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Review of Fishery and Auxiliary Data for Chilipepper rockfish in the Eureka/Conception/Monterey INPFC Areas:

a Qualitative Assessment of the Status of the Stock in 1992

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Abstract

A qualitative assessment of the stock of chilipepper (Sebastes goodei) indicates that the present Allowable Biological Catch (ABC) of 3,600 mt should be maintained until a quantitative assessment is completed in 1993. Estimated landings have risen in recent years, with 1991 landings exceeding the ABC by about 300 mt. These landings have come primarily from the trawl fishery, but the combined landings from three other fisheries have been substantial since 1984. Length and age frequencies indicated a strong 1984 year class, which entered the trawl fishery in large numbers in 1987, the recreational fishery in 1986, and the hook-and-line and set-net fisheries in 1988. This strong year class will likely influence the fisheries through 1992-1993. Auxiliary data, including biomass indexes from the NOAA triennial cruises and effort data from the recreational fishery, indicated that the stock was stable or increasing at least until 1989. In preparation for the 1993 quantitative assessment, life history parameters for chilipepper were developed.

Introduction

Chilipepper (Sebastes goodei) is a significant component of the California mixed-rockfish fishery. Since 1985, chilipepper trawl landings have exceeded those for bocaccio (Sebastes paucispinis), an important species with which it is often caught (Bence and Rogers 1992). The chilipepper stock is concentrated between Point Conception and Bodega Bay, California (Pearson 1991), so it is not important in fisheries operating north of California.

The most recent assessment for chilipepper was done in 1986 (Henry 1986). That assessment indicated that the stock was moderately exploited and provided no evidence that fishing mortality levels had been increasing over time. The assessment treated landings as coming from a single fishery and used only trawl age-composition data. Since that assessment, the hook-and-line/ long-line and set-net fisheries have increased in relative importance, and there have been substantial revisions in estimates of landings. Furthermore, auxiliary information in the form of an effort time series from the recreational fishery and an index of abundance for NMFS research surveys are now available.

In this document, we present and review the available age-composition, length-composition, landings, auxiliary, and life history data. Our primary objective was to provide a qualitative assessment of the current status of the chilipepper stock in the Conception/Monterey/Eureka INPFC areas. A secondary objective was to lay the groundwork for a quantitative assessment of the stock using the stock-synthesis program (Methot 1989 and 1990), a task we expect to complete during the next year.

Landings

Total estimated landings of chilipepper have varied considerably since 1980 (Figure 1). The landings have been somewhat cyclical since 1982, with estimated landings progressively increasing 1982-1985, decreasing 1985-1987 and increasing again 1987-1991 (Figure 1). The 1991 estimated landings of 3905 mt were higher than the landings in any other year since 1980. A high percentage of the landings came from the trawl fishery in all the years considered, but after 1984 combined landings from the other fisheries were substantial (Figure 1). All the landings were estimated following procedures outlined in Bence and Rogers (1992).

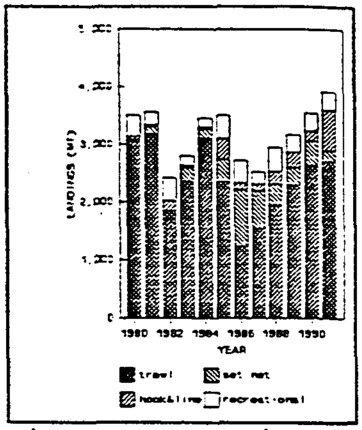

Figure 1. Estimated chilipepper landings.

We estimated that most of the trawl-caught chilipepper were landed in the Monterey area each year (Table 1). By-catch of chilipepper from the offshore Pacific hake (Merluccius productus) fishery, as reported by observers on the vessels (Methot and Dorn pers.comm.), are also given in Table 1. The by-catch in 1991 was significant, coming from a relatively few tows in the Monterey area.

Table 1. Estimated trawl landings of chilipepper for the Conception (C), Monterey (M), and Eureka (E) areas; combined with by-catch from the Pacific hake fishery.

	TRAWL (MT)			BY-CATCH (MT)	TOTAL(MT)
YEAR	C	M	E		
1980	327	2698	27		3053
1981	411	2536	241		3189
1982	346	1301	197		1844
1983	275	1853	232		2360
1984	602	2352	155		3109
1985	256	1970	123		2349
1986	172	954	101	2	1229
1987	149	1307	80	1	1537
1988	337	1523	92	2	1954
1989	440	1756	97	4	2297
1990	379	2004	205	48	2636
1991	393	1619	168	522	2702

Estimated chilipepper set-net landings varied from almost none in 1983 to nearly 1000 MT in 1986 (Table 2). There were no set-net landings allowed in the Eureka area, and Monterey landings have exceeded Conception area landings since 1981.

Table 2. Estimated set net landings of chilipepper for the Conception (C), Monterey (M), and Eureka (E) areas.

YEAR	C	M	E	TOTAL
1980	33	6	0	39
1981	100	19	0	119
1982	0	6	0	6
1983	8	227	0	235
1984	12	152	0	165
1985	45	354	0	399
1986	205	775	0	980
1987	252	405	0	657
1988	107	251	0	358
1989	71	228	0	299
1990	114	313	0	426
1991	26	160	0	186

The hook-and-line/long-line fishery landings were usually below 100 MT before 1985 and varied from 157 to 415 MT from 1985 through 1990 (Table 3).

Table 3. Estimated hook caught landings of chilipepper for the Conception (C), Monterey (M), and Eureka (E) areas.

YEAR	C	M	E	TOTAL
1980	43	13	2	58
1981	31	1	0	32
1982	124	49	11	184
1983	30	14	1	45
1984	22	6	0	28
1985	231	104	28	363
1986	34	79	12	125
1987	30	78	13	121
1988	64	133	21	218
1989	91	150	27	268
1990	39	109	22	170
1991	270	381	58	709

Recreational catch of chilipepper has varied from about 150 to 400 mt (Table 4). Recreational landings in 1990 and 1991 were assumed to be the same as the estimated value for 1989. Landings for the recreational fishery for 1980-1989 were obtained in a database from John Witzig (NMFS, Washington D.C.).

Table 4. Estimated recreational catch of chilipepper for Southern and Northern California.

Year	Total
1980	354
1981	220
1982	392
1983	163
1984	157
1985	391
1986	392
1987	206
1988	415
1989	308

Length and Age Frequencies

The length and age frequencies, supplemented by length-at-age data, showed evidence of a strong 1984 year class. All length and age frequencies (Figures 2-7) are presented at the end of this document. The 1987 trawl fishery length frequencies indicated a high percentage of small fish (Figure 2). This group was associated with a distinctive mode in total length (tl), particularly for the females (30-32 cm). This mode could be traced moving to progressively larger sizes in 1988-1991 (Figure 2). The age frequencies indicated that this was the 1984 year class, since there was a high percentage of three year old fish in 1987 and four year old fish in 1988 (Figure 3). The trawl length-at-age data for 1987 confirmed the relation, with a mean tl of 32.6 cm for three year old females. If the 1984 year class follows the pattern of the strong 1975 year class evident in the age frequencies (Figure 3), it would be expected to have a large influence on the trawl fishery only until age 8 or 9 (1992 or 1993).

The 1984 year class evidently entered the other fisheries/cruise at ages 2 or 4 rather than age 3. Evidence of the strong year class was less distinct in the other data sources, but in 1988 there appeared to be a substantial group entering the set-net (female mode 36 cm tl) (Figure 4) and hook-and-line fisheries (female mode 38 cm tl) (Figure 5). The trawl length-at-age data for 1988 had a mean size of 36 cm for four-year-old females. The recreational data was not separated by sex, so year classes were blurred (Figure 6). There was, however, some sign of a shift to younger fish which began in 1986 and a strong mode at progressively larger sizes in the following years. The 1986 triennial cruise data showed the capture of a large group of young fish, with a mode of 26-28 cm tl for females (Figure 7). This is likely the 1984 year class, although they are larger than expected for two-year-old fish based on length-at-age data from the 1977 triennial cruise.

As evidenced by the various years in which the 1984 year class was evident in the different sources of data, the selectivities varied to an extent depending upon the type of fishery/cruise. The recreational fishery and the triennial cruises caught a higher percentage of small fish (20-30 cm tl) than did the trawl, hook and line, and set net fisheries (Figures 6 and 7 versus Figures 2,4 and 5), a pattern that was also evident in our analysis of bocaccio data (Bence and Rogers 1992). The set-net fishery caught a higher percentage of larger fish (> 40 cm tl) than did the trawl for a given year (Figure 2 versus Figure 4). This was also true for the hook-and-line fishery in the years prior to 1990 (Figure 2 versus Figure 5). Hook-and-line length frequencies were based on a smaller number of fish than those for the other fisheries, and so were less smooth. In all cases where data were separated by sex, the female lengths tended to have a wider range than did the males, and the average female caught was generally larger than the average male.

Auxiliary Data

The triennial survey abundance indexes and the recreational CPUE estimates indicated that the chilipepper stock remained stable 1980-1987 and may have increased 1988-1989 (Table 5), perhaps due the large 1984 year class. The estimated abundance based on the 1989 triennial cruise was considerably higher than the previous surveys. The CPUE for the recreational fishery also increased substantially in 1988 and 1989.

Table 5. Available auxiliary data regarding the chilipepper stock for the period 1980-1991.

YEAR	RECREATIONAL (CPUE)	TRIENNIAL INDEX (SE)
1980	0.35	10362 (5137)
1981	0.68	
1982	0.34	
1983	0.28	9399 (4399)
1984	0.27	
1985	0.56	
1986	0.45	10911 (2544)
1987	0.45	
1988	1.00	
1989	1.41	16615 (4969)

Life History Parameters

Our primary goal in developing the life history parameters was to lay the groundwork for a quantitative assessment of chilipepper using the stock-synthesis model or a related approach. In practice, the synthesis model, like all catch-at-age methods, requires an a-priori estimate of natural mortality. Since we will be using the size-based version of the synthesis model, we also need relations between mean length and age, coefficient of variation in length-at-age and age, and length and weight. The first two relations allow the synthesis model, given an estimate of the population numbers at age, to generate estimates of the population numbers at length. The third relation allows the model to translate catches in terms of numbers at length into biomass, which can be compared to observed landings. Additional relations between the proportion of the female population that is mature and length, and mass-specific fecundity and weight, although not required for the modeling, are useful in judging the current status of the stock. They allow the model's estimate of the stock-composition in terms of size and age to be translated into total spawning potential, where the spawning capacity of the stock is defined as the total number of eggs carried by the female population.

Although natural mortality can not be precisely estimated, a range of 0.15 to 0.20 seems reasonable. A natural mortality of 0.20 was suggested for chilipepper by Henry (1986) on the basis of a maximum age of 29 years, a von Bertalanffy k factor of 0.18, the proportion of very old fish in the population, and values for other rockfish. The other end of our range is closer to 0.13, which was the total mortality rate (Z) predicted using Hoenig's (1983) relation between Z and the maximum age (35 years) found when considering a substantial number of trawl samples.

The synthesis model has the ability to estimate a growth model internally, making use of length-at-age data. We explored the relation between length and age using a broader range of data than we could use in the model, as a method of obtaining starting values and reasonable ranges for the parameters. Growth curves for each sex were derived by fitting a form of the von Bertalanffy equation proposed by Schnute and Fournier (1980) using non-linear regression. This equation was:

$$Length_{age}=L_A+(L_M-L_A)\,\frac{(1-e^{(-k(age-A))})}{(1-e^{(-k(M-A))})}$$

where the estimated parameters are k, and L_A and L_M, representing expected mean total lengths at two ages (A<M). We used age 1 for

A and age 14 for M. Age 14 was chosen for M rather the maximum age in the samples because it produced lower mean square errors and correlations between parameters. Cerrato (1991) found that nonlinearity of the model; which generally results in biased, nonnormal parameter estimates; is greatly reduced when using an intermediate rather than maximum age for M. The resulting equations provided a good fit to the data (Figure 8).

After fitting the equation, lengths at infinite ages were calculated:

$$L_{\infty}=L_A-(L_A-L_M)\,e^{(k(1-M))}$$

The resulting values which could serve as initial values for the parameters in the synthesis model were:

♀ L_{∞}=52 cm, k=-0.20, L_1=17.4 cm
♂ L_{∞}=39 cm, k=-0.28, L_1=18.4 cm.

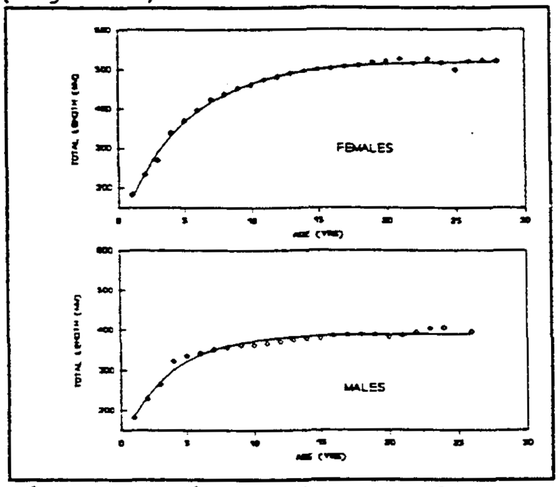

Figure 8. Fit of the growth curve

Each mean used to fit the von Bertalanffy equations was derived from samples of greater than ten fish, which came from a triennial cruise for ages 1-5 and from the trawl fishery for ages greater than five. These were selected from the available data (Figure 9) as being most representative of the population. The trawl data were from 1980-1988, the triennial data from 1977, and the sport fishery data from fish caught on party boats 1980-1984. The triennial cruise data were used for the younger ages because they provided the only available information for age 1 and the fish were collected using a smaller mesh size, decreasing the probability of selecting only the larger fish for a given

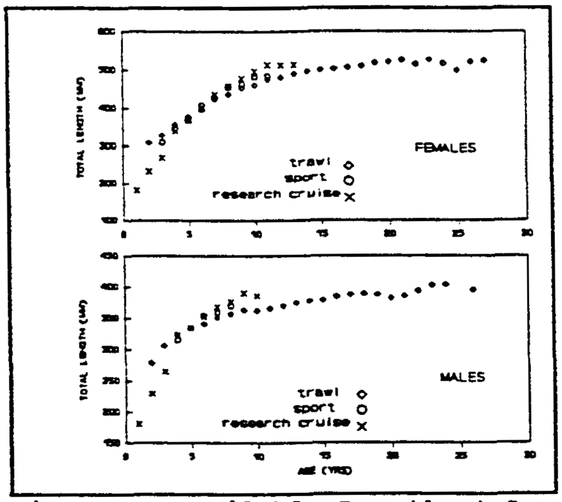

Figure 9. Available Length at Age Data.

age. The trawl fishery data were used for the larger ages because they were based on samples from a wider range of years, including more recent data, and were all that were available for ages greater than 15. The sport data were not used because they spanned only a few ages and the selectivity was unknown. The reason for the larger size at age in the sport and triennial data versus the trawl data for ages of about 7-15 years may be due to year effects or to different ageing methods (break-and-burn for the trawl 1982-1988 versus surface for the other years and data sources). The trawl data indicated that fish about 7-15 years in 1980 and 1981 were a larger size at age than in the subsequent years.

The linear regressions describing the relations between coefficient of variations in length at age (CV) and increasing age for each sex were fit to CV from samples of greater than 10 fish at age from the trawl fishery, using ages 3-21 (Figure 10). These data were selected because cv's from other ages or from the triennial cruise in 1977 were widely scattered, and we were primarily concerned with the ages in the range chosen. The resulting regressions, significant at $p<0.05$, were:

$$cv♀_{age} = 9.090 - 0.238 * age$$

$$cv♂_{age} = 8.285 - 0.207 * age$$

Estimates of CV for the minimum and maximum ages used in the model will be derived using those equations.

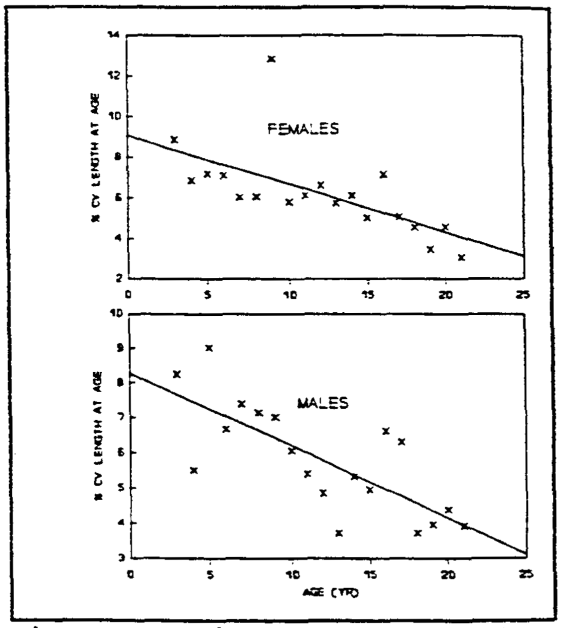

Figure 10. Fit to CV Trawl Data

Phillips (1964) gave parameters for a length-weight exponential equation, which we converted to predict weight in kg from total length in cm.

Parameters from an equation relating the proportion of females mature as a function of age were taken from Echeveria (1987), who estimated 50% maturity at 34 cm.

The relation between the mass specific fecundity and weight of the female fish (kg) was described by fitting a linear regression to derived data (Figure 11). The data were derived using information presented by Phillips (1964) on the number of eggs in female chilipepper of different lengths. We converted the lengths to weights using the regression supplied in the same paper. The regression fit to the derived data ($p<0.05$) was:

$$\frac{million\ eggs}{kg}=0.0926+0.0428*kg$$

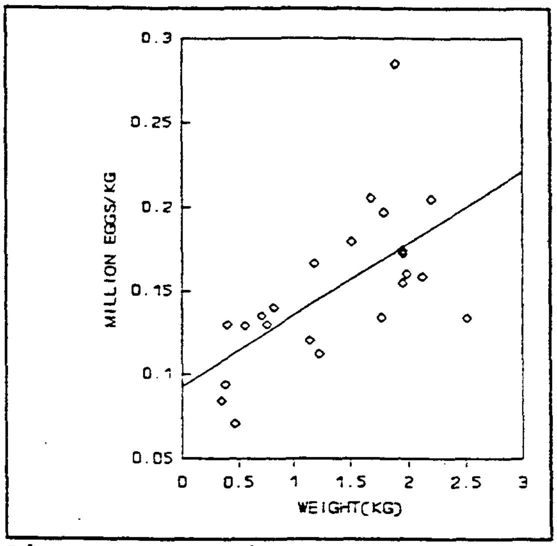

Figure 11. Fit to data from Phillips (1964).

Conclusions

The chilipepper stock, at least through 1989, appeared to be stable or increasing. The increase in landings since 1987 could be supported by the presence of a strong 1984 year class. The last strong year class (1975) apparently remained dominant in the trawl fishery until it was 8-9 years old. If this holds true for the 1984 year class, it would be expected to influence the trawl fishery in 1992-1993, but to a lesser extent than in recent years. The present ABC of 3,600 mt is less than the estimated 1991 landings of 3,905 mt. Without evidence of more recent strong year class entering the fishery, raising the ABC would not be justified in 1992. We recommend the keeping the ABC at the present level until a quantitative assessment is done in 1993.

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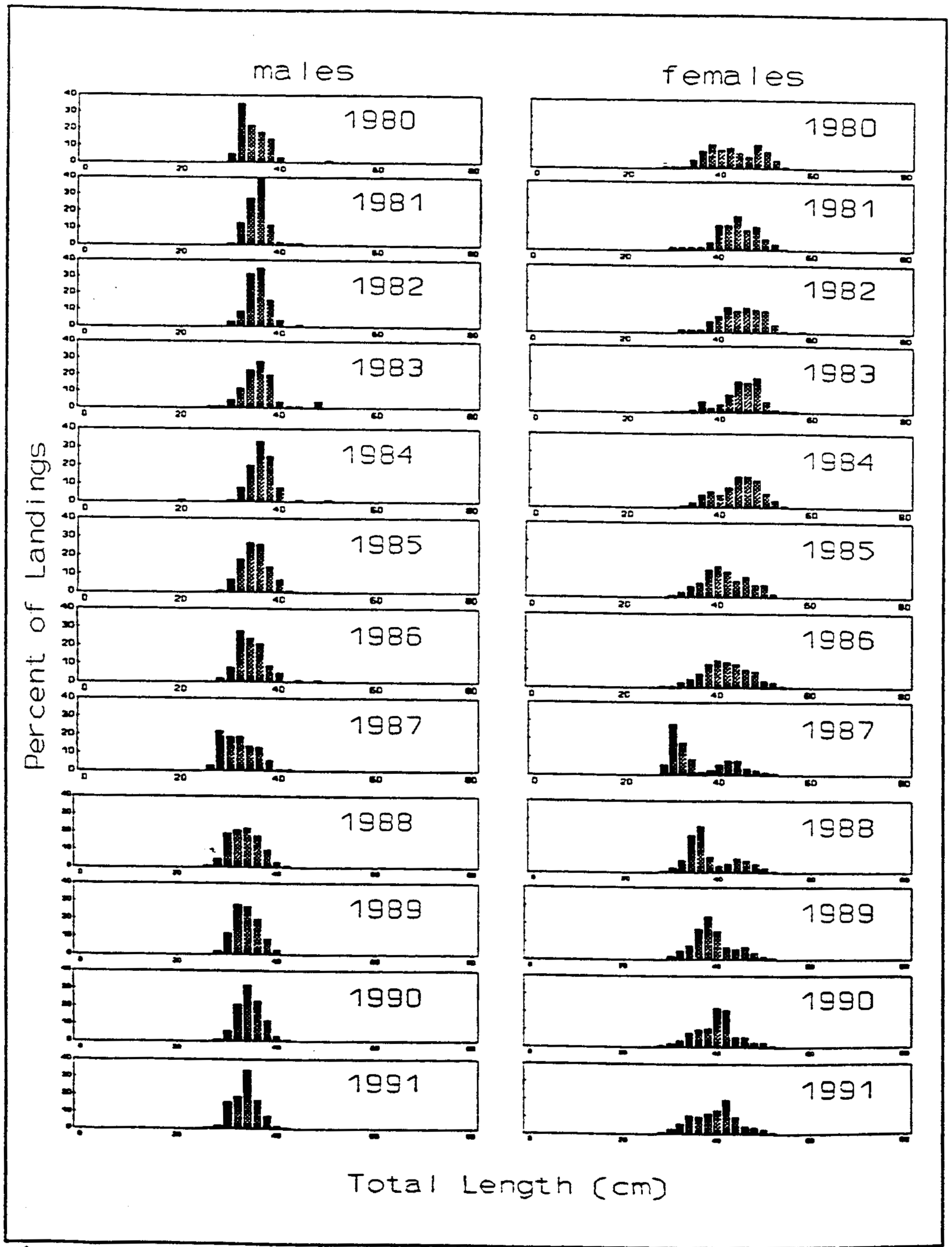

Figure 2. Length composition data for chilipepper based on samples from the California trawl fishery landings.

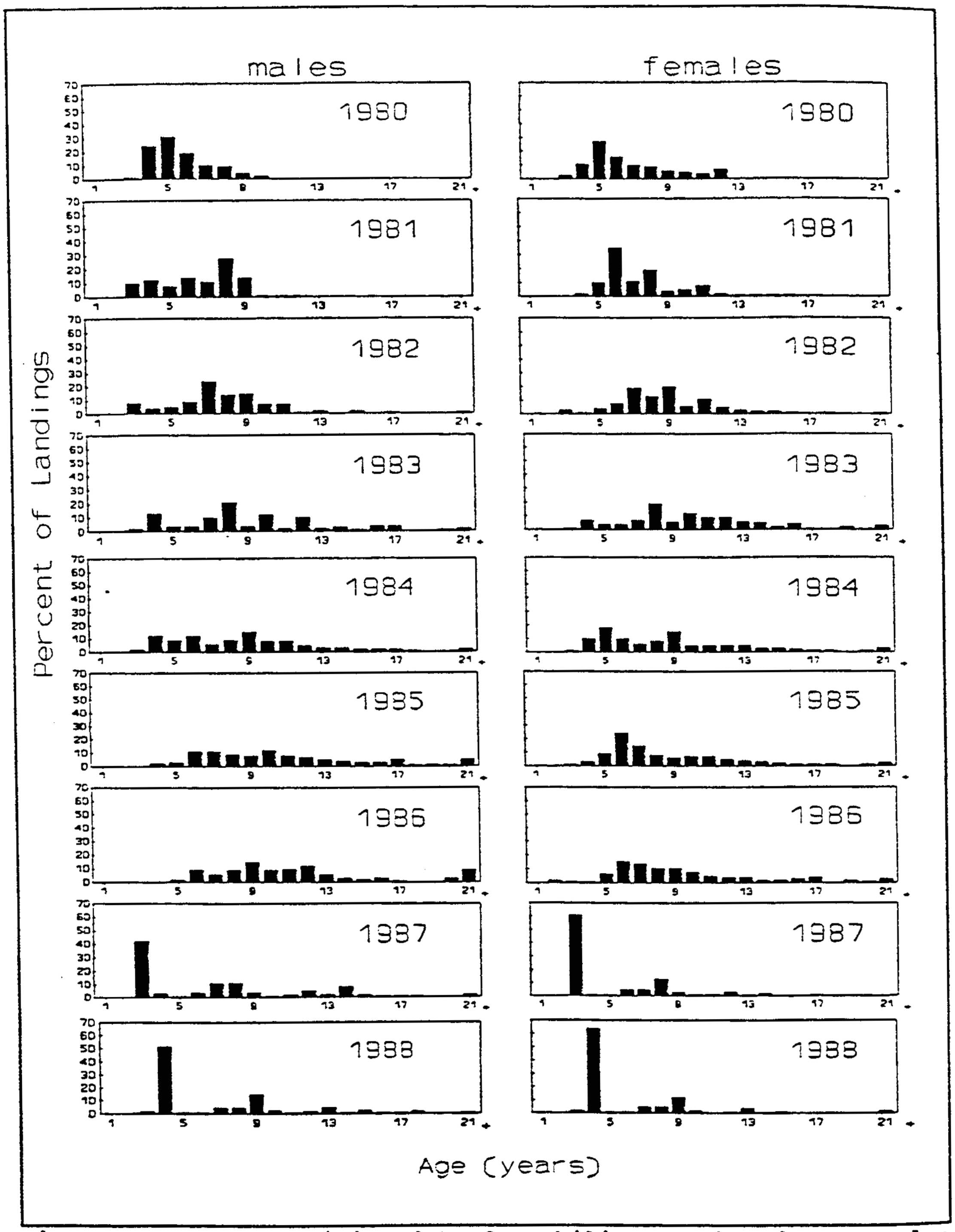

Figure 3. Age composition data for chilipepper based on samples from the California trawl fishery landings.

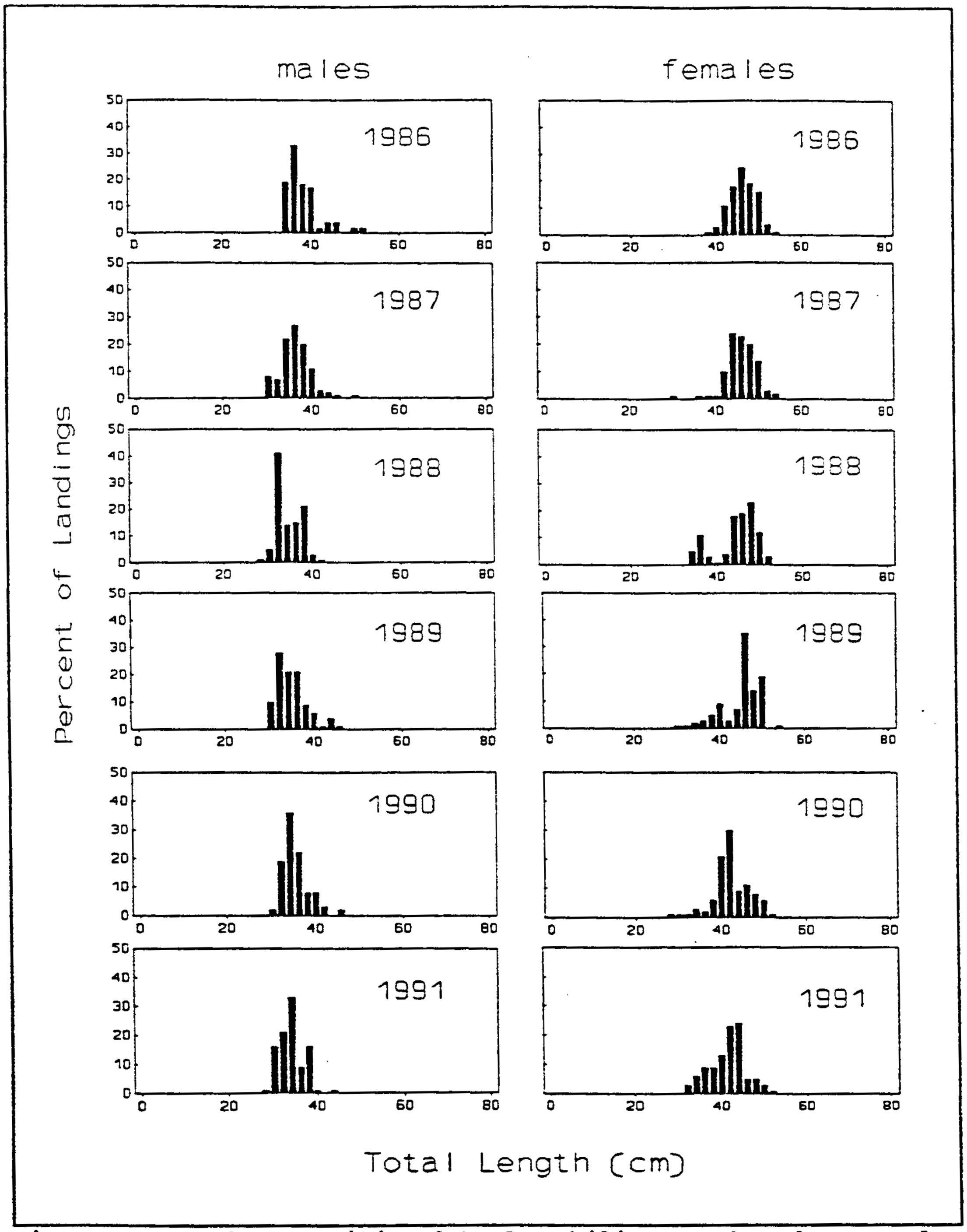

Figure 4. Length composition data for chilipepper based on samples from the California set-net fishery landings.

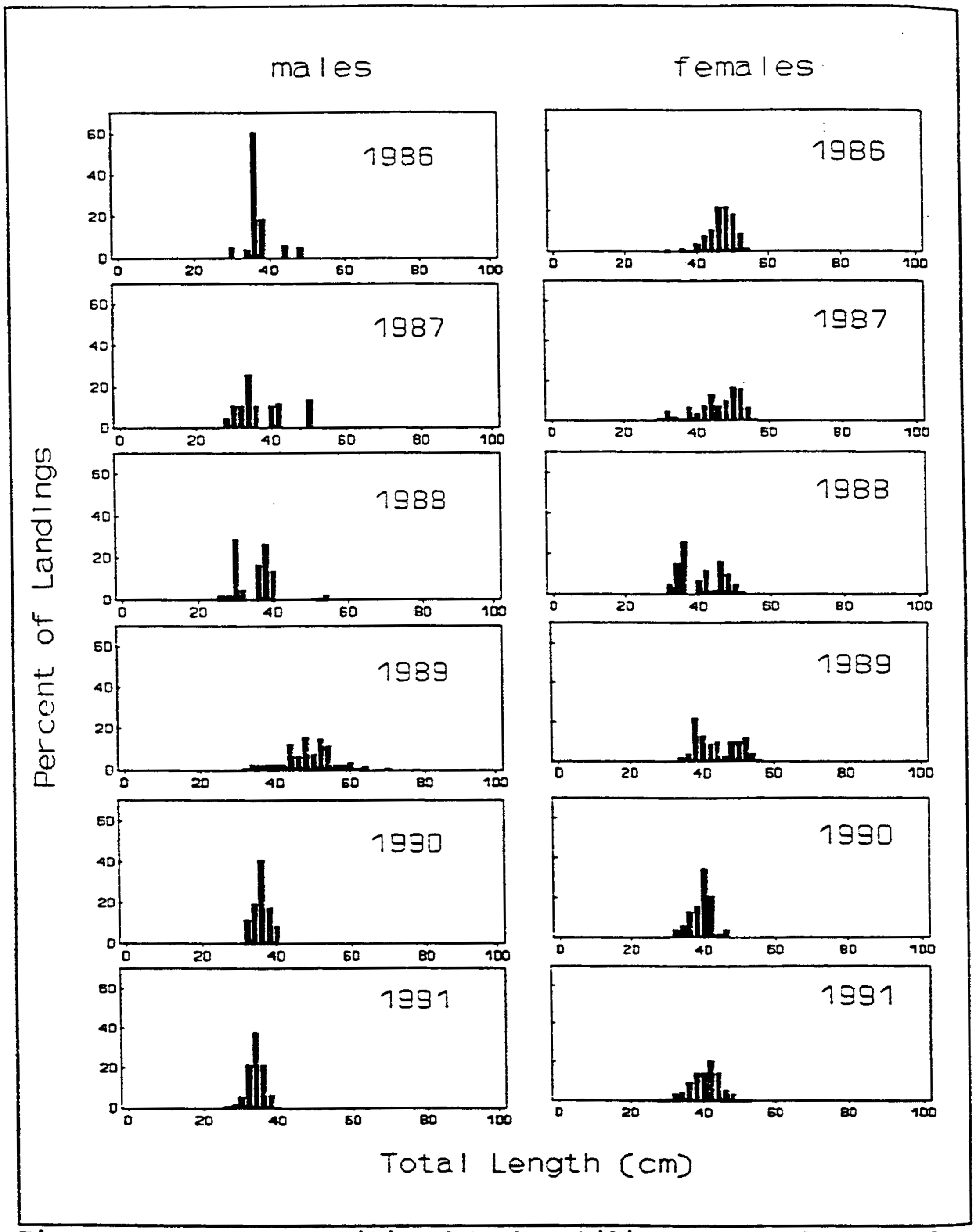

Figure 5. Length composition data for chilipepper based on samples from the California hook and line fishery.

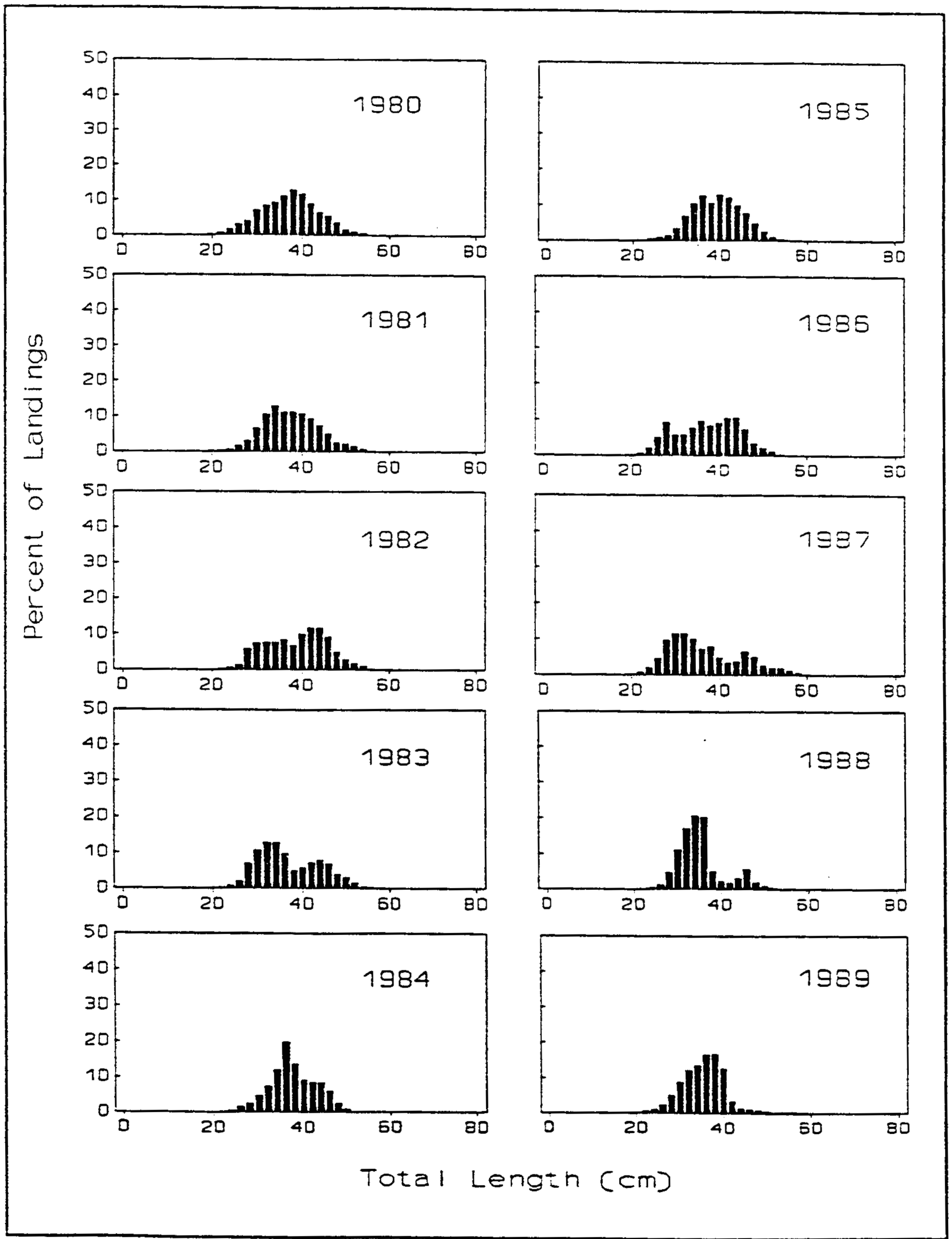

Figure 6. Length composition data for chilipepper based on samples from the California recreational fishery landings.

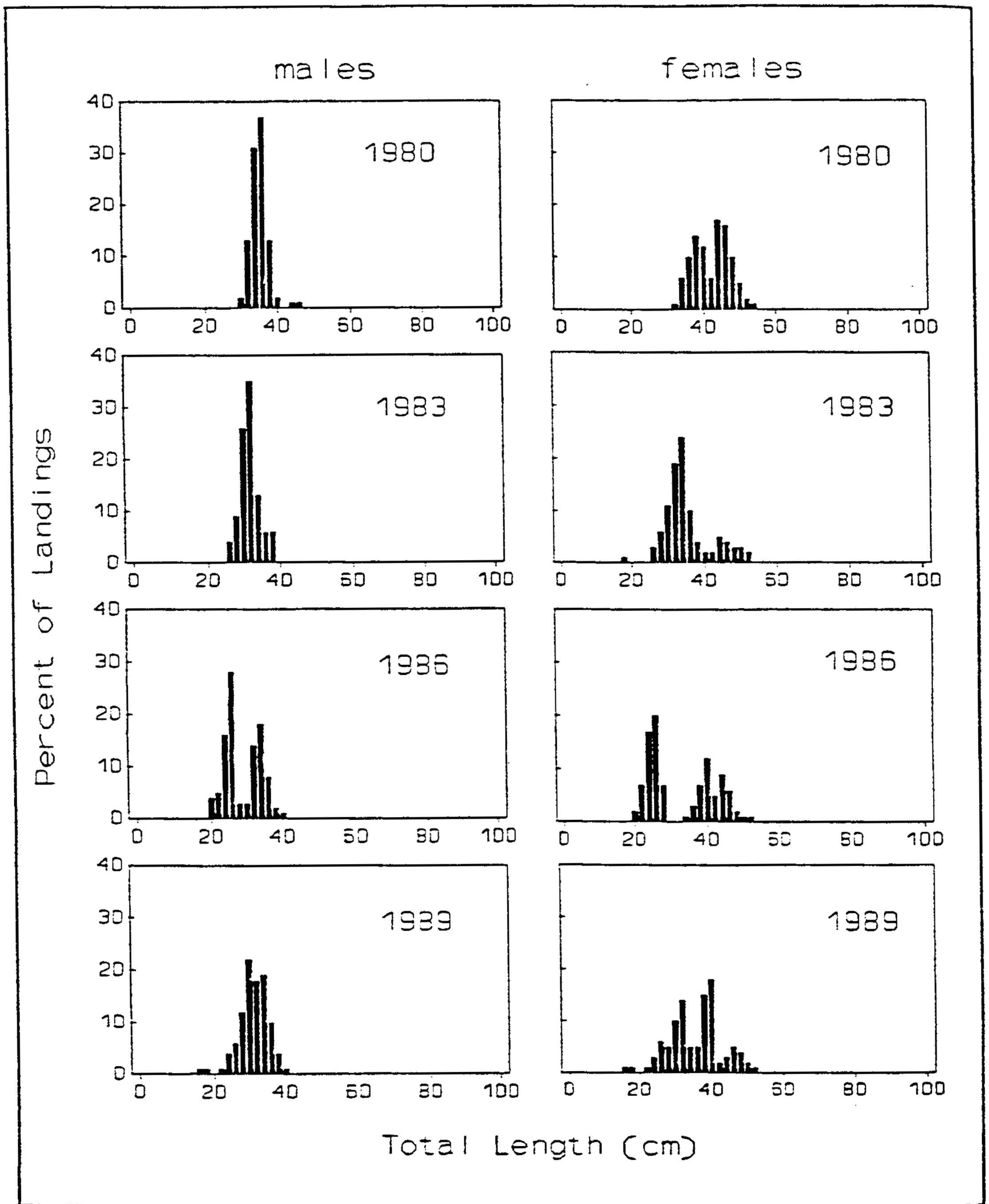

Figure 7. Length composition data for chilipepper based on samples from the NMFS triennial bottom trawl surveys.