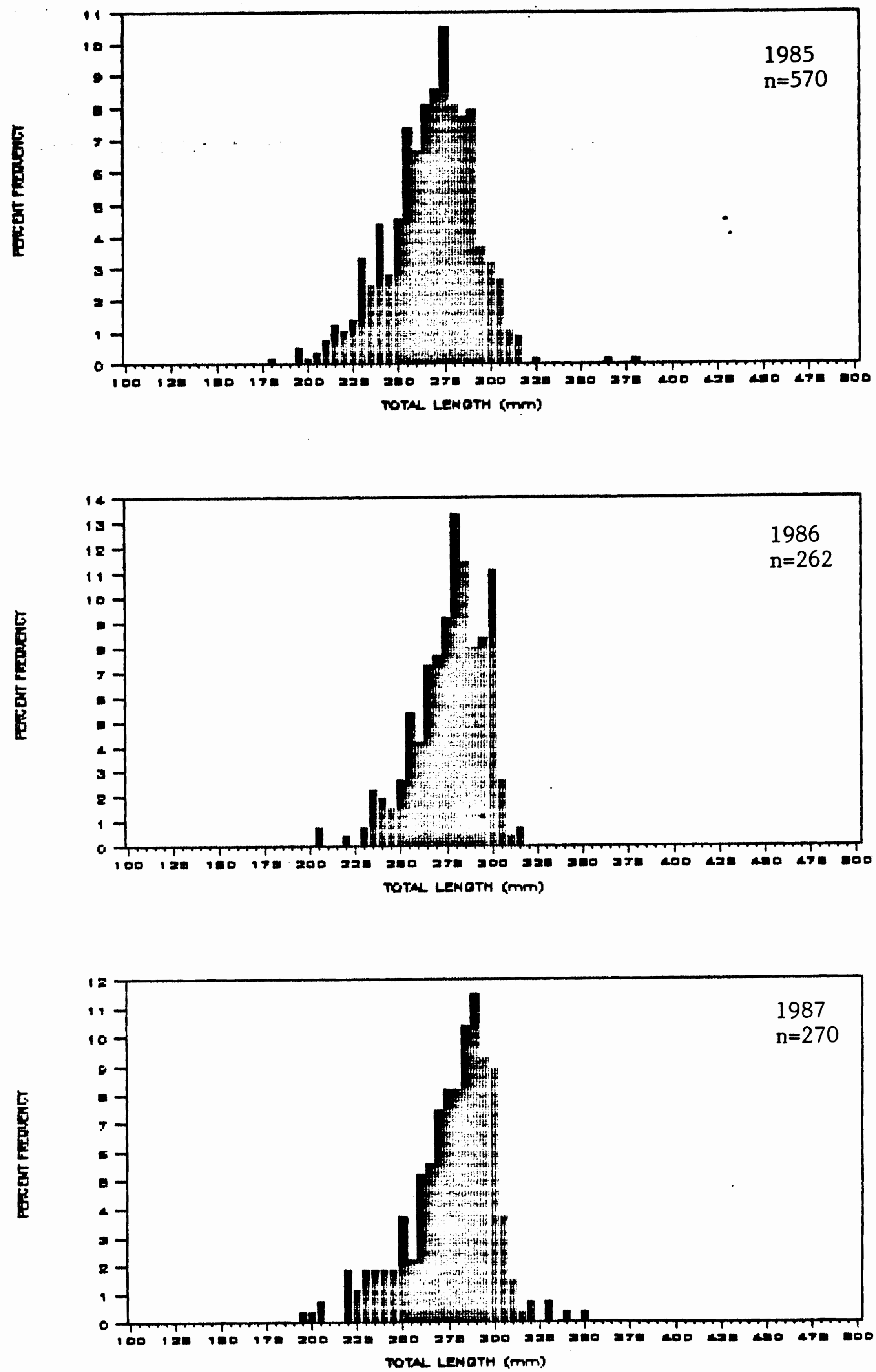



FIGURE 184. Size composition of released kelp bass from on-board observations of Los Angeles County commercial passenger fishing vessels. Size limit = 305 mm (12 in.).

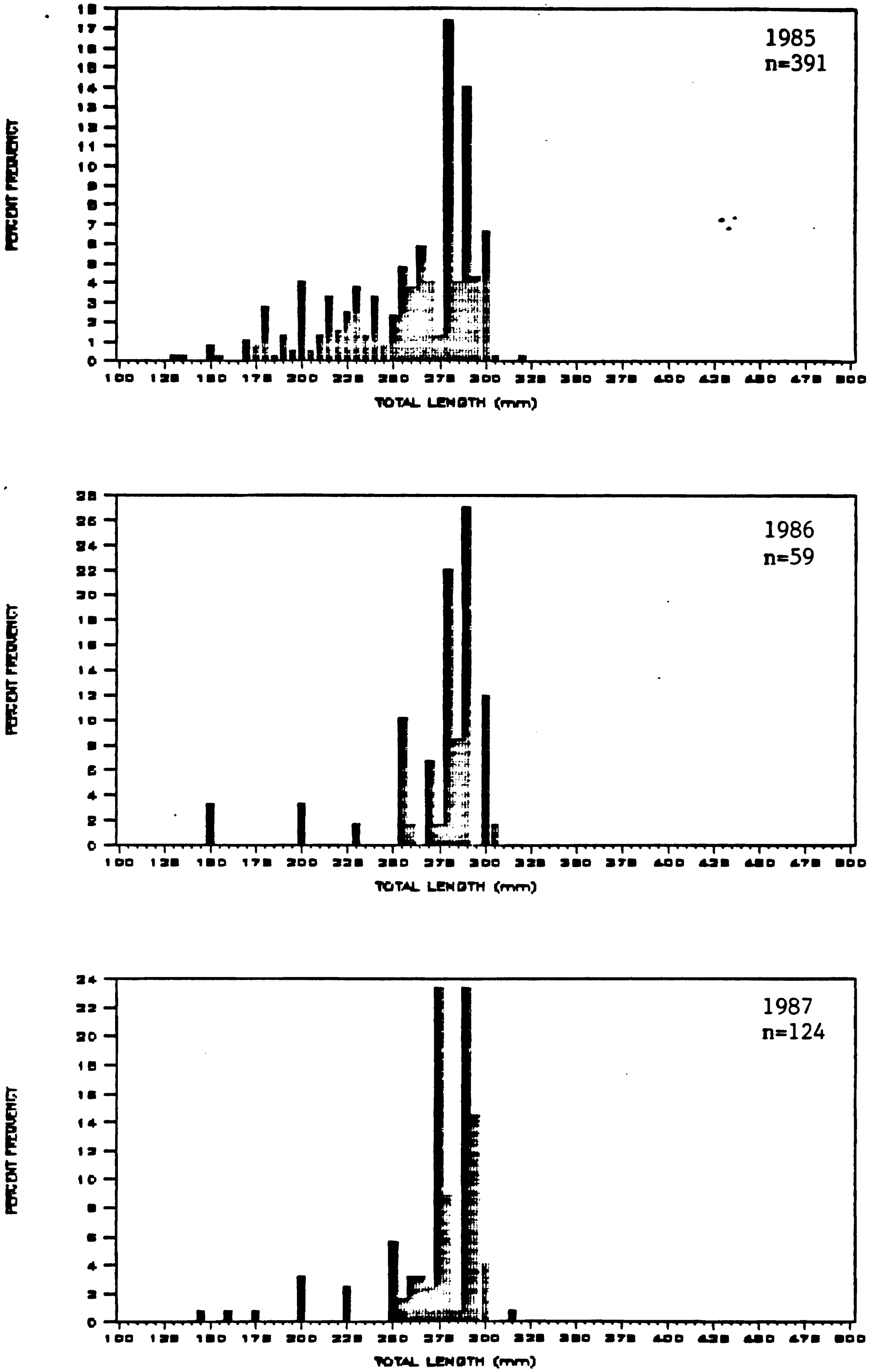



FIGURE 185. Size composition of released kelp bass from on-board observations of Ventura County commercial passenger fishing vessels. Size limit = 305 mm (12 in.).

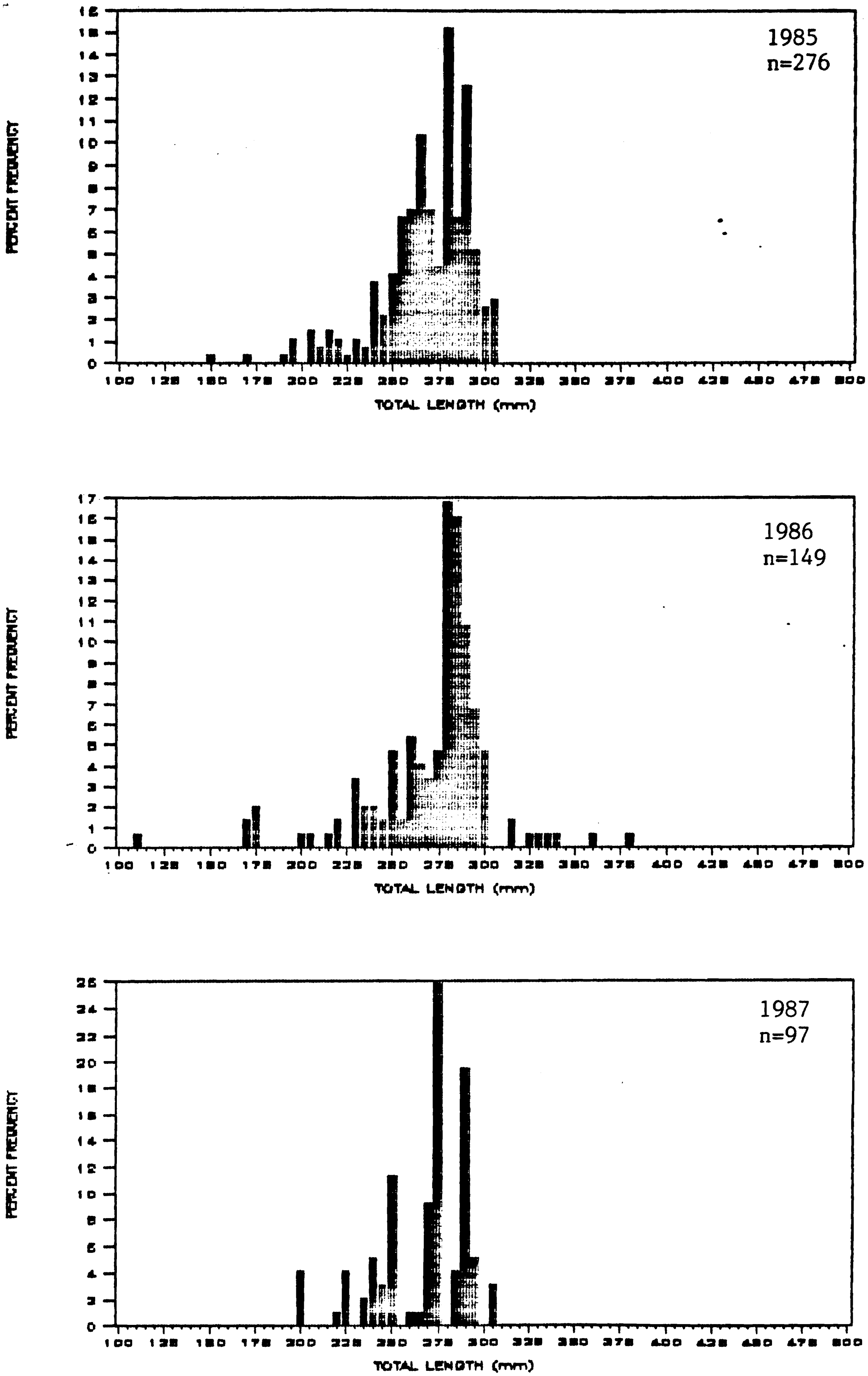



FIGURE 186. Size composition of released kelp bass from on-board observations of Santa Barbara County commercial passenger fishing vessels. Size limit = 305 mm (12 in.).

annual rate, 9.6% to 17.9%, followed by Santa Barbara County, 6.1% to 12.2%, Ventura County, 4.8% to 11.1%, and San Diego County, 3.8% to 9.4%.

Management Recommendations

Collins and Crooke (unpublished manuscript) felt that there may have been insufficient legal kelp bass available to satisfy CPFV anglers. The large number of kelp bass caught at or near the size limit, coupled with the large number of released fish indicates this is still the case. Because there is no commercial fishery for kelp bass, and due to the extreme pressure exerted on kelp bass by sport anglers, kelp bass populations probably can be influenced by sport fishing regulations more than those of most other marine sport fishes. Due to high fishing pressure, the minimum size limit should remain in place to protect kelp bass until they spawn at least once. But the size limit has probably altered the size distribution of kelp bass by decreasing the number of large fish and increasing the number of fish close to the size limit. The decreased abundance of larger, older fish could be a cause for concern. Without these older fish, the age classes supporting the kelp bass fishery is narrowed, increasing the chance of lowered catches due to poor recruitment years. Setting aside areas for reserves with no fishing, implementing a larger minimum size limit, and/or having a maximum size limit probably would increase the abundance of older, larger kelp bass.

## Spotted Sand Bass (Serranidae)

Although spotted sand bass is an important sport fish species by our criteria [it has a 305-mm (12-in.) minimum size limit], it is found primarily inside protected bays and harbors where CPFV's rarely fish. Consequently, we encountered too few of them in our survey to perform any type of analysis.

## California Barracuda (Sphyraenidae)

### Catch Estimates

Southern California. According to our IRI, California barracuda (henceforth referred to as barracuda) annually ranked as the fourth or fifth most important fish to the southern California CPFV fleet (Table 12). Young (1969) stated that CPFV landing operators ranked barracuda as the most important fish to the CPFV fleet. In 1971, DFG implemented a 711-mm (28-in.) minimum size limit for all sport-caught barracuda, greatly reducing CPFV landings.

The estimated total catch of barracuda dropped 16% from 1985 to 1987 (Table 51). However, barracuda landings rose 53% from 1985 to 1987 (Table 51). The number of released barracuda decreased 41% from 1985 to 1987 (Table 51).

The ratio of kept to released barracuda rose from 0.4 to 1 in 1985, to 0.5 to 1 in 1986, to 1.0 to 1 in 1987. This increase was a function of both increasing catches of kept fish and decreasing catches of released fish. Peak total catches of barracuda were from June through August in 1985 through 1987 (Figure 187).

Estimated catches of barracuda have increased since Collins and Crooke's (unpublished manuscript) survey. The 1976 through 1978 estimated mean annual catch of legal barracuda [$\geq$ 711 mm (28 in.)] increased from 43,970 fish $\pm$ 9,761 (Collins and Crooke unpublished manuscript) to our 3-year study's estimate of 101,719 $\pm$ 13,996; the estimated mean annual catch of short barracuda increased from 46,817 $\pm$ 6,759 (Collins and Crooke unpublished manuscript) to our 3-year study's

TABLE 51. Catch Estimates (EST) and Coefficients of Variation [CV (%)] of California Barracuda from On-Board Sampling of Southern California Commercial Passenger Fishing Vessels for 1985 Through 1987.

| | FISH KEPT | | | | | | FISH RELEASED | | | | | | TOTAL CATCH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | | 1985 | | 1986 | | 1987 | |
| AREA | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV | EST | CV |
| San Diego County | 21,811 | 26 | 41,199 | 18 | 40,273 | 15 | 105,777 | 12 | 84,998 | 11 | 58,675 | 10 | 127,588 | 13 | 126,197 | 12 | 98,947 | 9 |
| Orange County | 1,506 | 59 | 15,083 | 35 | 27,359 | 36 | 24,338 | 20 | 51,631 | 14 | 34,581 | 16 | 25,844 | 20 | 66,713 | 16 | 61,940 | 20 |
| Los Angeles County | 77,418 | 18 | 46,052 | 22 | 90,543 | 19 | 135,383 | 10 | 70,271 | 14 | 65,348 | 14 | 212,800 | 12 | 116,323 | 16 | 155,892 | 14 |
| Ventura County | 3,536 | 25 | 5,672 | 25 | 1,920 | 35 | 13,868 | 19 | 10,202 | 20 | 5,671 | 28 | 17,404 | 18 | 15,874 | 20 | 7,591 | 27 |
| Santa Barbara County | 146 | 73 | 60 | 69 | 75 | 97 | 2,371 | 24 | 2,613 | 46 | 1,640 | 38 | 2,517 | 23 | 2,672 | 46 | 1,715 | 37 |
| Southern California | 104,417 | 15 | 108,065 | 13 | 160,170 | 13 | 281,736 | 7 | 219,714 | 7 | 165,915 | 8 | 386,153 | 8 | 327,779 | 8 | 326,085 | 8 |

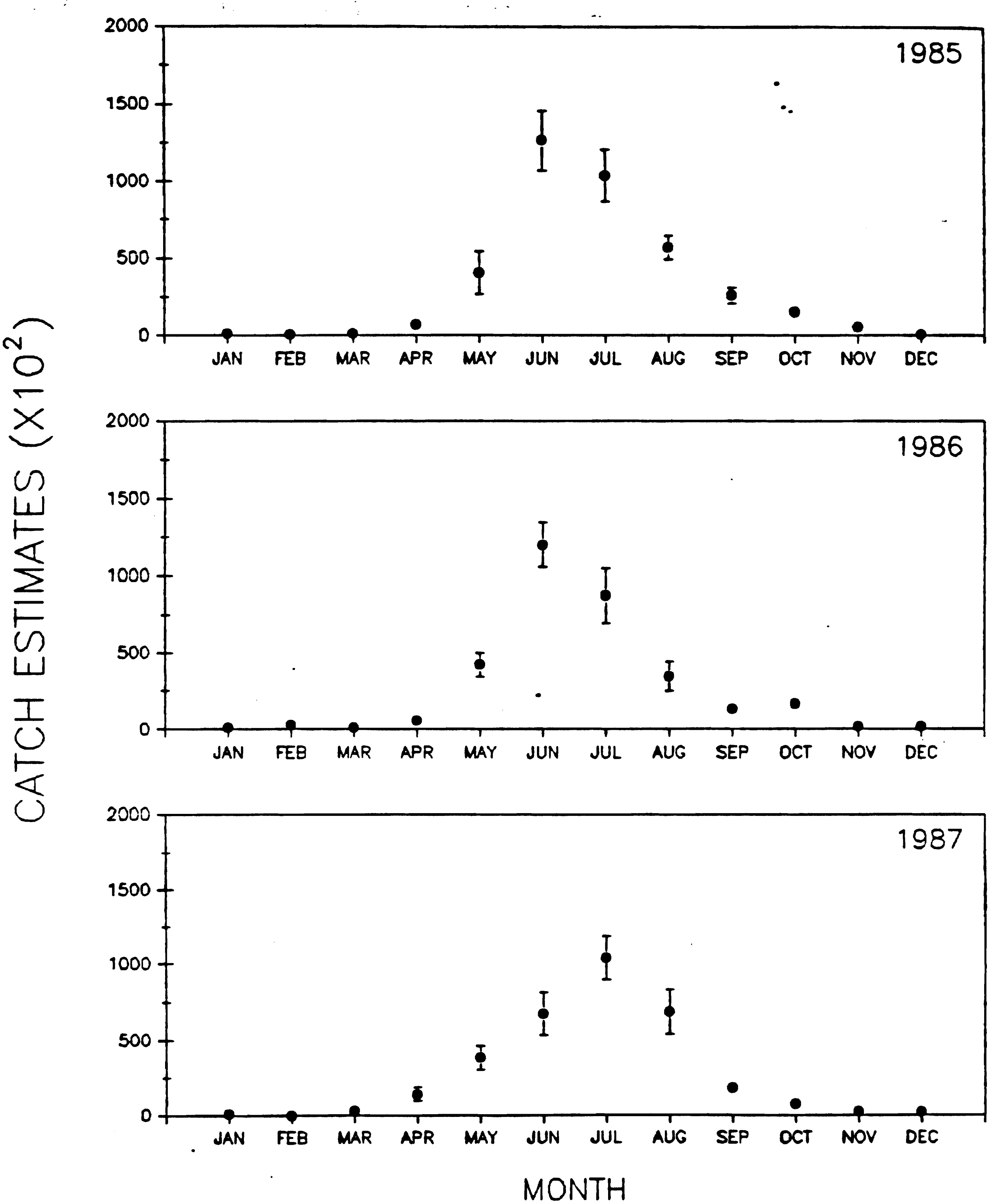



FIGURE 187. Monthly total catch estimates (number of fish) and standard deviations of California barracuda from on-board observations of southern California commercial passenger fishing vessels.

estimate of 244,954 $\pm$ 18,130. The ratio of legal to short barracuda was 0.3 to 1 in 1985 and 1986, and 0.7 to 1 in 1987. Collins and Crooke (unpublished manuscript) found that the ratio of legal to short barracuda was 2.5 to 1 in 1976, 0.6 to 1 in 1977, and 0.4 to 1 in 1978.

Because catches of barracuda are highly dependent on sea surface temperatures (Pinkas 1966), and because we did not correlate catches and sea surface temperatures, we do not know if increased barracuda catches from 1985 to 1987 were related to an increase in population size or a northerly migration due to warmer waters. However, the availability of legal barracuda to CPFV anglers increased during 1985 to 1987, as illustrated by increased catches of kept barracuda, and this has decreased incidences of retained sublegal barracuda. This might be due to high recruitment from 1981, 1982, and 1983 year classes reaching legal size. The decreased catches of released barracuda may be due to large numbers of legal fish available to CPFV anglers, and/or a weak 1984 year class of barracuda recruiting into the CPFV fishery (Figure 188). If the latter is true, there may be a decrease in barracuda landings when this age class reaches legal size.

Counties. Los Angeles County had the highest annual total catch of barracuda in 1985 and 1987, while San Diego County had the highest total catch in 1986 (Table 51). Los Angeles County accounted for 35% to 55% of the total catch of barracuda and 43% to 74% of the barracuda landings in southern California between 1985 and 1987 (Table 51). San Diego County accounted for 30% to 39% of the total catch of barracuda, and 21% to 38% of the barracuda landings in southern California between 1985 and 1987 (Table 51). Considerably more short barracuda were kept

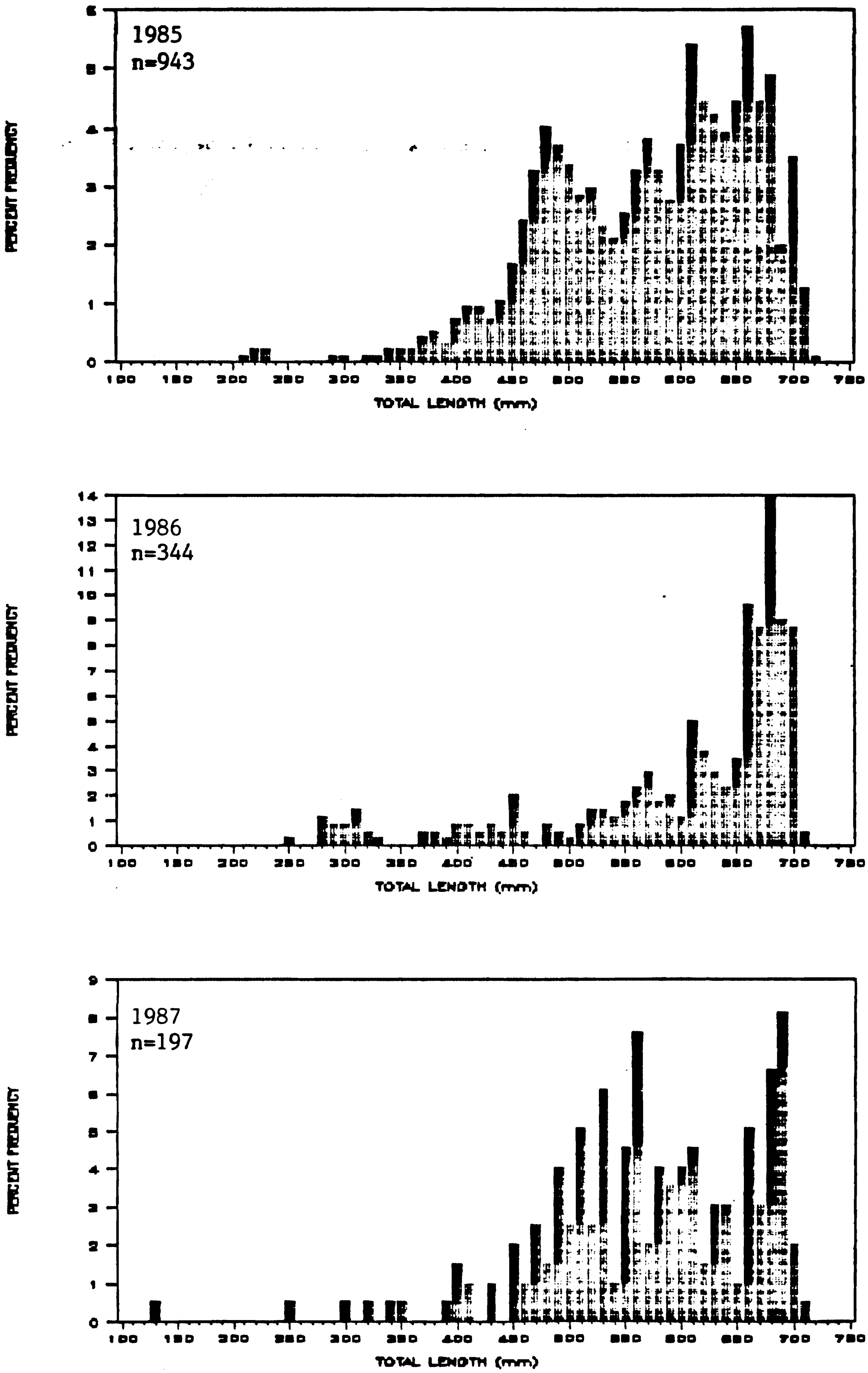



FIGURE 188. Size composition of released California barracuda from on-board observations of southern California commercial passenger fishing vessels. Size limit = 711 mm (28 in.).

by Los Angeles County CPFV anglers than were kept by San Diego County anglers. Barracuda catches dropped considerably north of Los Angeles County (Table 51).

Size Composition

Southern California. Annual mean lengths of kept barracuda for southern California rose from 738 ± 56 mm (29.1 ± 2.2 in.) in 1985 to 752 ± 43 mm (29.6 ± 1.7 in.) in 1987 (Figure 189). Modal size classes were 710 to 719 mm (28.0 to 28.3 in.) in 1985 and 720 to 729 mm (28.3 to 28.7 in.) in 1986 and 1987 (Figure 190).

The size composition of kept barracuda shifted towards larger fish from 1985 to 1987 (Figure 190). Kept barracuda measuring less than 711 mm (28.0 in.) decreased from 23% of the southern California barracuda landings in 1985 to 12% in 1987. From 1985 to 1987, kept barracuda measuring 711 to 759 mm (28.0 to 29.9 in.) and 760 to 809 mm (29.9 to 31.9 in.) increased from 48% to 52% and 20% to 27% of the southern California landings, respectively.

Modal size classes of released barracuda were 660 to 669 mm (26.0 to 26.3 in.) in 1985, 680 to 689 mm (26.8 to 27.1 in.) in 1986, and 690 to 699 mm (27.2 to 27.5 in.) in 1987 (Figure 188). In 1985 there seems to have been a strong year class of fish centered around 550 mm (21.7 in.), which, according to Schultze (1980), would be 2-year-old fish. A portion of this year class began to reach legal size in 1987 and probably contributed to the large increase in landings in 1987, and should continue to support landings in 1988 and 1989.

Unlike most of the other sport fish species with minimum size limits, there is a sizeable portion of kept barracuda that are clearly

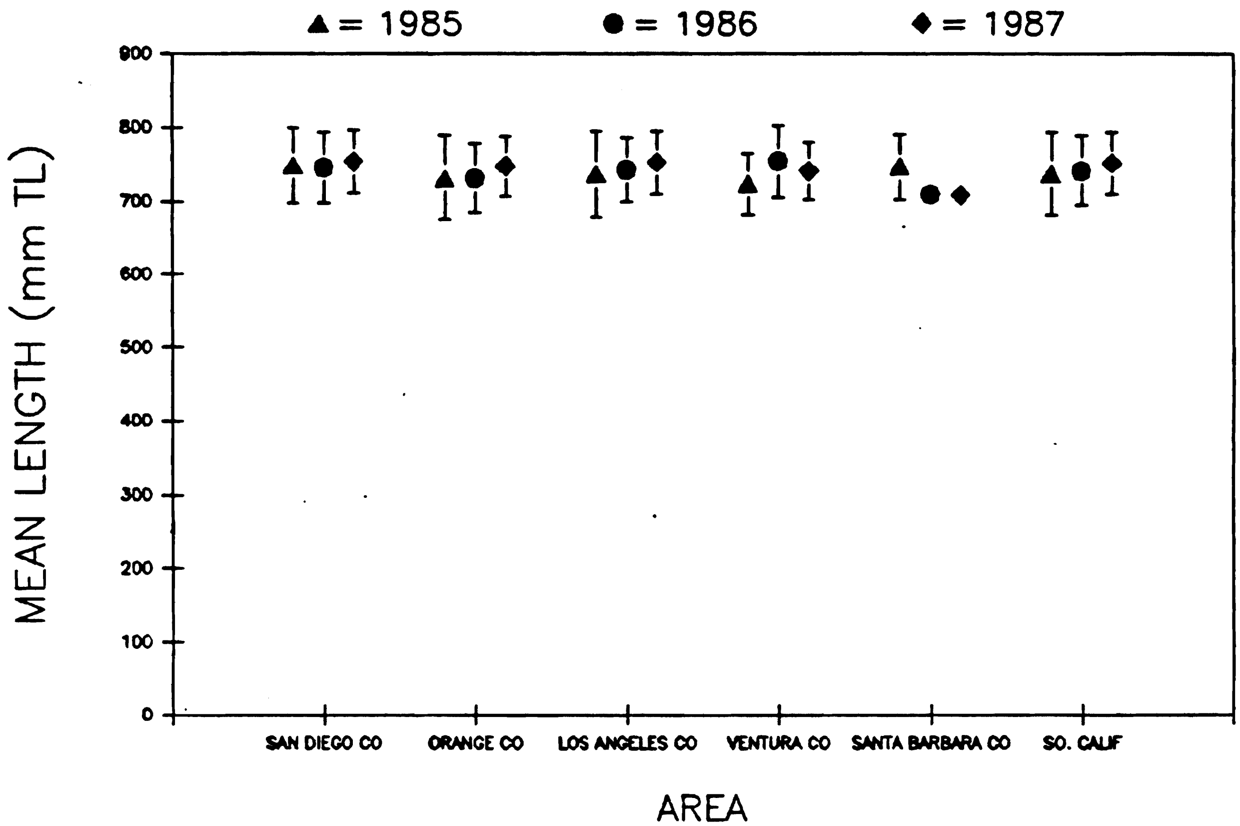



FIGURE 189. Mean lengths and standard deviations of kept California barracuda measured on board southern California commercial passenger fishing vessels. Size limit = 711 mm (28 in.).

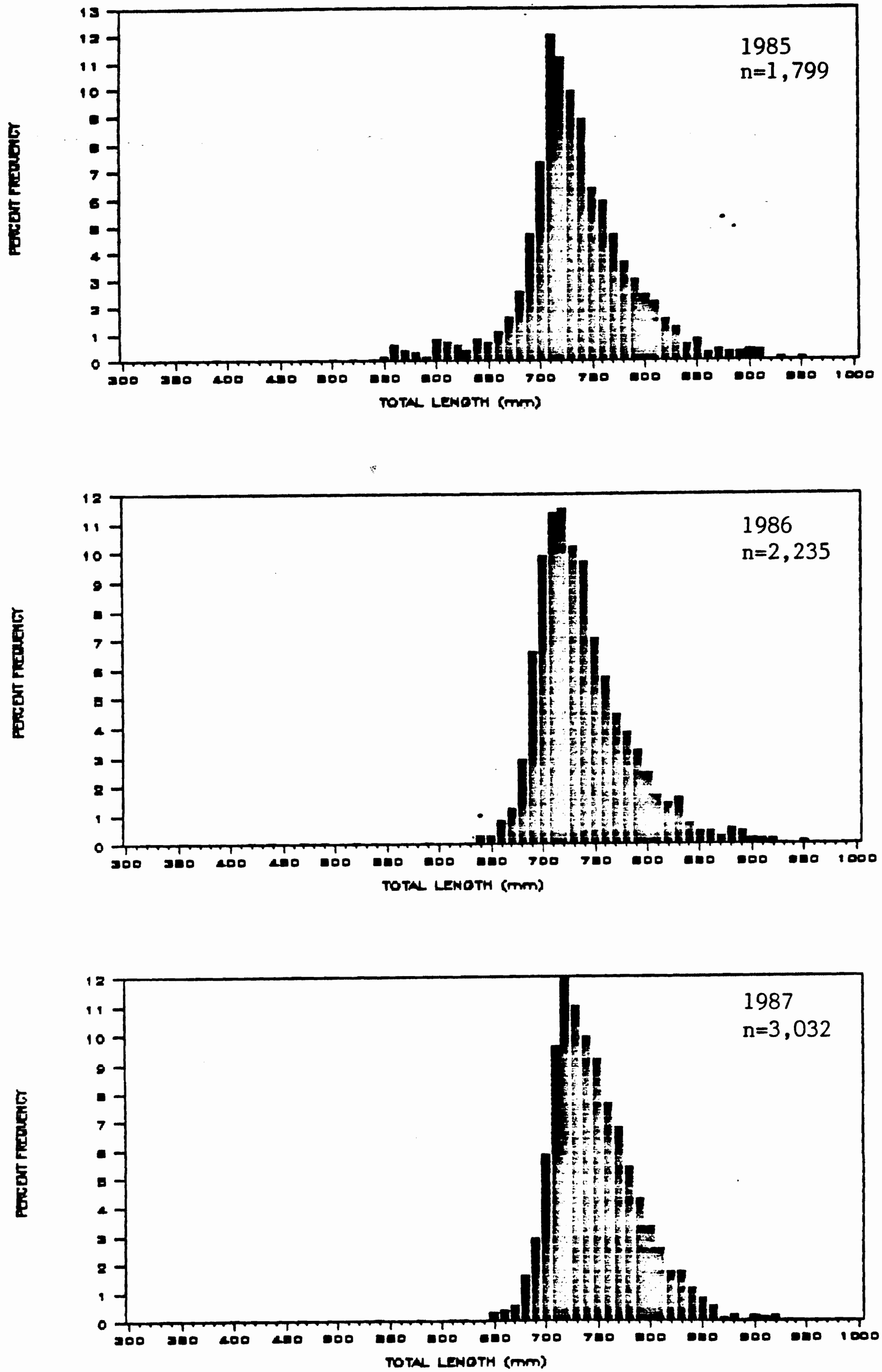



FIGURE 190. Size composition of kept California barracuda from on-board observations of southern California commercial passenger fishing vessels. Size limit = 711 mm (28 in.).

short. Kept barracuda measuring less than 700 mm (27.6 in.) accounted for 15% of the landings in 1985, 13% in 1986, and 6% in 1987. Although there seemed to be an improvement on the part of the angler to release undersize barracuda, it was probably due to good availability of legal fish and/or scarcity of short fish. We feel that when legal barracuda become scarce, and short fish more plentiful, high rates of short barracuda kept by CPFV anglers will return.

Counties. Mean lengths of kept barracuda were greatly affected by the amount of sublegal barracuda landed. In 1985 and 1987, kept barracuda from San Diego County had the largest mean length of any other southern California county (Figure 189), and the lowest incidence of sublegal barracuda landed with 13% and 11%, respectively. In 1986, kept barracuda from Ventura County had the largest mean length of any southern California county (Figure 189), and the lowest incidence of sublegal fish landed with 13%. The counties with the smallest mean lengths of barracuda also had the highest incidence of sublegal fish landed. In 1985 and 1987, kept barracuda from Ventura County had the lowest mean length of any southern California county (Figure 189), and the highest incidence of sublegal barracuda landed, 37% and 18%, respectively. In 1986 Orange County-caught barracuda had the shortest mean length (Figure 189) and the highest incidence of short fish landed (31%).

Length frequency analyses for kept barracuda by county exhibited similar patterns to one another (Figures 191 to 194). In all counties kept barracuda between 710 and 759 mm (28.0 and 29.9 in.) made up between 45% and 63% of the barracuda landings. Santa Barbara County did not have enough measured barracuda for analysis.

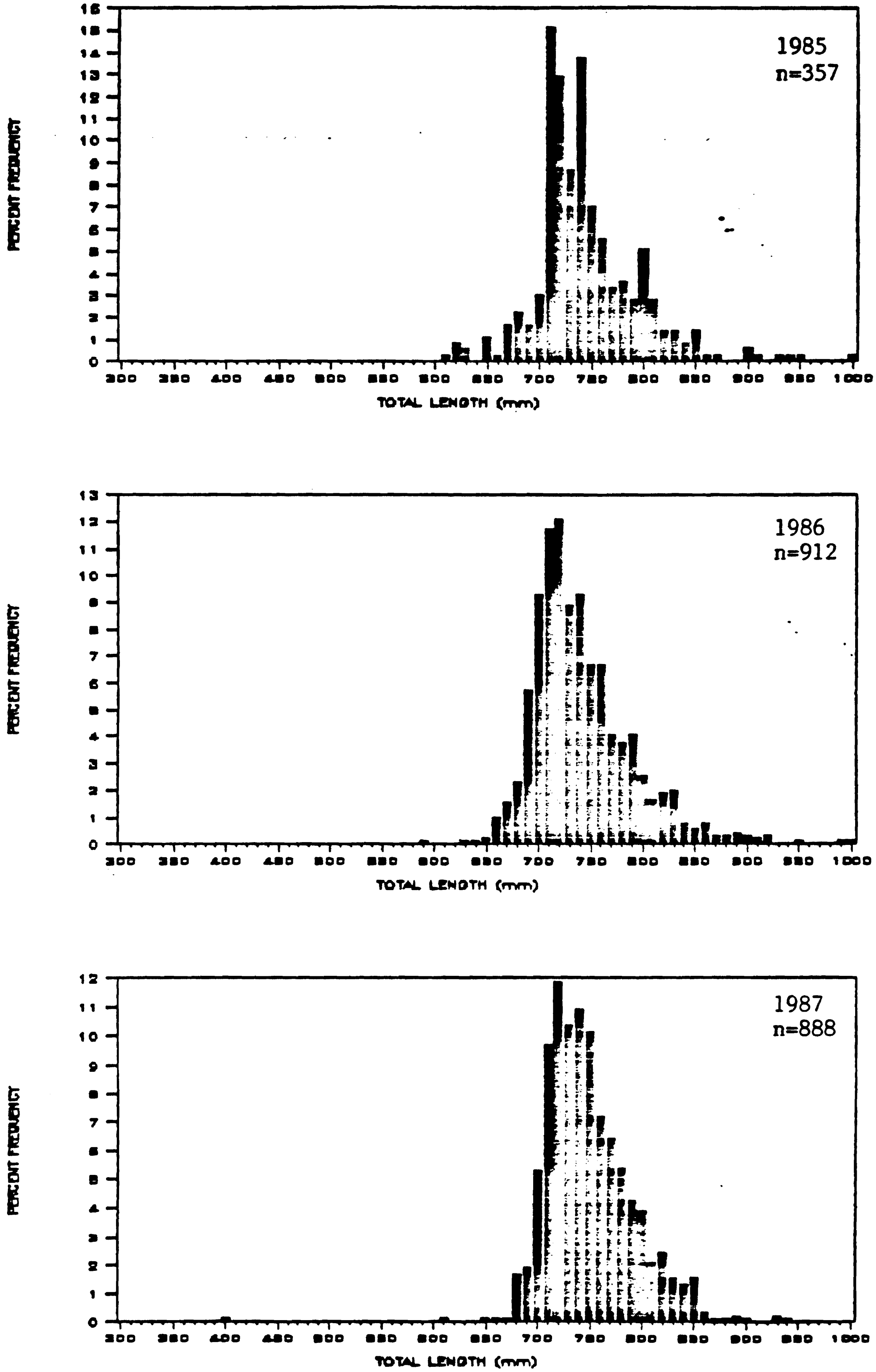



FIGURE 191. Size composition of kept California barracuda from on-board observations of San Diego County commercial passenger fishing vessels. Size limit = 711 mm (28 in.).

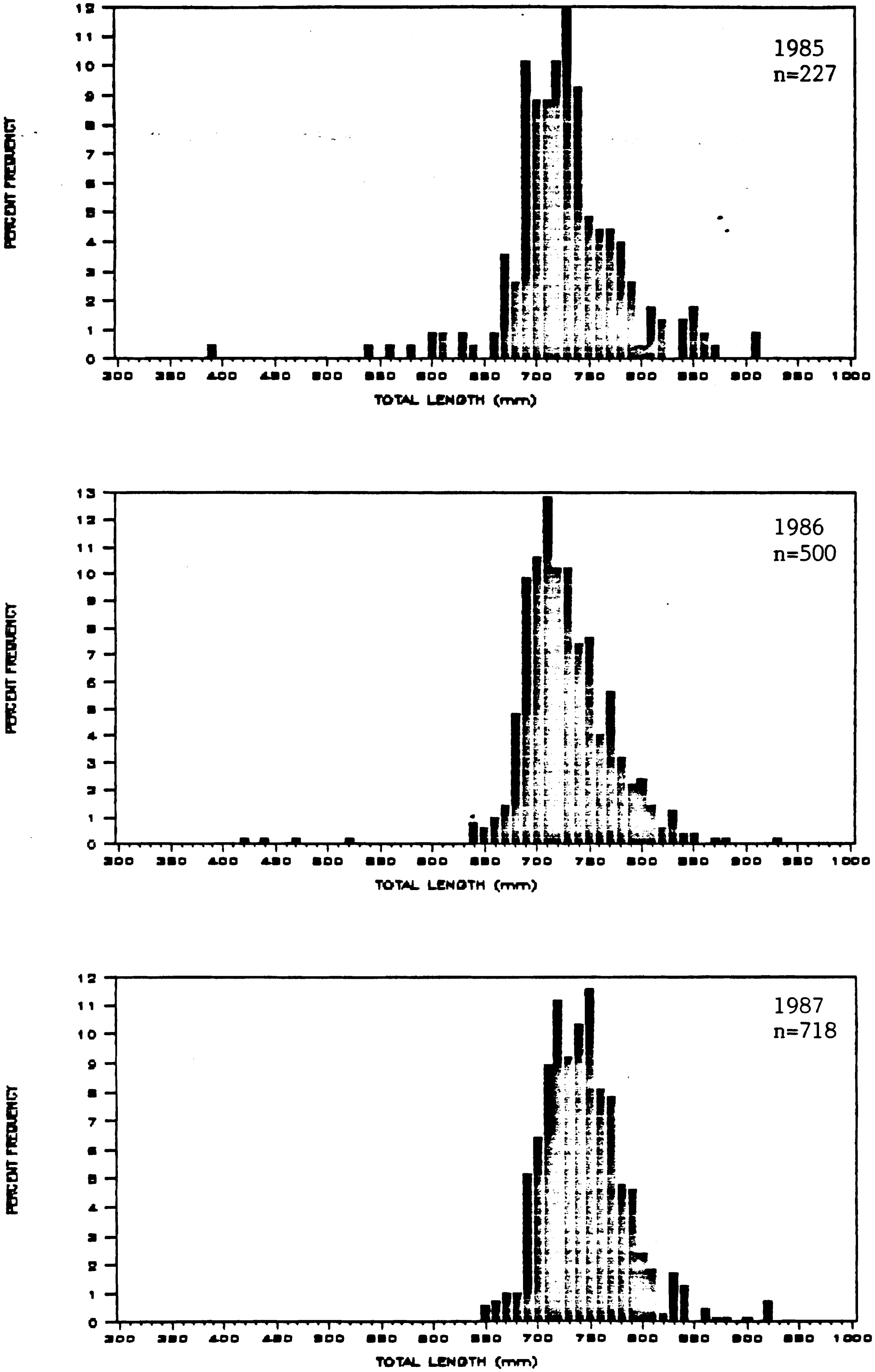



FIGURE 192. Size composition of kept California barracuda from on-board observations of Orange County commercial passenger fishing vessels. Size limit = 711 mm (28 in.).

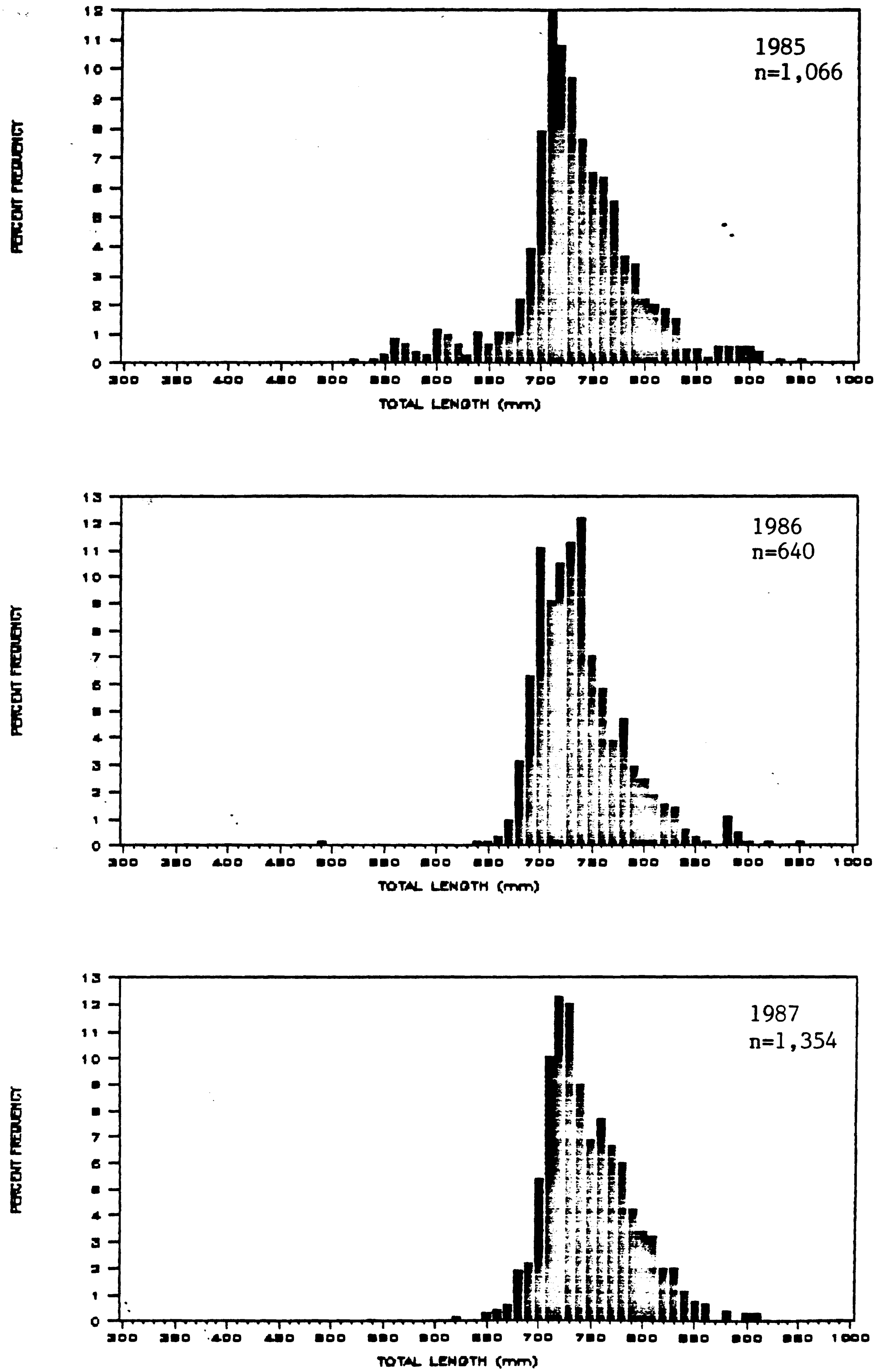



FIGURE 193. Size composition of kept California barracuda from on-board observations of Los Angeles County commercal passenger fishing vessels. Size limit = 711 mm (28 in.).

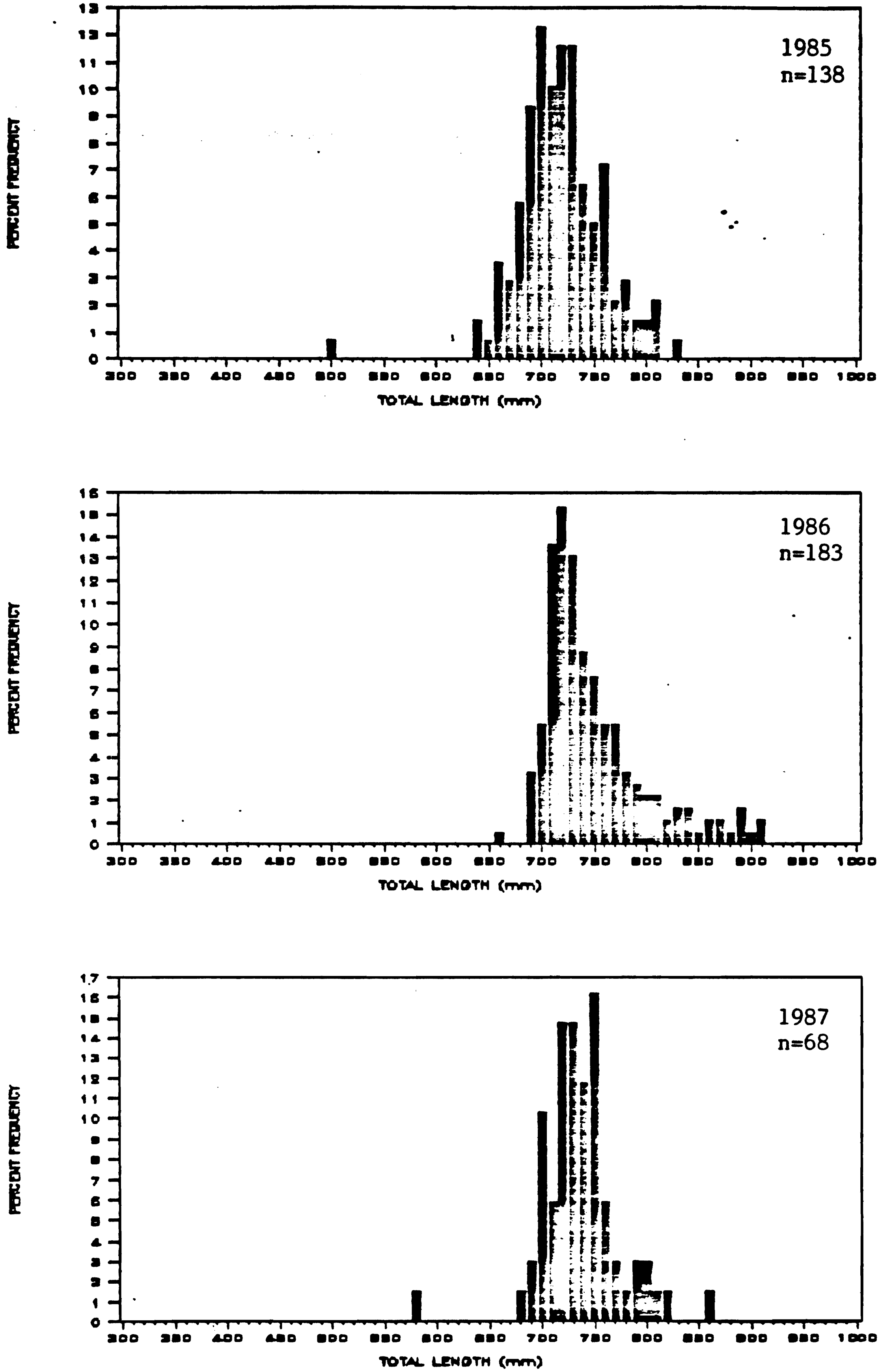



FIGURE 194. Size composition of kept California barracuda from on-board observations of Ventura County commercial passenger fishing vessels. Size limit = 711 mm (28 in.).

Management Recommendations

Because of uncontrollable factors such as migration, water temperature, and Mexico's management policies, DFG's management policies for barracuda probably have a limited effect on its population level. Landings increased from 1985 through 1987, and compared to the years immediately following implementation of the 1971 sport-caught barracuda regulation, they were well above average. However, we encountered high incidences of sublegal barracuda landings (over 30% in some counties), even though most CPFV anglers can identify barracuda and are aware of the minimum size limit. This high degree of disregard for the minimum size limit suggests that the species is very highly prized. Therefore, besides enforcement of the size limit regulation, we need to find a means of conveying to anglers the dangers to the barracuda resource of retaining sublegal fish. Otherwise, the resource will suffer. Also, educating anglers on proper release techniques would probably decrease a suspected (from our observations) high mortality rate of released barracuda.

## CONCLUSION

Although there has been a moderate increase in total catch of combined fish species between this study and that of the mid-1970's, disturbing trends have also become evident. There have been sizeable increases in the catches of Pacific mackerel, kelp bass, barred sand bass, and barracuda. However, there has been a decline of more than 50% in the CPFV rockfish catches. Key catch species such as bocaccio, chilipepper, and olive rockfish, which comprised 71% of the mid-1970's estimated rockfish catch, accounted for a large portion of the decline, down to 39% of this study's rockfish catch.

Because of the sharp decline in rockfish catches, we have recommended that the current 15-rockfish bag limit regulation be reduced to a 10-rockfish bag limit, and that additional conservation measures be implemented on the commercial rockfish fishery. If these recommendations are implemented, but prove to be inadequate, we would have no option but to recommend even more stringent measures.

In order to measure potential changes in a fishery, however, it is necessary to have an effective monitoring program. Our survey was such a program, whose database could also be used to evaluate the effects of habitat modifications (artificial reefs, kelp restoration, etc.), assess oil and/or chemical spill events, and provide information in mitigating resource allocation disagreements. Thus, we strongly recommend that the program be reinstated as soon as funding permits, and at no less than the previous level of sampling, in order to acquire a long-term database. The time series would allow us to not only detect trends in fisheries, but would also give insights into the causative components (fishing mortality, predation, oceanic conditions, etc.) driving the fluctuations in populations. We further recommend that, if funding permits, weekend/holiday trips and chartered trips be sampled. This could greatly increase the level of confidence of the catch estimates, as well as that of the other parameters measured.

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