STATUS OF THE CHILIPEPPER ROCKFISH STOCK IN 1998

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Appendix to

STATUS OF THE PACIFIC COAST GROUNDFISH FISHERY
THROUGH 1998 AND RECOMMENDED ACCEPTABLE
BIOLOGICAL CATCHES FOR 1999

STOCK ASSESSMENT AND FISHERY EVALUATION

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Executive Summary

The west coast population of chilipepper rockfish (*Sebastes goodei*) in the combined Eureka, Monterey, and Conception areas of the International North Pacific Fishery Commission (INPFC) was assessed using the stock synthesis length-based model. Four distinct fisheries were explicitly treated, including: (1) the trawl fishery, (2) the setnet fishery, (3) the hook-and-line fishery, and (4) the recreational fishery. Landings, age, length, and length-at-age data from these four fisheries were supplemented with three survey indices, which included a catch-per-unit-effort index from the Alaska Fisheries Science Center's triennial west coast shelf survey, a catch-per-unit-effort index derived from the California commercial trawl logbook data base, and a research time series of age-1 pre-recruit abundance. Selectivity patterns changed over time, but were linked among the four fisheries, i.e., they shared a common temporal effect.

Status of Stock: The chilipepper stock is at a moderate level of biomass and is not believed to be overfished. Stock biomass declined from ~55,000 mt during the 1970's to ~35,000 mt in the mid-1990's. Biomass was at an historic high of 58,500 mt in 1974 but has since decreased by about 45% to 32,000 mt in 1998. This decrease was temporarily offset by a very strong 1984 year-class as it passed through the fishery. The combined fisheries exploitation rate (i.e., total catch as a percentage of available biomass) hit a low of 4.2% in 1970 and peaked at 19.8% in 1989. The combined exploitation rate has been below the target fishing mortality rate (~13% at $F_{40\%}$) since 1993.

Management Advice: Chilipepper is a relatively productive rockfish, with a sustainable harvest rate of 7 - 13% per year. Although stock biomass has been fished down from 1970-98, biomass actually increased from 1986-91 due to an exceptionally favorable recruitment event. Female spawning output is currently 46 - 61% of the virgin output. Given the current amount of spawning and recent trends in recruitment, a decrease in the harvest rate may be needed to maintain the productivity of the stock and the long-term viability of the fishery.

Catch and Status Table (Catch weights in thousands of metric tons and recruitment in millions of age-1 fish): Chilipepper rockfish (*Sebastes goodei*).

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Commercial Landings	2.2	2.9	2.9	3.2	2.4	2.2	1.8	2.0	1.8	1.4	1.4
Commercial Discards[1]	-	-	-	-	-	-	-	-	-	-	-
Recreational Landings	0.4	0.3	0.3	0.1	-	-	-	-	-	-	-
Recreational Discards[1]	-	-	-	-	-	-	-	-	-	-	-
Total Catch[2]	2.6	3.2	3.2	3.3	2.5	2.3	1.9	2.0	1.8	1.5	1.5
ABC[3]	3.6	3.6	3.6	3.6	3.6	3.6	4.0	4.0	4.0	4.0	3.4
Stock Biomass	35.6	37.3	37.7	38.3	38.1	36.8	36.4	34.4	35.3	33.3	32.0
Recruitment (Age 1)	33.9	41.0	35.0	20.6	33.5	13.7	48.5	12.1	19.4	10.8	22.7
Exploitation Rate	18%	20%	18%	16%	12%	8%	7%	9%	7%	6%	6%

[1]Assumed to be minimal. [2]Total catch used in the assessment. [3]Allowable biological catch.

Stock Distribution and Identification: Chilipepper range from Baja California to British Columbia and inhabit depths of 25 to 200 fathoms. Because the species has an extended pelagic larval phase (~150 d), spatial dispersal of larvae apparently links recruitment among areas. The chilipepper stock is defined here as the contiguous population off the coasts of Oregon and California and within the Conception, Monterey, and Eureka INPFC areas. This region represents the center of the chilipepper distribution.

Data and Assessment: The current assessment of the chilipepper stock covers the time period of 1970-98. Information sources to evaluate stock condition included commercial fishery length and age samples, commercial fishery logbook data, research survey data from a NMFS continental shelf bottom trawl survey, and a NMFS midwater trawl survey of pre-recruit abundance. Estimates of stock biomass and fishing mortality were derived with the length-based version of the stock synthesis model.

Catches: Total combined landings from the four chilipepper fisheries were relatively stable at 2,000 - 3,000 mt/yr from early in the 1970's until 1991. Since 1991 landings have declined steadily, such that the current harvest is ~1500 mt. Discards are believed to be minimal.

Stock Biomass: Stock biomass declined from about 50,000 mt in 1980 to roughly 32,000 mt in 1998. Biomass reached an historic low of 25,700 mt in 1986, but increased by ~50% to 38,300 mt in 1991. This increase was due to recruitment of the exceptionally strong 1984 year-class.

Fishing Mortality: Exploitation rate increased from a low of 4.2% in 1970 to a peak of 19.8% in 1989. Since then it has declined to 5.8% in 1998. Exploitation rates have been below the target (~13% at $F_{40\%}$) since 1993.

Recruitment: Chilipepper recruitment varied without obvious trend in the 1970's. In the early 1980's recruitment was low, but was more than offset by a very strong 1984 year-class. Recruitment was good and fairly stable from 1986-94, but has been poor in more recent years. The extreme variability in chilipepper recruitments, reflected in the potential offered by years like 1984, make it difficult to predict reproductive success.

Biological Reference Points: Based on new life history information on growth, maturation, and natural mortality rates, the target chilipepper fishing mortality rate (defined equal to $F_{40\%}$) results from a combined fisheries exploitation rate of 13%. Exploitation rates at the alternative biological reference points of $F_{50\%}$ and $F_{60\%}$ were 9% and 7%, respectively.

Projections: Harvest projections for 1999-2001 were conducted for $F_{40\%}$, $F_{50\%}$, and $F_{60\%}$. The projected ABCs at those rates were 3,724 mt, 2,744 mt, and 1,978 mt, respectively. Since they were calculated on the basis of a 3-year mean, however, they may overstate the longer-term productivity of the stock.

Sources of Uncertainty: The primary sources of uncertainty in this stock assessment were: (1) the statistical uncertainty associated with the fit of the various data sources to the base model, (2) the effect of including two, somewhat disparate, survey indices (logbook & triennial), and (3) the difficulty of projecting what future recruitment is likely to be.

Research Recommendations: The fishery selectivity patterns of chilipepper were distinctly linked and resulted in an abrupt decline in the mean size-at-age of catch samples collected among the three commercial fisheries in 1993. This pattern is suggestive of interannual variability in the distribution of the stock, perhaps associated with El Niño events. To better understand the interaction between the chilipepper population and the fishers that harvest it, we recommend that additional fishery-independent surveys be conducted to better define temporal patterns in spatial distribution.

Special Comments: The analysis of California trawl logbook data was based on applying an estimate of the percentage chilipepper to the reported catch-per-unit-effort of "rockfish." This analysis would rest on substantially firmer ground if the various rockfish market categories were equivalent to the taxonomic groupings upon which the logbook data were organized. Under the present system, use of a single composite "rockfish" reporting category greatly diminishes the utility of these data.

Sources of Information: The fundamental data upon which this assessment is based depend upon the port sampling process to estimate species composition and the biological characteristics of the landings (i.e., age-, length-, and sex-composition). Continued and improved access to all fishery sectors, including especially the hook-and-line fishery, is essential to maintaining a basis for managing the chilipepper stock.

Introduction

Chilipepper (*Sebastes goodei*) is a reddish pink rockfish that inhabits water depths ranging from 40-350 m along the west coast of North America, from British Columbia to southern Baja California. Its principal population center is in the region bounded to the north by Cape Mendocino and to the south by Point Conception. It has a pale lateral line and relatively few head spines in comparison with other *Sebastes* species (Eschmeyer *et al.* 1983). It also displays strong sexual dimorphism in size, with males reaching only 80% of the size of females (Lenarz and Wyllie Echeverria 1991).

Like all rockfish, chilipepper are primitively viviparous and bear live young at parturition. They copulate during September-October and extrude their larvae from December-February (Wyllie Echeverria 1987). Throughout the year they aggregate over deep rocky reefs, as well as sand and mud bottoms, although the young may be found in shallow water. The principal food of chilipepper are euphausiids (krill), squids, and small fishes (Love 1996).

The only information pertaining to subpopulation or stock structure is a study of protein electrophoretic patterns by Wishard *et al.* (1980). They concluded that, at least among the 5 rockfishes they examined, chilipepper was unusual in its very low levels of allozyme variability. This was exhibited by a heterozygosity of 0.004. Low-frequency variants occurred at only one of the 16 loci screened (6PG), and rare variants at only two more sites (PGM & PGI-2); the remaining 13 loci were monomorphic. Not surprisingly, with such low variability they were unable to demonstrate any population substructure from chilipepper tissue samples that were gathered from the latitudinal range bounded by 34 - 40° N.

Fishery Management History & Performance

Historically, chilipepper have been one of the primary species harvested in the central California rockfish fishery (Lenarz 1987), with landings going back to at least the turn of the century. Throughout the 1980's, landings from the four principal chilipepper fisheries (trawl, setnet, hook-and-line, and recreational) averaged over 2,700 mt $\cdot$ yr^{-1} in aggregate. In recent years landings have remained high (2,000 mt $\cdot$ yr^{-1}).

The Pacific Fishery Management Council (PFMC) was given management responsibility for west coast groundfish when the groundfish Fisheries Management Plan became effective in September 1982. For all practical purposes, full-time groundfish management by the PFMC began in 1983. Prior to that, groundfish management, including that for chilipepper, was the responsibility of individual states. State management was generally limited to area closures and minimum mesh sizes.

The regulatory history of chilipepper by the PFMC is detailed in Table 1 and the chronology of management performance is given in Table 2. Note that the Acceptable Biological Catch (ABC) of chilipepper for 1998 in the combined Eureka-Monterey-Conception INPFC areas is 3,400 mt. This represents a reduction from the 4,000 mt ABC that existed in 1997 and was implemented to reflect the new rockfish harvest policy of $F_{40\%}$. Even with that reduction, the contribution of chilipepper to the combined southern area ABCs of chilipepper, yellowtail, canary, and remaining rockfish has now increased to 66% of the total (Table 2).

Biological Information

A variety of information exists in the published literature concerning biological attributes of chilipepper that are important to management of the species. These fall into five categories, including growth, the length-weight relationship, maturity, fecundity, and natural mortality.

Phillips (1964) was the first to estimate a von Bertalanffy growth curve for chilipepper, although his work was based on an examination of scale annuli and he failed to treat each sex separately. Nonetheless, he estimated $L_\infty = 55$ cm, $K = 0.18$ yr^{-1}, and $t_0 = -0.23$ yr. Wilkins (1980) conducted a study of chilipepper growth based on samples from the 1977 NMFS triennial survey. He stratified his analysis by sex and determined ages through the examination of otoliths. His reported parameter estimates for the von Bertalanffy growth equation were: **♀♀:** $L_\infty = 53$ cm, $K = 0.18$ yr^{-1}, and $t_0 = -0.43$ yr; **♂♂:** $L_\infty = 39$ cm, $K = 0.30$ yr^{-1}, and $t_0 = -0.15$ yr. We note that his results for females compare remarkably well with Phillips earlier estimates. More recently, Rogers and Bence (1992) estimated sex-specific growth curves for chilipepper using the Schnute parameterization of the von Bertalanffy equation (1981), and ages obtained through the study of broken and burnt otoliths. They reported the following estimates: **♀♀:** $L_\infty = 52$ cm, $K = 0.20$ yr^{-1}, and $L_1 = 17.4$ cm; **♂♂:** $L_\infty = 39$ cm, $K = 0.28$ yr^{-1}, and $L_1 = 18.4$ cm. These results also compare favorably with those of Phillips (1964) and Wilkins (1980). In the current assessment we estimated the sex-specific parameters of the Schnute formulation internally within the synthesis model.

The relationship between length and weight was also studied by Phillips (1964), as well as by Love *et al.* (1990). Rogers and Bence (1992) elected to use Phillips' estimates in modeling chilipepper for the last assessment. For this assessment we queried a large scientific survey data base maintained by the Alaska Fisheries Science Center (RACEBASE) to extract all chilipepper specimens with nonmissing sex, fork length (FL [cm]), and weight (Wt [kg]) fields, that have been collected during NMFS triennial shelf trawl research surveys. That search resulted in 797 specimens, which were subsequently analyzed for sex-specific patterns in the length-weight curve. An analysis of covariance (ANCOVA) of the $\log_e$-transformed lengths and weights showed that the curves of males and females were significantly different ($P = 0.0001$). As a consequence, sex-specific length-weight regressions were determined by linear least-squares regression on the $\log_e$-scale, which were back-transformed to the arithmetic scale, with bias-correction, yielding:

$$Wt_{female} = 5.9343 \cdot 10^{-6}\ FL^{3.2399}$$

$$Wt_{male} = 3.4630 \cdot 10^{-6}\ FL^{3.4144}$$

with model r^2 values of 98.26% and 99.02%, respectively. These fixed estimates were input to the stock synthesis data file and were used in all model runs.

The maturity schedules of male and female chilipepper was studied by Gunderson *et al.* (1980), Wyllie Echeverria (1987), and Love *et al.* (1990). The first of these studies was severely handicapped by the fact that all specimens were collected during the July-August, 1977 NMFS triennial shelf survey, although chilipepper parturition occurs from November to March. Moreover, there were other internal inconsistencies in that study and, consequently, it was disregarded, even though the estimated female size at 50% maturity was substantially larger (37 cm FL) than reported by Wyllie Echeverria (1987). Results of the second study were presented in the form of maturity as a function of total length (TL), which required conversion of TL values to FL values through application of the regression equations of Echeverria and Lenarz (1984). That exercise yielded:

$$\Phi = \frac{1}{1 + \exp^{-0.3958(FL - 28.83)}}$$

where $\boldsymbol{\Phi}$ is the proportion of mature females at length FL. Lastly, because Love *et al.* (1990) presented only limited information on the maturity schedule of chilipepper (i.e., the estimated size at "first", 50%, and 100% maturity), we relied solely on the results of Wyllie Echeverria (1987) for modeling, as did Rogers and Bence (1993) in the previous assessment.

Information on the fecundity of chilipepper has been reported by Phillips (1964), Gunderson *et al.* (1980), and Love *et al.* (1990). In the previous assessment Rogers and Bence (1993) employed results from Phillips. We also analyzed that data and expressed chilipepper fecundity as:

$$\Omega = 0.9272 + 0.4278\ Wt$$

where $\boldsymbol{\Omega}$ is the number of larvae produced per unit female weight [10^5 larvae $\cdot$ kg^{-1}] and ***Wt*** is female weight [kg]. As indicated previously, results presented in Gunderson *et al.* (1980) contained internal inconsistency and were not examined further. Likewise, results presented in Love *et al.* (1990) do not include estimates of fecundity at length (or weight) for individual fish, but instead they report a regression equation of fecundity on total length (TL). Even so, composition of the fecundity regression with their length-weight regression produced weight-specific fecundities that are generally similar in absolute value and trend to results from Phillips.

In the prior assessment (Rogers and Bence 1993) the authors assumed the natural mortality rate (M) was 0.15 - 0.20 yr^{-1} for most runs of the synthesis model. This assumption was based primarily on the prediction of total mortality rate (Z) from information on the maximum age of chilipepper (35 yr) using Hoenig's (1983) regression equation. They note that Henry (1986) used a value of 0.20 yr^{-1} in the assessment preceding theirs. Although substantially more age data are available now than in 1993, the maximum observed age of chilipepper remains 35 yr. Thus, we estimate Z = 0.12 yr^{-1} from Hoenig's (1983) equation. In our modeling we were able to estimate sex-specific values of M internally within the stock synthesis model, which were reasonably well constrained (see below).

Fisheries Data

For the period 1980-96, all California commercial landings statistics used in this assessment were obtained using the expansion procedures documented in Erwin *et al.* (1997) and Pearson and Erwin (1997). Expanded annual landings from the California trawl, setnet, and hook-and-line fisheries were pooled over the Eureka, Monterey, and Conception INPFC areas. Oregon landings from the Eureka INPFC area were added to the California trawl statistics, although they represent at most 0.3% of landings in any one year. Lastly, the annual recreational take of chilipepper in California was extracted from the Marine Recreational Fishing Survey Statistics (MRFSS) data base. Because final expansions of the 1997 California fish ticket data (which are used to estimate commercial chilipepper landings) were not completed at the time this assessment was prepared, we used Pacific Fisheries Information Network (PACFIN) estimates of landings for that year. We also note that 1997 PACFIN estimates for the hook-and-line fishery appear to be low and are likely to increase when final expansions are completed. Likewise, the 1997 MRFSS data are still preliminary, so we used the mean of landings for the 1994-96 period to estimate landings in 1997. Lastly, we assumed that 1998 landings from all fisheries were equal to 1997.

To estimate landings by fishery for the period 1960-79 we determined the ratio of chilipepper to combined chilipepper-bocaccio (*Sebastes paucispinis*) landings, by fishery, for the period 1980-89. This ratio was established because there has been a well-known historical linkage in the markets of these two species (Lenarz 1987, Pearson and Erwin 1997). Those results showed that for the trawl, hook-and-line, and recreational fisheries the proportion of chilipepper to the combined catch of chilipepper and bocaccio was relatively stable during the four year period from 1980-83, with values of 40%, 35%, and 20% for the trawl, setnet, and recreational fisheries, respectively. As a result we used those proportions and applied them to the estimated landings of bocaccio, by fishery, to estimate the historical landings of chilipepper. That is:

$$\hat{Y}_{it} = \frac{p_i}{1 - p_i} \cdot X_{it}$$

where $\hat{Y}_{it}$ is the estimated landings of chilipepper in fishery i {i = trawl, setnet, or recreational} during year t {t = 1960-79}, p_i is the fishery specific proportion given above, and X_{it} is the estimated landings of bocaccio from fishery i during year t obtained from Ralston *et al.* (1996). Note that we assumed that landings from the setnet fishery prior to 1980 were negligible. The resulting time series of landings over the period 1970-97 is shown in Figure 1.

A variety of compositional data was available to the assessment for each of the three commercial fisheries (Table 4). In particular, sex-specific age composition data were obtained from the NMFS Tiburon Laboratory's Groundfish data base (TIGRBASE) for the trawl, setnet, and hook-and-line fisheries (Tables 5-10, Figures 2-4). All age compositions used in the assessment were generated by the otolith break-and-burn method and were based on catch-weighted expansions of port sampled specimen age data using the methods outlined in Erwin *et al.* (1997) and Pearson and Erwin (1997). Although coverage was most complete for the trawl fishery, adequate samples also existed from the setnet and hook-and-line fisheries, particularly for the latter years.

Length composition data for each of the three commercial fisheries were much more plentiful than the age data (Table 4) and are summarized in Tables 11-16 and Figures 5-7. Like the age composition information, they were extracted from TIGRBASE and reflect catch-weighted expansions of port sampled specimen length data using procedures detailed in Erwin *et al.* (1997) and Pearson and Erwin (1997). The data show clearly the strong sexual dimorphism in size of chilipepper, with males seldom reaching FL in excess of 40 cm. Note that the length composition data for setnet males in the years 1994-96 were determined to be in error and were excluded from the simulation modeling.

The third form of compositional information that was incorporated into the population model was mean length-at-age from the three commercial fisheries. Again, all ages that were used were based on the otolith break-and-burn method, but in this instance the data were not weighted by the catch, but simply represented the mean length-at-age of port sampled chilipepper by sex, year, and commercial fishery. If less than 100 fish of both sexes combined were aged from a fishery in a year, the data were deemed to be too sparse to be useful and they were not included in the model.

With respect to the recreational fishery, the length composition of the landings was obtained from the MRFSS data base (Figure 8). In this instance the data were only available in a form that was combined by sex and, as a result, that is the way it was entered into the model. Also, available from the MRFSS data base was an estimate of chilipepper catch-per-unit-effort (CPUE). That time series was utilized in the prior assessment (Rogers and Bence 1993) and showed a dramatic decline in CPUE in recent years (Figure 9). Note that, unlike the situation with the landings data, no attempt was made to bridge the 1990-92 gap in the availability of MRFSS length-frequency and CPUE statistics.

Commercial Trawl Logbook Index

Trawl logbook data have been routinely provided to the NMFS Tiburon Laboratory by the California Department of Fish & Game. At Tiburon the data are converted to a consistent format and are inputted to TIGRBASE. In the last assessment (Rogers and Bence 1993), this source of information was not used because most *Sebastes* spp., with the exception of widow and splitnose rockfish (*S. entomelas* and *S. diploproa*), are not identified to species in the trawl logbook data, but instead are lumped under the general category of "rockfish." Nonetheless, in the spirit of the Terms of Reference for Groundfish Stock Assessments, an effort was made to scrutinize the logbook data to evaluate their utility in assessing chilipepper.

First, we identified California Department of Fish & Game (CDF&G) reporting blocks where the preponderance of chilipepper have been caught. This required a linking of commercial market sample data to the trawl logbooks. This was accomplished by listing all port samples containing at least two chilipepper specimens and matching those samples, by vessel and date, with the trawl logs. In those instances where the nominal catch of rockfish in the logbook was reported to have been taken from more than one CDF&G block, the data were discarded. If all the rockfish were reported from a single block on the trip, it was identified as a location where chilipepper were caught. Subsetting on this list of CDF&G blocks, we then selected all "rockfish" logs and tallied trawling effort on a block-by-block basis. By examining the spatial distribution of these blocks and the amount of trawling effort that had occurred within them, in relation to the known geographic distribution of the chilipepper stock (Gunderson and Sample 1980) and of chilipepper landings (Pearson and Ralston 1990), we selected a further subset of 26 blocks as indicative of sites where chilipepper and/or bocaccio were likely to comprise a large portion of the nominal rockfish catch (i.e., 403, 409, 410, 411, 416, 417, 425, 433, 440, 441, 450, 451, 459, 460, 466, 474, 475, 476, 502, 503, 504, 510, 518, 520, 639, and 640). Note that these CDF&G blocks fall almost exclusively in the Monterey to Fort Bragg region (i.e., 36°30' - 39°00' N)

A query of TIGRBASE was then performed, wherein all positive "rockfish" tows that were conducted in those 26 distinct CDF&G reporting blocks were retrieved. A General Linear Model (GLM) was applied to these data in an attempt to account for interannual variability in catch-per-unit-effort (CPUE). Specifically the CPUE of "rockfish" in those CDF&G reporting areas that historically have been dominated by the chilipepper/bocaccio market category (see above) was calculated as:

$$\Psi_{ijklm} = (lbs\ rockfish)_{ijklm} \div (hours\ trawled)_{ijklm}$$

where Ψ_{ijklm} is the observed CPUE in year $\boldsymbol{i}$ during period $\boldsymbol{j}$ by vessel $\boldsymbol{k}$ at location $\boldsymbol{l}$ in haul $\boldsymbol{m}$. This statistic was then logarithmically transformed and fitted a GLM model of the form:

$$\log_e(\Psi_{ijklm}) = \mu + Y_i + P_j + V_k + L_l + \varepsilon_{ijklm}$$

where $\boldsymbol{\mu}$ is the average log{CPUE}, $\boldsymbol{Y_i}$ is a year effect, $\boldsymbol{P_j}$ is a bimonthly period effect (Jan-Feb, Mar-Apr, May-Jun, Jul-Aug, Sep-Oct, & Nov-Dec), $\boldsymbol{V_k}$ is a vessel effect, $\boldsymbol{L_l}$ is a location effect, and $\boldsymbol{\varepsilon_{ijkl}}$ is a normal error term with mean zero and variance σ^2, i.e., $\mathbb{N}(0,\sigma^2)$.

An analysis of variance of the model indicated that all four main effects were highly significant ($P < 0.0001$), with an overall model $r^2 = 0.41$. The back-transformed year-specific model prediction of CPUE, with bias-correction, was then calculated as:

$$\hat{\Psi}_i = \exp\left[\mu + Y_i + \bar{P}_j + \bar{V}_k + \bar{L}_l + \frac{\sigma_\varepsilon^2}{2}\right]$$

where $\boldsymbol{\bar{P}_j}$ is the mean of the 6 bimonthly period effects, $\boldsymbol{\bar{V}_j}$ is the mean of the 160 vessel effects, $\boldsymbol{\bar{L}_k}$ is the mean of the 26 spatial effects, and $\boldsymbol{\sigma_\varepsilon^2}$ is the model mean-squared error.

These annual estimates of "rockfish" catch rate were then partitioned into a presumptive chilipepper catch rate by multiplying the estimated annual index obtained from the GLM model by the proportion that chilipepper constituted in the combined "rockfish" commercial catch in the Monterey to Fort Bragg region. That proportion was determined directly by extracting all rockfish landings on a year by port basis from TIGRBASE and expressing the catch of chilipepper as a fraction of the combined catch of all *Sebastes*, exclusive of widow and splitnose rockfish, which are distinguished uniquely in the trawl logbook database. Note that, since chilipepper has increased substantially in importance over time, going from ~25% of the combined "rockfish" catch in 1982 to almost 60% in 1996 (Figure 10), the relative allocation of the annual index to chilipepper increased over time. As a consequence, the estimated rate of decline in chilipepper abundance was substantially less than the rate of decline in the combined "rockfish" index (Figure 11). The time series of estimated chilipepper CPUE was then entered into the stock synthesis model as an annual survey statistic collected over the 1980-96 time interval. The model interpreted the data using a selectivity function with fixed parameters, which were initially estimated directly from the trawl fishery data. Lastly, because the precision of the estimates was quite high, but the structural bias was unknown, the estimated coefficient of variation for estimates of chilipepper CPUE was arbitrarily increased from 4% to 10% to reflect the overall uncertainty associated with this treatment of CPUE more realistically.

AFSC Triennial Shelf Trawl Survey

The Alaska Fisheries Science Center has conducted extensive sea surveys along the west coast of the United States on a triennial basis since 1977 (Wilkins 1996). Data from these bottom trawl surveys were used in the last assessment of chilipepper by Rogers and Bence (1993), although since that time an additional survey has been completed (1995) and those new data are included here. We also include data from the 1977 triennial survey, which was excluded from the last assessment because it did not extend into waters as shallow as those sampled in later surveys. However, to adjust for interannual differences in the depth range sampled and the latitudinal range covered by the triennial survey, we endeavored to standardize catch rates through the application of a GLM model, that was similar in nature to the analysis of logbook statistics. First, a query was made to RACEBASE to determine the spatial distribution of chilipepper rockfish along the west coast of the United States. Only tows with ***performance*** codes ≥ 0 (i.e., "good" tows) and ***haul_type*** = 3 (bottom trawl) were accepted. The area swept was calculated as the product of ***distance*** and ***width*** variables, which was then standardized to dimensions of ha. Finally, the catch rate of chilipepper (including zero catch tows) was expressed in units of [kg/ha].

Results showed that chilipepper in the triennial survey are caught primarily at latitudes below 41° N and in water depths ranging 75 - 325 m. Further analysis was then restricted to regions satisfying those criteria. The locality information was next binned, with latitudes ($\boldsymbol{L_j}$) rounded to the nearest 2.0 degrees (i.e., 34, 36, 38, and 40) and depths ($\boldsymbol{Z_k}$) to the nearest 50 m (i.e., 100, 150, 200, 250, and 300). These two variables, as well as the year of the survey ($\boldsymbol{Y_i}$), were then introduced into a GLM of the form:

$$\log_e(CPUE_{ijkl} + 0.05) = \mu + Y_i + L_j \cdot Z_k + \varepsilon_{ijkl}$$

where $CPUE_{ijkl}$ is the catch rate of chilipepper in year $\boldsymbol{i}$ {i = 1977, 1980, 1983, 1986, 1989, 1992, and 1995} from latitude bin $\boldsymbol{j}$ and depth zone $\boldsymbol{k}$ taken in tow $\boldsymbol{l}$, $\boldsymbol{\mu}$ is the average $\log_e$-CPUE over all tows, and $\boldsymbol{\varepsilon_{ijkl}}$ is a normal error term with mean zero and variance σ^2, i.e., $\mathbb{N}(0,\sigma^2)$.

Results of the ANOVA showed that both the year and latitude-depth interaction terms were highly significant, with the overall model accounting for 33% of the total variation in $\log_e$-CPUE. As with the logbook index, the back-transformed year-specific model prediction of CPUE, with bias-correction, was calculated as:

$$\widehat{CPUE}_i = \exp\left[\mu + Y_i + \overline{L}_j \cdot \overline{Z}_k + \frac{\sigma_\varepsilon^2}{2}\right]$$

where $\overline{\boldsymbol{L}}_j \cdot \overline{\boldsymbol{Z}}_k$ is the mean of the 20 crossed latitude and depth effects and $\boldsymbol{\sigma_\varepsilon^2}$ is the model mean-squared error. Results of the analysis indicate that chilipepper abundance was low and stable from 1977-1983, increased markedly during 1986 and 1989, and declined noticeably since then (Figure 12).

These GLM estimates of chilipepper abundance were entered into the assessment model as a survey statistic of relative abundance. In addition to the estimated CPUE time series, we incorporated catch-weighted estimates of chilipepper length composition by sex in the model (Figure 13). These data were provided directly to the assessment team by staff at the AFSC. The model used the length-frequency data to estimate the parameters of a survey selectivity function.

SWFSC Midwater Trawl Recruit Survey

The SWFSC Tiburon Laboratory has conducted annual sea surveys since 1983 that are designed to estimate the relative abundance of pelagic juvenile rockfishes along the central California coast. The amount of interannual variability observed in these midwater trawl surveys, in addition to correlations with the temporal patterns of settled juveniles, have previously indicated that CPUE statistics from the survey accurately gauge year-class strength (Ralston and Howard 1995). More recently, results from bocaccio have shown explicitly that the midwater trawl index is highly correlated with independently obtained estimates of recruitment to the fishery obtained from the stock synthesis model (Ralston and Ianelli, In press).

The Tiburon recruitment index is calculated after the raw catch data are adjusted to a common age of 100-d to account for interannual differences in age structure. The abundance data are gathered during three consecutive sweeps of a series of 36 fixed stations that are arrayed over 7 spatial strata that extend from Carmel (36° 30' N) to Bodega Bay (38° 20' N). Adjusted catches of pelagic juvenile rockfish are $\log_e$-transformed and individual stratum means, variances, and standard errors are calculated for each sweep using conventional formulae appropriate to a stratified sampling design. The final index is calculated as the bias-corrected antilog of the largest stratified mean observed among the three consecutive sweeps of the survey grid (catch of 100-d fish/15 min trawl). Note that, since only one sweep of the study area was completed during the early years of the survey, and chilipepper are relatively early spawners that are prone to early settlement, we only included indices of abundance for the 1986-97 time span in the model. Although the survey measures the abundance of pelagic young-of-the-year juveniles, the data for chilipepper were entered into the synthesis model as indices of age-1 abundance in year $t+1$. To account for the likely occurrence of compensatory mortality during the first year of life (Adams and Howard 1996) and to ensure comparability of the interannual variability in survey estimates with recruitments to the fishery at age-1, the midwater trawl survey indices were transformed using a power function to reduce their variance, i.e.,

$$\tilde{I}_i = I_i^{\beta}$$

where I_i is the untransformed abundance of chilipepper young-of-the-year pelagic juveniles in year i, β is the power of the transformation, and $\tilde{I}_i$ is the transformed value of the index. The transformation was conducted by varying β until the CV of the $\tilde{I}_i$ was equal to the measured CV of recruitments to the fishery at age-1 from 1987-94. Specifically, a value of $\beta = 0.31$ reduced the CV of the SWFSC midwater trawl survey from 1.23 to 0.48, while preserving the ranking of year-class strength among years.

The resulting transformed time series of estimated age-0 abundance showed relatively strong year-classes were generated in 1987, 1988, and 1993 (Figure 14). There was, moreover, a good correlation between estimates of recruitment from the Tiburon midwater trawl survey and recruitments obtained independently from the model, when nil emphasis was placed on the survey. This specific comparison serves as a validation step for use of the survey in predicting impending recruitment (Figure 15). Lastly, the selectivity pattern of the survey was modeled by assuming the survey samples only one age class (i.e., option #3).

Changes Since Last Assessment

There are a number of significant differences between the stock assessment presented here and the assessment prepared by Rogers and Bence (1993). They include:

- The model was initialized to start in 1970 instead of 1980 so that 1970-79 recruitments could be explicitly estimated.
- Sex-specific length-weight parameters were estimated from AFSC triennial survey data.
- Only age data obtained by the otolith break-and-burn method were used, which excluded trawl ages from 1980-81.
- The fisheries dependent data (landings, age, and length compositions) were extended forward from 1992-96.
- New break-and-burn otolith age readings were obtained for 1982, 1983, and 1986.

- Age composition and mean length-at-age data were included from the setnet and hook-and-line fisheries.

- The California trawl logbook data were analyzed and included as a survey statistic of relative abundance.

- The AFSC triennial survey was analyzed using a General Linear Model (GLM) and the years 1977 & 1995 were added.

- The SWFSC midwater trawl survey of pre-recruit abundance was added.

- The MRFSS recreational CPUE series was de-emphasized (see below).

- A more flexible approach to time-varying selectivities was implemented (see below).

- Growth and natural mortality rate parameters were evaluated internally within the model and then fixed (see below).

Model Description

The stock synthesis model developed by Methot (1990, In press) was used to model the population dynamics of the chilipepper stock. The model is a forward-projecting, separable, age-structured population model. The separability assumption requires that the fishing mortality rate experienced by fish of age ***a*** in year ***t*** ($F_{a,t}$) is defined by the product of a year-specific full-selection instantaneous fishing mortality rate (F_t) and an age-specific value of selectivity (s_a), i.e., $F_{a,t} = F_t \cdot s_a$. Key features of the model are that it incorporates a multinomial error structure for both age and length composition data, it explicitly models ageing errors when constructing predicted age composition data, and it conveniently allows a variety of data elements to be combined and evaluated under one umbrella formulation. In particular, all data types are combined in a total $\log_e$-likelihood equation of the form:

$$\ell_{Total} = \sum_{i=1}^{m} \ell_i \cdot \lambda_i$$

where ℓ_{Total} is the total $\log_e$-likelihood of the model and the ℓ_i are the individual $\log_e$-likelihoods for each of the ***m*** data components used by the model. These are weighted by "emphasis" factors (λ_i), such that in combination the various data sources used by the model can be controlled. To reduce the influence of one data type the particular λ_i can be reduced to a nil emphasis (e.g., 0.001).

The model is typically configured to treat observations of age and length composition data to be measured with a multinomial sampling error structure. In particular, a $\log_e$-likelihood component for the ***i***th type of age data takes the form:

$$\ell_i\ (p \mid \hat{p}) = \sum_t n_{i,t} \sum_a p_{i,a,t} \cdot \log_e(\hat{p}_{i,a,t})$$

where $\boldsymbol{p_{i,a,t}}$ is the observed proportion of fish that are age $\boldsymbol{a}$ in samples collected in year $\boldsymbol{t}$, $\boldsymbol{\hat{p}_{i,a,t}}$ is the model's prediction of that proportion, and $\boldsymbol{n_{i,t}}$ is the year-specific sample size upon which the observed proportions are based. The model then performs an iterative search for values of $\boldsymbol{\hat{p}_{i,a,t}}$ that will maximize ℓ_i. Length composition data are fitted in a similar manner. Survey data, however, are usually modeled with a lognormal error term, i.e.,

$$\ell_i = -\sum_t \left[\log_e (\sigma_{i,t}) + \frac{\log_e (I_{i,t} / \hat{I}_{i,t})^2}{2\sigma^2_{i,t}} \right]$$

where ℓ_i is the $\log_e$-likelihood component for the $\boldsymbol{i}$th survey, $\boldsymbol{I_{i,t}}$ is the observed value of the survey index in year $\boldsymbol{t}$, $\boldsymbol{\hat{I}_{i,t}}$ is the model's prediction of the index value, and $\boldsymbol{\sigma_{i,t}}$ is the standard error of the statistic on $\log_e$-scale.

For this assessment, the length-based version of the synthesis model was used, which is consistent with the prior chilipepper assessment (Rogers and Bence 1993). The length-based version of the model allows more effective use of length-frequency data and permits fishery selectivity patterns to be influenced and/or controlled by the size of fish. We note that all modeling of chilipepper used the version of the length model that was compiled on May 28, 1998 and is 622KB in size (SYNL32R1.EXE). Initial modeling was conducted using a convergence criterion of 0.01 log-likelihood units, but after a preferred model was obtained the criterion was reduced to 0.001.

This assessment explicitly models the 1970-98 time period, although estimated landings from 1960-69 were used to generate an initial equilibrium population in 1970 supporting the historical harvest (1,238 mt). Observed age compositions of fish from 1982 onwards were used to estimated recruitments during the 1970-81 period when no age data were available. All of the age data used in the model were binned into 21 categories that extended from age-1 to age-21+. The summary age range was set from age-3 to age-21+ to be approximately equal to the exploitable age range (summary biomass ≈ exploitable biomass). Likewise, the age data were all treated as unbiased but imprecise, with percent agreements equal to 90% at age-1 and 30% at age-21. Both values were determined by re-aging a substantial subsample of otoliths by two different age readers. Length data were binned into 25 categories, which extended from 10-60 cm FL in 2 cm intervals.

The model was arranged so that selectivity was a function of length only. There were 18 likelihood components, of which 16 were associated directly with the fit of the model to the data elements and two related to the spawner-recruit relationship (Table 17). Although the model was structured to be flexible enough to treat the trawl logbook data as either a separate survey or as a fishery CPUE statistic, functionally that information was included as a survey only by placing a nil emphasis (0.001) on the trawl CPUE component. This was done to make effective use of the error estimates produced by the GLM and, also, in recognition of the fact that much of the interannual variability in trawl fishery selectivity may have been captured by the spatial effects in the GLM model.

Model Selection

Initial runs of the model were quite elementary and were simply designed to achieve convergence of the model and starting parameter values for the more detailed modeling effort to follow. Early runs did not include a time-varying component in the selectivity curves of any of the fisheries or surveys, but selectivities were instead fit with a general 10 parameter selectivity curve (Methot, Unpubl. MS). For that purpose selectivity option #7 was employed, which scales selectivity patterns to the maximum observed size, as opposed to the mean size at old age ($\sim L_{\infty}$). That selectivity option includes: 3 parameters for the ascending limb, 3 parameters for the descending limb, a single parameter for defining where the transition occurs between the ascending and descending limbs, and 3 parameters for controlling the offset of the male selectivity curve relative to the female curve.

Preliminary runs were designed to evaluate the general shape of the selectivity curves of each of the various surveys and fisheries. Results showed that in no case did the selectivity pattern of males differ from that of females over sizes where males were observed to occur (i.e., $\leq$ 40 cm FL). Consequently, the 3 male-specific parameters were dropped from all selectivity models. Likewise, with the exception of the triennial survey, estimates of initial selectivity at minimum size (10 cm FL) were very small for all 4 fisheries and that parameter was fixed at 0.00 in all subsequent runs. We noted that the trawl fishery and the triennial survey were well described with a simple 3 parameter logistic model, whereas the setnet, hook-and-line, and recreational fisheries all showed clear evidence of domed-shaped selectivity patterns. As a result, those latter fisheries were modeled with more complex 7 parameter selectivity models, of which one parameter (initial selectivity) was routinely fixed. Also, the selectivity pattern of the midwater trawl recruit survey was described using stock synthesis availability option #3, which specifies a single age that is sampled and is clearly appropriate for a young-of-the-year survey. Finally, once a reasonable but parsimonious selectivity model was obtained for the trawl fishery (i.e., a simple 3 parameter logistic with initial selectivity fixed), those exact parameter estimates were used to model the selectivity of the trawl logbook survey. In all further runs of the model the availability pattern of the trawl logbook "survey" was not estimated.

A stock synthesis model was developed for chilipepper in 1997 and the results of that effort were evaluated at the STAR panel meeting held at the SWFSC in La Jolla, California. That preliminary stock assessment did not proceed to a conclusion, largely because of a model specification issue that could not be resolved in a timely manner, i.e., whether to model chilipepper with an approach that emphasized time-varying growth or to treat chilipepper fishery selectivities as time-varying. It was evident to the authors of this assessment that a resolution of that issue, prior to the onset of modeling would be highly desirable. Consequently, a variety of data analyses were performed to highlight the conceptual differences between these approaches and to settle on one modeling strategy from among the two alternatives. The considerable results of those analyses support the view that lack of fit to the mean length-at-age data obtained from the three commercial fisheries was due to changing availability of the stock to the fisheries over time. That conclusion was based on a variety of factors, including: (1) linked patterns in mean length-at-age among the three commercial fisheries, (2) apparent negative annual length growth increments associated with compensatory growth in the following year, (3) a re-examination of the otolith data for 1993, which showed a severe negative anomaly in mean length-at-age, (4) an analysis of the seasonal pattern of landings and its effect on fisheries mean length, (5) a consideration of the timing of hyaline zone formation in the otoliths and the effect that might have on assigned ages, and (6) an examination of the depth distribution of chilipepper in the AFSC triennial shelf survey from 1977-95. Those analyses were presented to the STAR panel at Evergreen State College in Olympia, Washington and it was argued that the most parsimonious explanation of the data was that interannual variability in the distribution of the stock affected the various "samples" from the fisheries. Consequently, further modeling effort was directed towards adding realism to the model by incorporating a time-varying component to the fishery selectivities. However, to balance the added complexity of that goal, and because there was a clear linkage among the trawl, setnet, and hook-and-line fisheries in the mean length-at-age data, the time-varying signal was introduced into the model to affect all four fisheries in an identical manner. Specifically, the simple model was altered so that the ascending inflection point of the selectivity curves for the trawl, setnet, hook-and-line, and recreational fisheries was allowed to vary by year, but was linked among the four fisheries. When this modeling strategy was implemented, a very large gain in the total log-likelihood of the model was achieved (~1,000) at the cost of relatively few new parameters (15).

The next step in model development was to examine the ability of the model to estimate the 10 growth parameters (5 for each sex) and the 2 sex-specific natural mortality rate parameters (Table 18). Results of that effort showed that the model was capable of estimating those values and produced biologically realistic results. For example, for females the model estimated a natural mortality rate of 0.223 yr^{-1} and a von Bertalanffy growth coefficient of $K = 0.192$ yr^{-1}. Similarly, for males the model estimated $M = 0.253$ yr^{-1} and $K = 0.233$ yr^{-1}. We note that sex-specific differences in these rate constants are expected to be of this magnitude and direction, given the considerable sexual size dimorphism displayed by chilipepper. For reference and by comparison, application of the Hoenig (1983) equation to the maximum observed age of chilipepper (35 yr for both sexes), yielded an estimate of $M = 0.12$ yr^{-1}. However, we also note that application of the Jensen (1997) equation to the estimated K values obtained for the two sexes yielded M values in the range of 0.28 - 0.34 yr^{-1}. Upon recommendation of the Olympia STAR panel, however, in all further modeling runs the growth and natural mortality parameters were fixed at their estimated values. Similarly, the STAR panel recommended that the MRFSS recreational fishery CPUE index be uniformly deleted from the model due to insufficient documentation of the effort statistic used in its calculation. In all subsequent modeling the emphasis value (λ_i) placed on that data component was therefore reduced from 1.00 to 0.001.

The last step in model development was to evaluate the validity of the SWFSC midwater trawl survey in predicting chilipepper year-class strength. To accomplish this, the emphasis value on the survey was reduced to nil (0.001) and the model was allowed to converge. The estimated age-1 recruitments for the 1987-94 time period (i.e., 1986-93 year classes) from that converged model were then used to estimate β and the midwater trawl survey statistics were transformed to match the coefficients of variation (see **SWFSC Midwater Trawl Recruit Survey** above). The clear positive correlation between the two independently estimated series (Figure 15) then served to validate the recruit survey and, as a result, in all further modeling the emphasis level on the midwater trawl survey was returned to a value of 1.00.

Base-Run Results

The final base-run model that was accepted by the Olympia STAR panel is summarized in Tables 17 & 18. Note that the compositional data (age, length, and mean length-at-age) were fully and equally emphasized for all fisheries and surveys. Likewise, the triennial survey CPUE, the trawl logbook "survey", and the midwater trawl recruit survey were fully emphasized. In contrast, the trawl logbook CPUE and recreational CPUE statistics were de-emphasized (see above). This model produced a total log-likelihood of -5735 and resulted in an estimated 31,963 mt of chilipepper summary biomass (age-3+) at the beginning of 1998. The parameter list (Table 18) shows that the base model contained 107 structural parameters, but of those 39 were fixed. Of the 68 estimated parameters, most were selectivity parameters (23 time invariant & 15 time-varying) and recruitments (29). Recall, however, that the 12 growth and natural mortality parameters were estimated at an earlier stage in model development and were subsequently fixed.

Population trends of the chilipepper stock from 1970-98 under the base model are shown in Table 19 and Figure 16 and the recruitment time series is presented in Table 19 and Figure 17. Results show that in the 1970s the exploitable age-3+ biomass of the stock was stable at ~55,000 - 58,000 mt. During the early 1980s, a period of high fishing pressure and weak recruitments, the stock declined in abundance to a low of ~26,000 in 1986. The influx of a huge 1984 year class, however, quickly rebuilt the stock to in excess of 38,000 mt, where it remained until 1997. Currently stock biomass appears to be in a state of slow but increasing decline. In comparison, the spawning output of the stock followed an overall similar pattern, but reached its nadir one year later in 1987. Note that, with the exception of 1993, recruitments of age-1 fish from 1987-94 remained relatively strong. However, since 1995 recruitments have been rather weak.

Exploitation rates for the four fisheries are depicted in Figure 18. From 1970-98 the exploitation rate of the trawl fishery has exceeded the other three fisheries, with the exception of 1986 (when the setnet fishery exploitation rate was larger) and 1992 (when the hook-and-line fishery exploitation rate was larger). The recreational fishery has never exceeded an exploitation rate of 2%. In the terminal year of the simulation the only significant fishery, at least in terms of exploitation rate, is the trawl fishery, which is responsible for removals on the order of 5-6%.

Presented in Figure 19 is the interannual time-varying pattern evident in the selectivities of the four chilipepper fisheries. Most notable is the dramatic reduction that occurred in the ascending inflection points of the curves in 1993. The model interpreted the reduction in mean length-at-age for samples collected in that year as due to the increased harvest of small fish. This was likely due to a decrease in the availability of larger/older fish to the fleets. However, there is, in addition to the 1993 anomaly, a long-term decline in the minimum size of chilipepper that are entering the fisheries.

Overall patterns of fishery and survey selectivities are given in Figures 20 & 21. Note that interannual variability in the ascending inflection points of the fisheries is clearly expressed, but that is not the case with the two surveys. Also noteworthy is the asymptotic/logistic selectivity patterns of the trawl fishery, the trawl logbook survey, and the triennial shelf trawl survey. In contrast, the setnet fishery, hook-and-line fishery, and recreational fishery all demonstrate dome-shaped availability patterns, with the setnet fishery being most peaked and the recreational fishery harvesting the smallest fish.

Residual plots were prepared to examine the goodness of fit of the base-run model to the various compositional data. For that purpose we follow Sampson (1996) and define standardized residuals (r_s) as follows:

$$r_s = \frac{(p - \hat{p})}{\sqrt{\dfrac{\hat{p} \cdot (1 - \hat{p})}{n}}}$$

where p is the observed proportion at age (or length), $\hat{p}$ is the expected proportion, and n is the effective sample size of the frequency vector (see **Model Description** above). Thus, a standardized residual of $\pm$ 1.0 represents a deviation between the model and the data of one standard error. Ordinary residuals (r) were calculated to represent the fit of the model to the mean length-at-age data (i.e., $r = [x - \hat{x}]$), where x is an observation of mean length-at-age and $\hat{x}$ is the model prediction of that value.

Presented in Figures 22-31 are contoured standardized residuals and ordinary residuals of the age compositions, length compositions, and mean length-at-age compositions for the trawl, setnet, hook-and-line, and recreational fisheries, as well as the triennial trawl survey. Note that, when possible, sex-specific plots are presented. The contour plots are shaded so that regions of white represent data elements that are well fit ($r_s < 1$ and $r < 2$ cm), whereas lightly shaded areas coincide with data elements showing moderate lack of fit ($1 \le |r_s| < 2$ and $2 \le |r| < 4$). Darkly shaded areas identify those regions displaying the most severe lack of fit ($|r_s| \ge 2$ and $|r| \ge 4$). While there are certain data elements that are poorly fit (e.g., the proportion of 15 year-old females captured in the trawl fishery in 1995), for the most part the residual patterns show broad regions of white, some light grey, and little dark grey. These findings indicated the composition data were generally well fit by the model.

Lastly, the fit of the base-run model to the three surveys is presented in Figure 32. We note that the trawl logbook "survey" was fit better than the AFSC triennial shelf survey. That result is no doubt due to the lower precision of the latter survey (CV = 24%), in spite of the fact that the CV of the logbook survey was artificially increased by a factor of 2.5 from 4% to 10%. The very good fit of the model to the last three years of the midwater trawl recruit survey is because there are no other data in the model that provide information on the strength of those year-classes (1995-97) since the compositional data end in 1996.

Uncertainty & Sensitivity Analyses

Randomization Tests

As a test of sensitivity the base model was subjected to a randomization of the estimated parameter seeds and the model was allowed to converge to a new solution. Each perturbed parameter (z') was generated by drawing a uniform deviate (U) and altering the base parameter value (z) according $z' = 0.9\ z + 0.2\ U$. Thus, the effect was to randomly alter each of the fitted parameters over the range of ± 10% of their values. As with the base model the convergence criterion was set equal to 0.001, . This randomization and refitting procedure was then repeated 100 times and results are summarized in Figures 33-37. Results presented in Figure 33 show that the model displayed good convergence stability, returning to within ~2.5 log-likelihood units in all 100 randomizations. Within that suite of fits the ending summary biomass ranged ~1,000 mt, or about 3%.

It is also informative to examine the goodness of fit of each of the data components relative to other specific data components, within the range of solutions encountered in the randomization procedure. Thus, presented in Figure 34 are plots of the log-likelihood of the three trawl compositional data components against one another. The upper panel shows that when the trawl age composition data were well fit, the trawl length-frequency data were too. Conversely, there was some level of conflict between the trawl length-at-age data and the other two data types, i.e., a negative correlation was evident in their component log-likelihoods. Similar results are presented in Figure 35 & 36 for the setnet and hook-and-line fisheries, respectively. Most striking is the strong positive correlation between the goodness of fit to the setnet length composition data and the mean length-at-age data, suggesting that these data elements are in substantial harmony with one another. Note that the data elements from the hook-and-line fishery show more scatter and display less of a coherent pattern than the two other commercial fisheries.

The last figure in the randomization series (Figure 37) shows relationships among the log-likelihood fits of selected "survey" components to one another. Note in the upper panel that, although the triennial survey and the logbook survey had substantially different time trends (Figure 32), the base model repeatedly converged to a region of substantially similar fit vis-à-vis the two surveys. In the middle panel the triennial survey abundance component is plotted against the triennial survey length compositional component; the negative relationship demonstrates that some level of internal tension exists between the two triennial survey components. In the bottom panel one can see that the midwater trawl recruit survey and the triennial survey length composition data are in accord, suggesting that the triennial survey, with its finer mesh net, may capture chilipepper small enough to estimate year-class strength.

Profiling on Natural Mortality

Perhaps the most important parameter(s) estimate in any stock assessment is the natural mortality rate (M). Earlier it was indicated that the data were capable of estimating sex-specific natural mortality rates of chilipepper and of producing biologically plausible results. Nonetheless, for the base model M values were fixed, as were growth parameters. To evaluate the sensitivity of the base-run model to different natural mortality rate values, the model was profiled with different $M_♀$ and $M_♂$ values. Specifically, $M_♀$ was fixed at 9 values ranging from 0.14 - 0.30 yr^{-1} in 0.02 increments, while $M_♂$ ranged from 0.18 - 0.34 yr^{-1}. Each of the 81 resulting combinations was allowed to reconverge, with results presented in Table 20. Note that the parameter estimates used in the base model (Table 18) lie on a sharp ridge of total log-likelihood. Nonetheless, at the extremes of the table (i.e., low or high M values) the fit of the model to the data was seriously degraded. We view these results as supporting the fixed values of M used in the base-run model.

To highlight the sensitivity of the absolute value and trend in chilipepper biomass to the choice of M, we graphed the estimated time series of exploitable biomass under the base model and compared that with models containing low and high natural mortality rates (see Table 20 for specifics). Results show that, if M is actually lower than postulated in the base model, the decline in biomass has been less severe and the stock is smaller than otherwise indicated. Conversely, if M values are actually higher than those used in the base model, the stock has experienced a much more substantial decline in abundance, but the stock is larger than under the base model.

Sensitivity to Assumed Catch History

Due to uncertainty associated with the estimated catch history of chilipepper prior to 1980, a simple sensitivity analysis was performed, wherein the ratios of chilipepper to the combined chilipepper/bocaccio catch in the various fisheries were altered. For the base model, the percentage chilipepper was assumed to be 40%, 35%, and 20% of the trawl, setnet, and recreational fisheries, respectively. Setnet landings were assumed to be nonexistent. Moreover, those percentages were assumed to be constant throughout the 1960-79 time period (see **Fisheries Data** above). For the sensitivity analysis, however, the percentages were assumed to be half of those values from 1960-70 (i.e., 20%, 17%, and 10%), and to then increase in a linear manner from 1970 to 1980, such that their terminal values in 1980 were equal to the assumed values under the base model. We note that those alterations were requested by the STAR panel and were based on specific comments received by the panel from members of the fishing industry. When the catch history was altered in this way, and the base model was allowed to converge using the newly constructed data file, the ending summary biomass of age-3+ fish was estimated to be 31,369 mt and the total log-likelihood was -5732. Thus, the overall effect of altering the catch history was to improve the fit by 3 log-likelihood units and to decrease the ending biomass by 594 mt, a reduction of 1.8%. We consider both changes to be insignificant and we therefore conclude that the base model is robust to our assumptions concerning the catch history prior to 1980.

Harvest Projections

Historically, the Pacific Fishery Management Council (PFMC) has set ABCs for rockfish stocks using a constant rate harvest policy. For a number of years an $F_{35\%}$ policy was used as the default harvest rate, which is the rate of fishing that reduces the spawning potential per recruit (SPR) to 35% of the unfished condition (Clark 1991, 1993). In 1997 the default PFMC harvest rate was reduced to $F_{40\%}$ and the ABCs of many rockfish species were adjusted downwards.

Moreover, with the passage of the new Sustainable Fisheries Act (U. S. Public Law 104-297) there now exist national requirements to manage stocks using biomass thresholds. How those requirements will be implemented on the west coast is not yet finalized, but for the purposes of performing a harvest projection of chilipepper a harvest policy must be assumed.

The projections that are reported here are based on several constant harvest rate policies, largely because it is not obvious that the chilipepper stock is overfished or is in need of precautionary management. Depending on how one defines "virgin spawning output" the current spawning output of the stock can be expressed as a bounded range. Specifically, if one assumes that the mean of all observed recruitments from 1970-98 is a reasonable estimate of virgin recruitment (an optimistic assumption), then current spawning output is 61% of the unexploited output (43,550 [10^5 larvae]). Conversely, if one assumes that the level of recruitment required to produce a population in equilibrium with catches prior to 1970 is a better estimate of recruitment in the absence of exploitation, then it follows that the spawning output of chilipepper is now 46% of the unfished output (58,500). In either case, we conclude that chilipepper is not overfished.

Presented in Figure 39 are several graphs that show the relationship of (1) "combined" F, (2) stock spawning output, and (3) spawning potential per recruit to the chilipepper exploitation rate. Note that "combined" F is simply the sum of the full selection fishing mortality rates (i.e., $F_{a,t}$ at $s_a = 1.00$) from the four fisheries, which jointly subject the stock to competing risks. It is apparent that an exploitation rate of ~7% reduces SPR to 60% of virgin. Similarly, exploitation rates of ~9% and ~13% reduce SPR to 50% and 40%, respectively, of the unexploited condition. These calculations assume that the selectivity curves of each of the four fisheries are equal to the estimated curves in the terminal year of the base model, and that the ratios of fishing mortality rates among the fisheries is similarly constrained.

To estimate the chilipepper ABC under several different harvest rates the population was projected forward for 3-5 years and the total yield determined. Results show (Table 21) that if the default $F_{40\%}$ policy is followed, the average annual catch of chilipepper over the 3-year horizon from 1999-2001 is 3,724 mt. For comparison, ABCs based on $F_{35\%}$, $F_{50\%}$, and $F_{60\%}$ are also given. In addition, we have calculated ABCs over a five year projection horizon to illustrate the point that the stock is estimated to be in a state of decline, given recent observed recruitments (Table 19) and the assumed level of recruitment in future years. Depending on the harvest policy used to project mean total yield, the difference in projected ABCs when using alternative time horizons (3 year or 5 year) becomes more serious as the exploitation rate increases, going from a 6% difference at $F_{60\%}$ to a 12% difference at the $F_{40\%}$ rate.

The relationship between age-1 recruitment and the spawning output of the chilipepper stock is shown in Figure 40. Clearly evident is the huge 1984 year-class that rebuilt the stock in the late 1980's (Figures 16 & 17). Also, shown are the two estimates of virgin spawning output discussed above, i.e., one based on the mean of observed recruitments and one based on the equilibrium recruitment required to initialize the model in 1970. Lastly, replacement lines at several constant SPR harvest rates are shown, including the default $F_{40\%}$ rate. In that regard, it is noteworthy that, at least since 1984, recruitment has been wholly insufficient to sustain an $F_{40\%}$ yield, while simultaneously maintaining the population's spawning output at a stable level.

Decision Table

To analyze the impact of uncertainty in model specification on the results of this assessment a decision table was prepared. That analysis was designed to contrast models that selectively excluded (i.e., de-emphasized) the AFSC triennial shelf trawl CPUE index and the California trawl logbook CPUE index. This particular spectrum of uncertainty was selected because of the disparate trends in the two relative abundance indices (Figures 11 and 12) and the importance of auxiliary information, including CPUE statistics, in constraining model fits (Deriso *et al.* 1985).

The decision analysis was implemented as follows: (1) obtain converged versions of three different models, i.e., the base model, a model with the AFSC survey de-emphasized ($\lambda = 0.001$), and a model with the logbook index de-emphasized, (2) for each of the three models determine the average recruitment of age-1 fish from 1993-98 to use in projecting the population forwards, (3) for each model calculate the proper $F_{40\%}$ ABC over a 3-year projection horizon, (4) extend the modeled time period from 1998 to 2001 and re-estimate each of the three models, assuming an annual harvest at each of the three possible ABCs from 1999-2001 (nine possible combinations), and (5) for each of the nine combinations calculate the ratio of spawning output in the year 2001 to that in the year 1995.

The purpose of this analysis was to evaluate the impact to the stock (i.e., the relative reduction in spawning output) when an improper management action is taken (harvesting an incorrectly specified ABC). Results show (Table 22) that the ending biomass of the base model was slightly lower than either of the other two alternatives, and as a consequence, so was the ABC. Note that if the base model actually represents the true state of nature (our fundamental assumption) and the correct management decision is made (an ABC of 3,726 mt is harvested), the spawning output of the chilipepper stock in the year 2001 is projected to be 69% of that in 1995. In like fashion, the 8 remaining cells in the table present the impact to the stock of the various other combinations of population model and management action.

We note that in no case is there an adverse effect to the stock of harvesting the ABC of the base model, which is not surprising since that ABC is the smallest of the three possibilities. Similarly, the greatest penalty for making the wrong management decision occurs when the ABC of a "No Logbook" model (4,110 mt) is removed from a population represented by the base model. In that situation the spawning ratio is projected to be 66%, rather than the correctly specified 69%. We conclude from these comparisons that the base model is robust to the choice of model, at least within the array of possibilities we have identified.

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Table 1. Chronology of the regulatory history of chilipepper rockfish, which has been managed as a component of the *Sebastes* complex, by the Pacific Fishery Management Council. Regulations governing bocaccio (*S. paucispinis*) are assumed to indirectly affect chilipepper rockfish.

Date	Regulation
1/1/83	Coastwide 40,000 pound trip limit on *Sebastes* complex.
8/14/87	Increased coastwide ABC for chilipepper to 3,600 mt.
1/1/91	25,000 pound trip limit, no more than 5,000 pounds of bocaccio in the Eureka, Monterey, and Conception INPFC areas.
1/1/93	50,000 pounds of *Sebastes* complex per two weeks, no more than 10,000 pounds of bocaccio south of Cape Mendocino.
10/6/93	Increased the biweekly catch limit of bocaccio to 15,000 pounds.
5/1/94	Eliminated 10,000 pound trip limit for *Sebastes* complex caught by setnet in California, retained 40,000 pound monthly limit.
9/1/94	Increased monthly cumulative limit for *Sebastes* complex for the limited entry fishermen to 100,000 pounds from 80,000 pounds.
1/1/95	Changed cumulative monthly limit for *Sebastes* complex south of Cape Mendocino to 100,000 pounds, no more than 30,000 pounds of bocaccio. For open access, non-trawl fishery, 40,000 pound monthly limit of *Sebastes* complex with a 10,000 pound trip limit for hook-and-line gear.
1/1/97	Changed to a bimonthly limit of 200,000 pounds of *Sebastes* complex south of Cape Mendocino. For the limited entry fishery, south of Cape Mendocino, 40,000 pound monthly limit with no more than 4,000 pounds of bocaccio.
10/1/97	Changed to monthly cumulative limit of 75,000 pounds of *Sebastes* Complex south of Cape Mendocino, no more than 5,000 pounds of bocaccio.

Table 2. Management performance in obtaining the Allowable Biological Catch (ABC) of chilipepper.

Year	ABC[a]	Landings[b]	% Chilipepper[c]
1980	-	2,769	-
1981	-	2,252	-
1982	-	1,935	-
1983	2,300	2,671	18%
1984	2,300	2,257	18%
1985	2,300	2,410	18%
1986	2,300	1,756	18%
1987	3,600	1,754	26%
1988	3,600	1,965	26%
1989	3,600	2,528	26%
1990	3,600	2,652	26%
1991	3,600	2,498	26%
1992	3,600	1,350	26%
1993	3,600	1,518	26%
1994	4,000	1,361	28%
1995	4,000	1,645	29%
1996	4,000	1,540	29%
1997	4,000	1,427	43%
1998	3,400	???	66%

a. 1997 SAFE document

b. Landings and catch are suspected the same since it assumed that there is no discard. Landings for 1980-96 from California Department of Fish and Game's port sampling expansion data. Landings for 1997 are from PacFIN.

c. Number represents the chilipepper ABC divided by the sum of the ABCs of chilipepper, canary, yellowtail, and remaining rockfish in the southern area (Eureka-Conception INPFC areas).

Table 3. Landings (mt) of chilipepper rockfish by fishery. Values prior to 1980 are estimated by ratio to bocaccio landings.

Year	Trawl	Hook-and-line	Setnet	Recreational
70	1096	159	0	184
71	1071	226	0	109
72	1592	319	0	272
73	2146	445	0	426
74	2016	415	0	610
75	2121	445	0	560
76	2111	450	0	436
77	1711	371	0	316
78	1598	353	0	248
79	2115	474	0	477
80	2758	133	11	356
81	2204	222	48	272
82	1895	265	40	389
83	2299	124	372	162
84	1989	36	268	156
85	1779	239	631	395
86	959	210	807	395
87	1396	68	358	203
88	1660	224	305	415
89	2209	379	319	308
90	2352	257	300	256
91	2184	657	314	128
92	1059	1083	291	32
93	1249	723	269	17
94	1238	484	123	23
95	1557	319	88	11
96	1496	250	44	37
97	1375	19	52	24

Table 4. Summary of chilipepper length and age composition sample sizes for each of the three commercial fisheries. Given is the actual number of fish that were either lengthed or aged for each fishery and year. The number in brackets is the number of samples (i.e., trips) from which the fish were obtained. Note that the 1980-81 age compositions were based on surface ages and were not used.

	Length Composition						Age Composition					
Year	Hook Gear		Setnet Gear		Trawl Gear		Hook Gear		Setnet Gear		Trawl Gear	
1980	42	[3]	0	[0]	1590	[191]	***11***	***[2]***	***0***	***[0]***	***1512***	***[188]***
1981	0	[0]	0	[0]	958	[125]	***0***	***[0]***	***0***	***[0]***	***923***	***[122]***
1982	29	[2]	0	[0]	1604	[170]	0	[0]	0	[0]	1032	[119]
1983	20	[3]	75	[6]	2610	[269]	8	[3]	68	[6]	2302	[252]
1984	20	[2]	42	[7]	4762	[286]	0	[0]	42	[7]	3576	[202]
1985	283	[10]	514	[37]	7163	[338]	100	[7]	266	[35]	3270	[303]
1986	213	[16]	824	[113]	4080	[219]	173	[11]	414	[41]	2013	[111]
1987	27	[2]	387	[35]	4160	[194]	14	[2]	159	[30]	2267	[190]
1988	122	[10]	539	[69]	4407	[191]	5	[2]	214	[41]	2167	[177]
1989	284	[22]	644	[81]	4581	[183]	9	[1]	311	[68]	2524	[174]
1990	80	[6]	953	[99]	5053	[205]	15	[3]	443	[79]	1706	[134]
1991	1788	[40]	486	[36]	7850	[213]	424	[17]	96	[7]	1600	[66]
1992	2883	[84]	898	[60]	3120	[95]	745	[38]	406	[42]	1680	[82]
1993	3307	[79]	967	[35]	2952	[80]	1037	[27]	188	[12]	1132	[38]
1994	3602	[83]	901	[44]	3827	[116]	251	[11]	253	[9]	742	[76]
1995	842	[24]	738	[31]	3717	[114]	249	[8]	60	[3]	1306	[57]
1996	1138	[41]	310	[19]	3257	[115]	189	[11]	37	[2]	803	[64]
Total:	14680	[427]	8278	[672]	65691	[3104]	3230	[143]	2957	[382]	30555	[2355]

Table 5. Age composition of trawl females.

Age (yr)	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.00%	0.00%	0.00%	0.00%	0.00%	0.38%	0.00%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%
2	0.02%	0.00%	0.01%	0.01%	0.75%	0.34%	0.06%	0.06%	0.40%	0.77%	0.15%	0.34%	0.05%	0.34%	0.33%
3	2.88%	0.68%	1.46%	0.51%	0.98%	31.33%	1.85%	3.73%	2.85%	5.93%	6.50%	3.61%	4.19%	2.31%	7.88%
4	2.36%	5.87%	7.67%	1.74%	0.91%	1.08%	38.12%	3.83%	5.17%	7.77%	10.41%	12.52%	4.91%	10.82%	2.04%
5	6.52%	2.02%	14.23%	5.54%	5.01%	0.59%	0.75%	38.84%	3.96%	9.34%	10.24%	12.81%	9.35%	7.00%	8.55%
6	1.83%	4.49%	7.13%	17.60%	12.12%	3.34%	0.45%	0.48%	22.85%	7.12%	9.25%	9.76%	8.43%	13.19%	9.75%
7	12.41%	7.84%	4.07%	8.30%	14.27%	4.88%	3.30%	0.26%	4.52%	18.08%	6.56%	6.53%	9.43%	6.35%	4.36%
8	6.85%	19.57%	4.92%	5.19%	3.40%	10.37%	2.75%	2.12%	1.56%	2.48%	11.44%	5.64%	5.54%	5.01%	5.23%
9	9.22%	6.95%	10.61%	3.31%	5.23%	2.73%	6.90%	2.45%	2.15%	0.76%	3.00%	9.13%	1.07%	4.50%	5.58%
10	2.81%	10.35%	3.60%	4.83%	3.23%	0.50%	1.71%	5.15%	1.88%	1.38%	0.68%	1.97%	6.74%	1.48%	2.31%
11	5.07%	2.33%	3.34%	4.91%	5.84%	0.92%	0.53%	1.05%	2.78%	2.09%	1.05%	0.67%	1.42%	5.71%	1.00%
12	5.61%	4.73%	2.85%	3.04%	1.61%	2.42%	0.72%	0.21%	0.44%	1.58%	1.13%	1.75%	0.11%	2.22%	4.39%
13	2.30%	3.25%	3.15%	2.56%	2.92%	1.01%	2.04%	0.31%	2.16%	0.45%	1.43%	1.00%	0.93%	0.45%	0.36%
14	2.03%	2.83%	1.75%	1.29%	0.99%	1.50%	0.29%	1.47%	0.29%	0.95%	1.02%	1.19%	0.46%	1.01%	0.00%
15	1.39%	1.07%	1.99%	1.47%	1.29%	0.17%	0.79%	0.04%	1.12%	0.00%	0.58%	0.47%	0.61%	3.78%	0.35%
16	0.53%	2.09%	1.36%	0.89%	1.61%	0.04%	0.01%	0.52%	0.18%	1.05%	0.23%	0.46%	0.27%	0.61%	0.78%
17	0.16%	0.25%	1.25%	0.57%	0.95%	0.48%	0.34%	0.00%	0.77%	0.00%	0.47%	0.06%	0.07%	0.72%	0.17%
18	0.07%	0.36%	0.45%	0.72%	0.65%	0.17%	0.22%	0.01%	0.18%	0.13%	0.23%	0.20%	0.02%	0.03%	0.04%
19	0.00%	0.38%	0.14%	0.26%	0.75%	0.18%	0.00%	0.09%	0.47%	0.00%	0.14%	0.19%	0.57%	0.00%	0.00%
20	0.11%	1.05%	0.84%	0.34%	0.33%	0.12%	0.05%	0.00%	0.26%	0.00%	0.11%	0.57%	0.60%	0.25%	0.81%
21+	1.70%	2.93%	1.34%	0.75%	1.20%	0.13%	0.32%	0.15%	1.28%	0.86%	0.28%	0.27%	0.08%	0.91%	0.12%

Table 6. Age composition of trawl males.

Age (yr)	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.00%	0.00%	0.00%	0.00%	0.00%	0.15%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	0.04%	0.02%	0.07%	0.02%	0.64%	0.12%	0.16%	0.13%	0.35%	0.46%	0.03%	0.25%	0.52%	0.35%	0.97%
3	0.85%	0.54%	0.73%	0.03%	0.43%	11.15%	0.47%	2.17%	3.01%	5.70%	1.83%	2.42%	2.42%	0.86%	5.42%
4	0.36%	3.65%	3.98%	0.51%	0.32%	1.27%	20.00%	2.88%	4.41%	5.36%	3.56%	6.70%	3.33%	4.77%	1.48%
5	7.17%	0.90%	2.80%	1.19%	1.66%	0.44%	0.34%	18.68%	2.45%	4.56%	3.69%	4.26%	5.17%	2.86%	4.85%
6	1.59%	1.21%	3.39%	4.60%	4.71%	1.81%	0.31%	0.44%	14.24%	2.77%	5.58%	3.78%	5.28%	4.10%	4.88%
7	6.28%	2.77%	1.39%	4.27%	6.57%	3.63%	1.49%	0.13%	2.98%	7.91%	3.20%	1.59%	4.43%	4.71%	5.25%
8	1.98%	4.27%	2.09%	3.42%	2.52%	6.64%	2.69%	1.82%	1.96%	3.25%	7.50%	1.20%	3.77%	2.63%	1.92%
9	7.09%	1.17%	3.68%	3.02%	4.42%	1.97%	5.62%	2.21%	1.46%	0.77%	3.35%	3.98%	5.85%	1.90%	4.23%
10	1.47%	2.12%	1.66%	5.13%	2.13%	0.75%	1.47%	4.39%	0.93%	1.45%	0.80%	2.03%	5.33%	1.05%	2.04%
11	4.01%	0.55%	2.36%	2.97%	4.51%	1.32%	0.41%	1.03%	2.59%	1.36%	0.46%	0.80%	2.88%	2.53%	4.00%
12	1.67%	1.11%	1.32%	2.95%	1.30%	2.50%	1.05%	0.49%	0.80%	1.63%	0.33%	0.58%	0.62%	2.32%	3.79%
13	0.32%	0.28%	1.06%	2.02%	2.91%	0.94%	2.05%	0.44%	2.36%	0.36%	1.12%	0.58%	0.65%	0.96%	2.22%
14	0.62%	0.55%	0.82%	1.37%	0.79%	1.61%	0.31%	2.00%	0.43%	1.19%	0.66%	0.35%	0.94%	0.76%	0.44%
15	0.62%	0.20%	0.71%	1.13%	1.03%	1.01%	0.70%	0.46%	1.89%	0.17%	0.71%	0.30%	0.91%	0.69%	0.24%
16	0.00%	0.57%	0.63%	1.03%	0.51%	0.40%	0.35%	0.83%	0.74%	1.02%	0.29%	0.62%	0.86%	1.56%	0.02%
17	0.06%	0.33%	0.45%	0.58%	0.25%	0.46%	0.45%	0.57%	1.92%	0.00%	0.34%	0.17%	0.41%	0.31%	0.36%
18	0.00%	0.21%	0.15%	0.43%	0.13%	0.34%	0.45%	0.09%	0.35%	0.40%	0.09%	0.28%	0.28%	0.27%	0.18%
19	0.00%	0.00%	0.09%	0.31%	0.13%	0.13%	0.10%	0.27%	0.75%	0.03%	0.28%	0.06%	0.02%	0.00%	1.88%
20	0.04%	0.23%	0.05%	0.28%	0.16%	0.25%	0.06%	0.02%	0.34%	0.00%	0.03%	0.25%	0.14%	0.27%	1.11%
21+	1.96%	0.27%	0.45%	0.94%	0.86%	0.42%	0.30%	0.18%	0.78%	0.86%	1.25%	0.59%	1.33%	0.41%	0.67%

Table 7. Age composition of setnet females.

Age (yr)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	0.00%	0.00%	0.00%	0.07%	0.00%	0.00%	0.00%	1.20%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
3	0.00%	0.00%	0.00%	0.20%	0.45%	0.10%	0.08%	1.94%	0.32%	0.00%	0.00%	0.30%	0.00%	0.00%
4	0.00%	0.00%	0.00%	0.05%	0.43%	26.49%	2.65%	2.69%	0.32%	0.95%	0.74%	0.00%	0.00%	0.00%
5	3.80%	0.00%	0.12%	0.09%	2.49%	0.33%	40.75%	3.65%	8.85%	4.63%	2.25%	2.38%	2.34%	3.32%
6	4.86%	0.00%	4.71%	0.77%	0.83%	1.68%	0.00%	41.97%	9.97%	7.55%	3.95%	9.08%	2.34%	0.00%
7	12.02%	9.64%	3.27%	6.27%	3.98%	1.92%	1.19%	5.33%	42.02%	10.77%	10.75%	7.53%	4.69%	3.32%
8	23.37%	9.64%	5.10%	5.74%	24.02%	5.44%	0.79%	0.50%	8.77%	31.10%	9.23%	11.41%	10.49%	13.30%
9	6.97%	27.04%	4.00%	9.68%	4.22%	17.47%	5.01%	1.90%	0.00%	6.14%	32.63%	6.74%	2.34%	11.76%
10	15.15%	22.86%	11.83%	10.06%	1.90%	3.99%	30.21%	3.53%	4.31%	1.21%	4.20%	13.00%	14.96%	8.44%
11	6.22%	16.41%	13.47%	15.90%	11.49%	1.95%	0.34%	4.21%	0.25%	3.22%	2.99%	1.36%	32.08%	6.65%
12	6.63%	3.14%	18.39%	10.87%	17.29%	4.09%	4.40%	1.63%	1.07%	3.24%	5.79%	1.35%	4.97%	24.04%
13	1.97%	0.00%	9.69%	7.95%	3.30%	11.06%	0.88%	1.91%	0.00%	2.04%	7.23%	1.56%	2.62%	0.00%
14	10.63%	4.05%	6.29%	2.98%	10.92%	0.70%	3.38%	1.14%	0.39%	2.28%	5.14%	0.76%	6.62%	3.32%
15	0.00%	4.08%	0.59%	9.45%	1.04%	3.17%	0.58%	2.98%	0.00%	1.52%	2.25%	0.24%	4.21%	0.00%
16	3.41%	0.00%	1.66%	6.98%	0.77%	0.00%	2.76%	0.12%	2.13%	1.06%	2.64%	0.09%	4.62%	3.32%
17	0.00%	1.58%	4.87%	1.44%	0.92%	0.43%	0.07%	1.62%	0.00%	1.89%	0.50%	0.99%	2.69%	6.91%
18	0.00%	0.00%	1.49%	3.58%	0.97%	0.00%	0.00%	0.06%	0.00%	1.44%	1.00%	0.12%	2.69%	5.37%
19	0.00%	0.00%	1.27%	0.09%	0.00%	0.84%	0.20%	0.00%	0.00%	0.90%	0.00%	0.00%	0.00%	5.12%
20	0.00%	1.55%	0.01%	0.64%	0.89%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
21+	0.00%	0.00%	0.59%	2.13%	1.41%	2.06%	0.00%	0.12%	0.00%	0.19%	0.00%	0.73%	0.00%	1.79%

Table 8. Age composition of setnet males.

Age (yr)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	0.00%	0.00%	0.00%	0.00%	0.00%	0.33%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
3	0.00%	0.00%	0.00%	0.00%	0.39%	0.00%	0.00%	0.34%	4.87%	0.36%	0.11%	0.40%	0.00%	0.00%
4	0.00%	0.00%	0.10%	0.03%	0.77%	10.20%	0.09%	1.72%	0.46%	2.06%	0.22%	0.11%	0.00%	0.00%
5	0.00%	0.00%	0.00%	0.03%	0.27%	0.33%	3.92%	0.35%	5.14%	1.25%	1.72%	2.05%	0.00%	0.00%
6	1.44%	0.00%	0.23%	0.33%	0.26%	0.46%	0.05%	9.77%	0.27%	4.23%	1.50%	7.92%	0.00%	0.00%
7	0.00%	0.00%	0.14%	0.20%	0.35%	0.00%	0.00%	2.55%	5.56%	2.97%	0.39%	4.64%	0.00%	0.00%
8	2.75%	0.00%	0.43%	0.13%	4.92%	0.69%	0.08%	1.85%	0.14%	4.80%	0.26%	8.20%	0.00%	0.00%
9	0.00%	0.00%	0.48%	0.88%	1.07%	1.58%	0.22%	0.11%	0.00%	0.68%	2.51%	4.62%	0.00%	0.00%
10	0.78%	0.00%	0.66%	0.40%	0.27%	0.47%	0.84%	0.71%	0.00%	0.05%	0.00%	9.53%	2.34%	3.32%
11	0.00%	0.00%	2.63%	0.93%	0.27%	0.00%	0.00%	1.16%	0.00%	0.00%	0.00%	1.02%	0.00%	0.00%
12	0.00%	0.00%	2.27%	0.23%	1.89%	0.32%	0.05%	1.24%	4.09%	0.82%	0.51%	0.73%	0.00%	0.00%
13	0.00%	0.00%	1.63%	0.70%	0.59%	2.94%	0.55%	0.47%	0.00%	0.56%	0.00%	0.73%	0.00%	0.00%
14	0.00%	0.00%	0.42%	0.45%	1.59%	0.29%	0.00%	0.53%	0.00%	0.46%	0.00%	0.00%	0.00%	0.00%
15	0.00%	0.00%	0.00%	0.08%	0.00%	0.22%	0.83%	0.89%	0.00%	0.32%	0.12%	0.14%	0.00%	0.00%
16	0.00%	0.00%	0.47%	0.09%	0.00%	0.00%	0.00%	0.76%	0.00%	0.00%	0.04%	0.76%	0.00%	0.00%
17	0.00%	0.00%	0.36%	0.00%	0.01%	0.00%	0.04%	0.56%	0.00%	0.72%	0.00%	0.73%	0.00%	0.00%
18	0.00%	0.00%	0.00%	0.31%	0.00%	0.45%	0.04%	0.02%	1.07%	0.07%	1.33%	0.00%	0.00%	0.00%
19	0.00%	0.00%	1.99%	0.10%	0.00%	0.00%	0.00%	0.05%	0.00%	0.49%	0.00%	0.00%	0.00%	0.00%
20	0.00%	0.00%	0.15%	0.06%	0.00%	0.00%	0.00%	0.13%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
21+	0.00%	0.00%	0.67%	0.10%	0.00%	0.00%	0.00%	0.28%	0.00%	0.00%	0.00%	0.78%	0.00%	0.00%

Table 9. Age composition of hook-and-line females.

Age (yr)	1985	1986	1987	1990	1991	1992	1993	1994	1995	1996
1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	0.00%	0.00%	0.36%	0.00%	0.76%	0.00%	0.00%	0.00%	0.00%	0.00%
3	0.00%	0.39%	0.00%	0.00%	2.81%	0.21%	3.60%	0.03%	0.48%	1.23%
4	0.00%	0.64%	0.29%	10.00%	3.24%	2.40%	15.87%	3.73%	1.94%	6.26%
5	0.00%	0.00%	0.00%	0.00%	9.78%	9.45%	11.75%	5.93%	3.43%	25.69%
6	2.48%	3.12%	0.00%	60.00%	8.96%	11.89%	12.88%	9.64%	15.50%	20.72%
7	5.39%	8.94%	0.18%	30.00%	26.24%	10.11%	10.60%	6.17%	18.65%	5.81%
8	13.16%	3.56%	57.78%	0.00%	6.65%	19.20%	7.50%	9.83%	10.33%	9.44%
9	5.14%	10.68%	0.20%	0.00%	3.28%	5.09%	14.74%	4.25%	9.50%	2.00%
10	12.96%	7.13%	8.22%	0.00%	2.05%	1.73%	2.64%	2.75%	2.91%	7.13%
11	7.26%	15.79%	0.10%	0.00%	1.36%	2.37%	0.95%	2.00%	3.84%	1.37%
12	20.95%	7.93%	8.42%	0.00%	2.16%	4.12%	0.97%	0.01%	2.16%	3.26%
13	3.76%	14.93%	0.10%	0.00%	0.00%	2.32%	1.87%	2.03%	0.00%	0.21%
14	9.05%	1.86%	0.00%	0.00%	0.62%	2.68%	1.14%	2.00%	0.66%	0.07%
15	5.56%	8.47%	0.00%	0.00%	0.18%	1.30%	0.47%	0.15%	0.00%	0.00%
16	3.92%	2.44%	0.00%	0.00%	0.40%	0.15%	0.37%	1.82%	0.30%	0.63%
17	2.64%	2.48%	8.22%	0.00%	0.00%	1.07%	0.36%	0.00%	0.00%	0.00%
18	1.44%	1.76%	0.00%	0.00%	0.30%	0.08%	0.35%	0.00%	0.00%	0.00%
19	0.00%	3.06%	8.22%	0.00%	0.00%	1.32%	0.28%	0.05%	0.11%	0.06%
20	2.04%	0.57%	0.00%	0.00%	0.00%	0.06%	0.38%	0.00%	0.27%	0.07%
21+	2.17%	0.64%	0.18%	0.00%	0.00%	1.08%	0.59%	1.83%	0.00%	0.00%

Table 10. Age composition of hook-and-line males.

Age (yr)	1985	1986	1987	1990	1991	1992	1993	1994	1995	1996
1	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	0.00%	0.00%	0.00%	0.00%	0.12%	0.01%	0.00%	0.00%	0.00%	0.00%
3	0.00%	0.00%	0.00%	0.00%	2.37%	0.05%	0.68%	0.00%	0.00%	0.18%
4	0.00%	0.00%	0.11%	0.00%	2.64%	1.03%	2.46%	3.65%	0.00%	1.26%
5	0.00%	0.00%	0.00%	0.00%	5.38%	5.07%	0.31%	5.49%	3.84%	2.38%
6	0.00%	0.00%	0.00%	0.00%	3.93%	2.76%	0.69%	9.09%	5.19%	1.32%
7	0.00%	0.80%	0.00%	0.00%	7.99%	2.18%	2.03%	5.52%	5.97%	3.08%
8	0.59%	0.00%	0.00%	0.00%	1.82%	4.21%	1.35%	9.08%	4.29%	2.07%
9	0.00%	0.00%	0.00%	0.00%	0.00%	1.64%	1.62%	3.72%	2.01%	0.12%
10	0.00%	1.27%	0.00%	0.00%	0.58%	0.54%	0.17%	2.05%	1.17%	2.03%
11	0.00%	0.39%	0.00%	0.00%	0.87%	0.50%	0.22%	1.84%	2.41%	0.55%
12	0.00%	0.05%	0.05%	0.00%	1.80%	0.70%	0.68%	0.00%	0.87%	2.43%
13	0.37%	0.95%	0.00%	0.00%	0.00%	0.22%	0.45%	1.84%	0.00%	0.00%
14	1.10%	0.79%	0.00%	0.00%	1.00%	1.50%	0.04%	1.81%	1.03%	0.00%
15	0.00%	0.88%	0.00%	0.00%	0.00%	1.37%	0.59%	0.03%	0.39%	0.00%
16	0.00%	0.02%	0.00%	0.00%	0.86%	0.08%	1.05%	1.81%	0.00%	0.63%
17	0.00%	0.39%	3.77%	0.00%	0.00%	0.84%	0.00%	0.00%	0.39%	0.00%
18	0.00%	0.00%	0.00%	0.00%	1.22%	0.30%	0.04%	0.00%	0.00%	0.00%
19	0.00%	0.00%	3.77%	0.00%	0.00%	0.13%	0.36%	0.00%	0.11%	0.00%
20	0.00%	0.00%	0.00%	0.00%	0.63%	0.00%	0.00%	0.00%	0.66%	0.00%
21+	0.00%	0.00%	0.00%	0.00%	0.00%	0.24%	0.00%	1.84%	1.56%	0.00

Table 11. Length compositions of trawl females.

FL (cm)	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
18	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
20	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.03%	0.00%	0.02%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%
22	0.03%	0.00%	0.32%	0.00%	0.01%	0.26%	0.02%	0.03%	0.00%	0.00%	0.00%	0.06%	0.01%	0.14%	0.00%	0.01%	0.06%
24	0.00%	0.00%	0.20%	0.03%	0.04%	0.08%	0.01%	0.11%	0.05%	0.06%	0.06%	0.40%	0.33%	1.00%	0.11%	0.48%	0.25%
26	0.21%	0.08%	0.23%	0.12%	0.23%	0.20%	0.46%	0.99%	0.47%	0.15%	0.21%	1.25%	2.25%	1.95%	0.71%	0.53%	1.96%
28	0.77%	0.55%	0.80%	0.57%	0.31%	0.77%	1.12%	4.36%	1.20%	1.64%	1.51%	2.53%	5.11%	7.60%	1.81%	2.11%	4.49%
30	0.78%	0.40%	2.15%	2.00%	1.17%	1.79%	1.99%	14.04%	5.02%	3.21%	2.95%	4.39%	8.11%	13.66%	2.77%	4.61%	4.52%
32	2.91%	1.11%	2.88%	2.68%	4.10%	3.82%	3.47%	11.99%	12.30%	5.26%	5.46%	6.94%	7.47%	9.13%	4.87%	5.88%	3.07%
34	5.73%	1.79%	2.28%	3.09%	7.38%	5.91%	7.02%	3.74%	13.61%	9.47%	6.14%	6.28%	7.09%	8.58%	6.83%	5.58%	3.79%
36	7.08%	8.50%	4.75%	3.47%	11.38%	10.80%	11.22%	2.58%	8.80%	15.88%	7.23%	7.07%	6.66%	8.71%	11.27%	7.59%	6.12%
38	9.66%	16.51%	7.80%	4.67%	8.38%	12.44%	12.25%	4.62%	3.44%	12.33%	13.35%	7.57%	7.81%	6.25%	6.63%	10.79%	5.70%
40	8.43%	11.64%	11.68%	11.43%	9.36%	7.96%	8.85%	7.01%	3.80%	4.02%	9.93%	7.97%	7.15%	5.19%	6.40%	9.34%	6.02%
42	11.40%	11.40%	12.28%	17.77%	9.95%	6.77%	8.02%	6.42%	5.75%	3.19%	4.36%	4.64%	6.17%	3.97%	5.00%	6.82%	5.40%
44	6.75%	6.22%	11.01%	12.96%	9.12%	6.11%	5.52%	3.19%	5.27%	3.09%	2.90%	2.81%	3.75%	2.11%	4.33%	4.18%	2.27%
46	5.51%	7.52%	7.12%	10.32%	6.53%	4.31%	3.39%	2.11%	1.95%	1.23%	2.08%	1.48%	2.11%	0.66%	2.05%	3.07%	1.74%
48	3.99%	4.76%	5.95%	7.02%	4.63%	2.08%	1.74%	0.96%	1.54%	0.69%	1.07%	0.98%	1.44%	0.41%	1.00%	0.86%	0.61%
50	1.54%	1.64%	2.04%	2.88%	1.21%	0.42%	0.46%	0.29%	0.50%	0.08%	0.30%	0.37%	0.26%	0.07%	0.09%	0.33%	0.13%
52	0.12%	0.07%	0.44%	0.28%	0.34%	0.10%	0.03%	0.01%	0.04%	0.00%	0.03%	0.12%	0.00%	0.00%	0.07%	0.13%	0.03%
54	0.00%	0.00%	0.58%	0.31%	0.13%	0.02%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%
56	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%
58	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
60+	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Table 12. Length composition of trawl males.

FL (cm)	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
18	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
20	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.05%	0.01%	0.01%	0.00%	0.00%	0.00%
22	0.00%	0.00%	0.57%	0.02%	0.00%	0.01%	0.08%	0.01%	0.01%	0.02%	0.09%	0.01%	0.02%	0.19%	0.04%	0.11%	0.82%
24	0.19%	0.00%	0.01%	0.06%	0.03%	0.02%	0.21%	0.11%	0.11%	0.07%	0.11%	0.42%	0.21%	1.23%	0.42%	0.85%	5.16%
26	0.22%	0.09%	0.75%	0.18%	0.29%	0.29%	0.89%	1.98%	1.22%	0.89%	0.79%	1.45%	1.75%	5.49%	4.89%	2.26%	10.91%
28	1.31%	0.12%	2.85%	1.44%	1.14%	2.57%	3.02%	8.39%	5.98%	4.47%	3.30%	5.77%	3.82%	9.50%	10.52%	6.70%	10.04%
30	4.99%	3.90%	4.00%	3.77%	3.28%	7.13%	9.14%	6.86%	8.73%	12.11%	8.95%	9.99%	8.24%	7.94%	12.52%	9.24%	8.73%
32	9.86%	9.11%	7.27%	4.33%	6.25%	11.17%	9.88%	8.80%	8.36%	12.05%	15.26%	13.88%	10.48%	4.30%	9.63%	11.14%	9.90%
34	10.74%	10.85%	7.60%	5.63%	7.65%	9.26%	6.84%	8.03%	7.10%	6.93%	8.73%	8.00%	6.38%	1.41%	5.90%	4.80%	6.51%
36	5.33%	2.70%	3.43%	3.25%	5.34%	4.40%	3.14%	2.66%	3.88%	2.75%	3.92%	4.13%	2.04%	0.46%	1.51%	1.85%	1.19%
38	1.09%	0.68%	0.87%	0.94%	1.07%	0.82%	0.61%	0.41%	0.44%	0.27%	0.88%	1.01%	0.66%	0.01%	0.46%	0.31%	0.22%
40	0.23%	0.01%	0.09%	0.19%	0.10%	0.31%	0.31%	0.22%	0.25%	0.04%	0.25%	0.22%	0.20%	0.00%	0.04%	0.11%	0.10%
42	0.31%	0.34%	0.01%	0.18%	0.17%	0.05%	0.14%	0.05%	0.16%	0.03%	0.00%	0.02%	0.14%	0.00%	0.12%	0.08%	0.05%
44	0.18%	0.00%	0.00%	0.18%	0.10%	0.05%	0.00%	0.00%	0.00%	0.00%	0.10%	0.07%	0.18%	0.00%	0.00%	0.09%	0.09%
46	0.31%	0.01%	0.00%	0.18%	0.18%	0.02%	0.03%	0.00%	0.00%	0.01%	0.00%	0.00%	0.06%	0.00%	0.00%	0.14%	0.00%
48	0.19%	0.00%	0.06%	0.01%	0.06%	0.06%	0.11%	0.00%	0.00%	0.00%	0.01%	0.05%	0.09%	0.00%	0.00%	0.00%	0.10%
50	0.06%	0.00%	0.00%	0.06%	0.08%	0.02%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%
52	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
54	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
56	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
58	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
60+	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Table 13. Length compositions of setnet females.

FL (cm)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
18	0.00%	0.12%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
20	0.00%	1.46%	0.00%	0.00%	0.00%	0.00%	0.00%	0.26%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
22	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.15%	0.00%	0.00%
24	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.27%	0.00%	0.15%
26	0.00%	0.00%	0.00%	0.00%	0.00%	0.06%	0.00%	0.62%	0.07%	0.00%	0.22%	1.86%	0.38%	0.26%
28	0.00%	0.00%	0.00%	0.06%	0.29%	0.06%	0.74%	0.99%	1.01%	0.60%	2.76%	2.90%	1.04%	0.73%
30	0.00%	0.00%	0.00%	0.17%	0.31%	0.33%	2.50%	1.09%	2.88%	1.66%	4.34%	2.53%	1.79%	1.05%
32	0.00%	0.00%	0.07%	0.04%	0.14%	6.04%	3.82%	2.19%	6.03%	2.34%	5.30%	4.61%	4.80%	2.41%
34	0.00%	0.00%	0.39%	0.13%	0.35%	12.16%	10.75%	2.41%	5.54%	5.11%	6.16%	3.90%	3.39%	2.63%
36	0.87%	0.00%	2.54%	1.09%	0.89%	2.45%	13.22%	6.04%	8.73%	6.36%	14.64%	4.66%	4.18%	4.54%
38	6.40%	0.00%	5.83%	4.61%	1.70%	1.05%	12.90%	22.43%	12.19%	10.18%	19.89%	5.64%	6.44%	9.65%
40	18.13%	20.52%	8.95%	18.52%	14.16%	1.28%	8.56%	20.56%	18.84%	15.96%	18.65%	8.94%	9.17%	12.72%
42	23.80%	35.51%	20.17%	18.82%	22.21%	25.17%	12.85%	4.33%	9.32%	16.38%	10.08%	11.98%	12.32%	16.03%
44	31.93%	23.91%	26.53%	22.83%	19.47%	22.73%	8.59%	7.12%	2.13%	7.00%	5.56%	5.51%	7.65%	14.83%
46	10.78%	11.29%	18.40%	20.68%	17.07%	11.43%	13.86%	4.86%	2.82%	6.40%	0.81%	2.34%	4.01%	6.07%
48	2.84%	5.60%	4.31%	5.52%	6.16%	3.06%	0.53%	2.38%	1.76%	2.66%	0.00%	1.15%	1.31%	3.86%
50	0.00%	1.58%	0.39%	0.75%	2.97%	0.47%	1.49%	0.22%	0.00%	0.43%	0.00%	0.10%	0.27%	0.00%
52	0.00%	0.00%	0.00%	0.00%	0.23%	0.00%	2.32%	0.05%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%
54	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
56	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
58	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
60+	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Table 14. Length composition of setnet males.

FL (cm)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
18	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
20	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
22	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.15%	0.00%	0.00%
24	0.00%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.16%	1.27%	0.00%	0.15%
26	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.21%	0.53%	0.99%	1.99%	0.38%	0.26%
28	0.00%	0.00%	0.05%	0.00%	0.79%	0.62%	1.28%	0.48%	3.42%	1.61%	2.69%	2.92%	1.04%	0.73%
30	0.87%	0.00%	0.23%	0.03%	1.84%	9.66%	1.85%	6.29%	5.38%	4.15%	4.75%	3.07%	1.79%	1.05%
32	1.64%	0.00%	2.49%	1.06%	3.20%	1.15%	2.76%	8.90%	7.98%	7.94%	1.95%	5.22%	4.80%	3.26%
34	0.78%	0.00%	5.61%	2.74%	3.24%	0.99%	1.05%	4.35%	4.65%	2.99%	0.83%	4.26%	3.52%	1.77%
36	0.00%	0.00%	2.43%	1.28%	2.38%	1.13%	0.53%	2.24%	3.71%	1.90%	0.20%	4.05%	4.18%	2.83%
38	1.97%	0.00%	1.57%	0.76%	1.55%	0.02%	0.23%	1.20%	1.92%	1.61%	0.00%	3.77%	5.82%	5.39%
40	0.00%	0.00%	0.00%	0.16%	0.20%	0.03%	0.11%	0.68%	0.29%	2.00%	0.02%	6.12%	7.94%	4.19%
42	0.00%	0.00%	0.06%	0.29%	0.27%	0.00%	0.00%	0.01%	1.11%	1.26%	0.00%	5.54%	7.79%	2.39%
44	0.00%	0.00%	0.00%	0.17%	0.24%	0.02%	0.00%	0.30%	0.00%	0.45%	0.00%	2.77%	4.45%	2.04%
46	0.00%	0.00%	0.00%	0.15%	0.21%	0.00%	0.00%	0.00%	0.00%	0.30%	0.00%	0.89%	1.24%	0.96%
48	0.00%	0.00%	0.00%	0.14%	0.09%	0.00%	0.00%	0.00%	0.01%	0.03%	0.00%	0.42%	0.31%	0.02%
50	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.13%	0.00%	0.00%	0.00%	0.00%
52	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%
54	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
56	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
58	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
60+	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Table 15. Length composition of hook-and-line females.

FL (cm)	1980	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
18	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
20	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.08%	0.00%	0.02%	0.00%	0.02%	0.32%
22	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.17%	0.11%	0.23%
24	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.75%	0.00%	0.00%	0.01%	0.16%	0.02%	0.88%	0.34%	0.00%
26	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.07%	0.75%	0.00%	0.00%	0.46%	0.29%	3.20%	2.85%	0.46%	1.70%
28	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	7.18%	0.16%	0.00%	0.42%	0.47%	6.46%	5.98%	2.64%	4.86%
30	0.00%	0.00%	0.00%	0.00%	0.00%	0.41%	0.32%	4.18%	0.04%	1.08%	1.91%	2.71%	12.04%	6.68%	4.79%	7.56%
32	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.14%	4.68%	3.55%	0.39%	5.00%	3.98%	10.67%	6.45%	5.30%	6.14%
34	0.00%	0.00%	0.00%	0.00%	0.09%	0.02%	0.00%	10.57%	9.10%	7.27%	7.55%	8.58%	10.15%	7.08%	4.76%	11.53%
36	0.00%	0.00%	0.00%	0.00%	2.05%	0.97%	4.20%	3.69%	8.36%	16.23%	14.53%	8.92%	8.48%	5.94%	6.94%	11.69%
38	9.68%	10.10%	2.22%	5.31%	10.29%	3.01%	18.76%	5.29%	1.69%	50.73%	9.47%	12.27%	6.09%	4.55%	13.03%	11.47%
40	0.22%	4.97%	17.74%	10.62%	15.00%	13.21%	26.14%	2.64%	5.75%	14.93%	13.52%	10.53%	3.72%	3.96%	6.18%	9.28%
42	0.11%	9.95%	8.89%	15.93%	10.33%	11.17%	15.20%	2.63%	2.04%	0.22%	6.29%	13.39%	2.13%	3.27%	4.03%	4.93%
44	19.57%	34.25%	11.07%	21.24%	33.20%	32.96%	11.37%	4.30%	0.90%	0.57%	3.48%	8.24%	1.54%	2.23%	2.89%	2.25%
46	39.78%	20.36%	28.78%	19.17%	15.42%	21.88%	4.16%	3.30%	1.29%	0.91%	1.80%	4.27%	0.54%	1.04%	1.27%	1.07%
48	29.89%	15.16%	29.08%	19.17%	7.52%	10.46%	11.54%	0.04%	1.72%	0.00%	0.37%	1.84%	0.31%	0.52%	0.75%	0.14%
50	0.22%	5.21%	0.00%	0.00%	0.66%	3.06%	0.22%	0.00%	0.10%	0.00%	0.11%	0.56%	0.12%	0.35%	0.33%	0.10%
52	0.00%	0.00%	0.00%	8.55%	0.00%	0.01%	0.00%	0.00%	0.06%	0.00%	0.00%	0.02%	0.03%	0.19%	0.00%	0.00%
54	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.02%	0.00%	0.00%
56	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
58	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
60+	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Table 16. Length composition of hook-and-line males.

FL (cm)	1980	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
18	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
20	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%
22	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.32%	0.17%	0.11%	0.00%
24	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.75%	0.00%	0.00%	0.80%	0.05%	2.43%	0.88%	0.34%	1.80%
26	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.75%	0.00%	0.00%	1.05%	0.23%	2.75%	2.85%	0.46%	2.20%
28	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.06%	7.18%	1.91%	0.00%	2.74%	1.78%	4.77%	5.96%	2.91%	0.55%
30	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	4.18%	8.78%	1.30%	7.55%	6.36%	6.21%	6.76%	5.15%	1.11%
32	0.00%	0.00%	2.22%	0.00%	1.43%	0.00%	0.24%	4.68%	5.30%	1.17%	11.85%	7.84%	6.76%	6.47%	6.39%	9.07%
34	0.00%	0.00%	0.00%	0.00%	1.70%	2.17%	0.06%	10.57%	33.57%	2.60%	7.61%	4.43%	4.92%	6.82%	5.24%	3.20%
36	0.11%	0.00%	0.00%	0.00%	2.16%	0.01%	0.00%	3.69%	12.81%	2.61%	1.69%	1.89%	2.38%	5.40%	5.76%	2.38%
38	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	7.44%	5.29%	1.88%	0.00%	0.46%	0.61%	1.22%	3.62%	8.27%	1.44%
40	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.64%	0.11%	0.00%	0.40%	0.18%	0.87%	3.19%	4.20%	2.29%
42	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	2.63%	0.29%	0.00%	0.43%	0.18%	0.62%	2.52%	2.29%	1.60%
44	0.00%	0.00%	0.00%	0.00%	0.14%	0.00%	0.00%	4.30%	0.12%	0.00%	0.20%	0.08%	0.49%	1.75%	2.54%	0.76%
46	0.11%	0.00%	0.00%	0.00%	0.00%	0.63%	0.00%	3.30%	0.13%	0.00%	0.20%	0.03%	0.33%	0.82%	1.00%	0.19%
48	0.22%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.04%	0.17%	0.00%	0.00%	0.01%	0.23%	0.37%	0.83%	0.09%
50	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.10%	0.00%	0.00%	0.08%	0.12%	0.19%	0.59%	0.07%
52	0.11%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.06%	0.00%	0.00%	0.04%	0.03%	0.05%	0.00%	0.00%
54	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.08%	0.00%
56	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
58	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
60+	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Table 17. Likelihood components, emphasis levels, and their relative values in the final fit of the base model.

	Likelihood Component	Emphasis	Value
1.	Trawl age composition	1.000	-561.83
2.	Trawl length composition	1.000	-576.66
3.	Trawl length@age	1.000	-712.25
4.	Setnet age composition	1.000	-804.03
5.	Setnet length composition	1.000	-573.48
6.	Setnet length@age	1.000	-362.18
7.	Recreational length comps	1.000	-478.30
8.	Hook age composition	1.000	-385.13
9.	Hook length composition	1.000	-654.54
10.	Hook length@age	1.000	-273.33
11.	Triennial survey CPUE	1.000	-8.59
12.	Triennial length comps	1.000	-321.27
13.	MWT recruit survey	1.000	6.60
14.	Trawl logbook CPUE	1.000	-21.64
15.	Trawl CPUE	0.001	15.17
16.	Recreational CPUE	0.001	-5.78
17.	Spawner-recruit Indiv	1.000	-8.55
18.	Spawner-recruit Mean	0.000	-13.33
	Total log-likelihood:		-5735.23

Table 18. Parameter list, estimated values, and estimation status (0 = fixed, 2 = estimated) in the final fit of the base model.

Parameter	Value	Estimated/ Fixed
Natural Mortality		
1. Female natural mortality	.223	0
2. Male natural mortality	.253	0
Trawl fishery selectivity		
3. Min size selecti	.000	0
4. Size@ascend infl	.197	2
5. Ascending slope	.505	2
Setnet fishery selectivity		
6. Transition lengt	43.873	2
7. Min size selecti	.000	0
8. Size@ascend infl	.632	2
9. Ascending slope	.351	2
10. F-max size selec	.282	2
11. F-descend inflec	.080	2
12. F-descend slope	3.595	2
Recreational fishery selectivity		
13. Transition lengt	41.461	2
14. Min size selecti	.000	0
15. Size@ascend infl	.304	2
16. Ascending slope	.479	2
17. F-max size selec	.245	2
18. F-descend inflec	.050	2
19. F-descend slope	.475	2
Hook-and-line fishery selectivity		
20. Transition lengt	45.000	2
21. Min size selecti	.000	0
22. Size@ascend infl	.432	2
23. Ascending slope	.462	2
24. F-max size selec	.191	2
25. F-descend inflec	.153	2
26. F-descend slope	2.708	2
Triennial survey selectivity		
27. Min size selecti	.255	2
28. Size@ascend infl	.397	2
29. Ascending slope	.878	2
Midwater trawl survey selectivity		
30. MWT SURVEY AGE	1.000	0
31. MWT-M SELECTIVIT	1.000	0
Trawl logbook selectivity		
32. Min size selecti	.000	0
33. Size@ascend infl	.450	0
34. Ascending slope	.440	0

Table 18. -- cont'd.

Ageing precision		
35. %AGREE @ 1 (MIN)	.900	0
36. %AGREE @ 21(MAX)	.300	0
37. POWER	1.000	0
38. OLD DISCOUNT	.150	0
39. %MIS-SEXED	.000	0
Trawl fishery CPUE		
40. Q-MEAN TRAWL	.008	0
41. Q-SLP TRAWL	.000	0
Recreational fishery CPUE		
42. Q-MEAN RECREATIO	.006	0
43. Q-SLP RECREATION	.000	0
Growth parameters		
44. FEMALE L1	12.885	0
45. FEMALE L2	47.479	0
46. FEMALE K	.192	0
47. FEMALE CV1	.231	0
48. FEMALE CV21	.085	0
49. MALE L1	18.229	0
50. MALE L2	33.523	0
51. MALE K	.233	0
52. MALE CV1	.157	0
53. MALE CV21	.102	0
Time-varying selectivity parameters		
54. TRAWL ASC INFLC	1.000	0
55. SETNET ASC INFLC	1.000	0
56. RECREA ASC INFLC	1.000	0
57. HOOK ASC INFLC	1.000	0
58. 1970-82 ENV	.286	2
59. 1983 Env	.303	2
60. 1984 Env	.291	2
61. 1985 Env	.243	2
62. 1986 Env	.256	2
63. 1987 Env	.256	2
64. 1988 Env	.267	2
65. 1989 Env	.261	2
66. 1990 Env	.260	2
67. 1991 Env	.227	2
68. 1992 Env	.203	2
69. 1993 Env	.109	2
70. 1994 Env	.174	2
71. 1995 Env	.220	2
72. 1996-98 Env	.172	2

Table 18. — cont'd.

Recruitment Parameters			
73.	VIRGIN RECR MULT	1.801	2
74.	B/H S/R PARAM	1.000	0
75.	BACKG. RECRUIT	.000	0
76.	S/R STD.DEV.	1.000	0
77.	Recruitment trend	.000	0
78.	Recruitment multiplier	1.000	0
79.	Recruit 70	2.133	2
80.	Recruit 71	1.882	2
81.	Recruit 72	2.545	2
82.	Recruit 73	.660	2
83.	Recruit 74	3.328	2
84.	Recruit 75	.967	2
85.	Recruit 76	2.739	2
86.	Recruit 77	.540	2
87.	Recruit 78	.921	2
88.	Recruit 79	.501	2
89.	Recruit 80	1.842	2
90.	Recruit 81	.686	2
91.	Recruit 82	.406	2
92.	Recruit 83	.196	2
93.	Recruit 84	.260	2
94.	Recruit 85	5.587	2
95.	Recruit 86	.718	2
96.	Recruit 87	1.573	2
97.	Recruit 88	1.354	2
98.	Recruit 89	1.640	2
99.	Recruit 90	1.402	2
100.	Recruit 91	.823	2
101.	Recruit 92	1.342	2
102.	Recruit 93	.546	2
103.	Recruit 94	1.939	2
104.	Recruit 95	.485	2
105.	Recruit 96	.775	2
106.	Recruit 97	.430	2
107.	Recruit 98	.908	2

Total Number of estimated parameters:	68
Total number of fixed parameters:	39
Total number of parameters:	107

Table 19. Trends in chilipepper stock biomass, spawning output, and recruitment.

	Age 1+ Biomass	Age 3+ Biomass	Spawning Output	Age 1 Recruits
Virgin	69,296	64,746	58,516	45,017
Equilibrium	61,865	57,315	47,946	45,017
1970	62,156	57,315	47,946	53,320
1971	62,442	57,272	47,924	47,061
1972	63,420	58,082	48,011	63,629
1973	62,598	57,820	47,480	16,512
1974	62,530	58,522	46,404	83,210
1975	61,400	55,060	45,502	24,183
1976	61,260	57,263	44,499	68,479
1977	59,907	54,914	43,872	13,500
1978	58,443	56,744	43,959	23,025
1979	55,865	53,907	44,093	12,513
1980	52,702	50,262	42,546	46,046
1981	48,753	45,113	39,778	17,147
1982	44,928	43,440	36,915	10,150
1983	40,736	39,894	34,201	4,908
1984	35,938	35,387	30,893	6,499
1985	36,094	30,767	27,866	139,679
1986	35,562	25,718	23,955	17,938
1987	37,235	34,673	21,837	39,313
1988	39,357	35,575	22,722	33,862
1989	40,965	37,293	24,454	40,992
1990	41,602	37,669	25,707	35,049
1991	41,346	38,311	26,562	20,582
1992	40,591	38,057	26,934	33,545
1993	39,513	36,821	27,520	13,655
1994	38,989	36,389	27,849	48,482
1995	37,996	34,373	27,852	12,114
1996	36,753	35,274	27,344	19,370
1997	34,988	33,333	27,033	10,760
1998	33,469	31,963	26,744	22,693

Table 20. Results of profiling the stock assessment model on female and male natural mortality rates (M [yr^{-1}]). Presented for each of 81 different combinations of these two parameters are the total log-likelihood values representing the model's fit to the data. Log-likelihood values greater than -5750 are shaded in grey. The two bolded and underlined combinations were used as bounds on the likely range of M (see text for further discussion).

	♀ M								
♂ M	0.14	0.16	0.18	0.20	0.22	0.24	0.26	0.28	0.30
0.18	-5778	-5842	-5943	-6055	-6197	-6421	-6727	-7112	-7573
0.20	-5756	**<u>-5755</u>**	-5799	-5880	-5975	-6117	-6342	-6648	-7031
0.22	-5821	-5759	-5742	-5767	-5829	-5912	-6056	-6282	-6588
0.24	-5962	-5846	-5771	-5739	-5747	-5792	-5866	-6014	-6242
0.26	-6169	-6006	-5878	-5790	-5744	-5737	-5766	-5837	-5989
0.28	-6433	-6228	-6054	-5916	-5816	-5756	-5735	-5750	-5826
0.30	-6745	-6503	-6289	-6107	-5958	-5848	-5775	**<u>-5742</u>**	-5751
0.32	-7099	-6824	-6575	-6354	-6163	-6006	-5884	-5801	-5756
0.34	-7487	-7185	-6905	-6650	-6421	-6223	-6057	-5926	-5833

Table 21. Projections of chilipepper yield under different constant harvest rate policies. Projected recruitments assumed equal to the average of 1993-98 recruitments. Bolded values represent the percentage reduction in spawning output from virgin conditions, defined optimistically on the basis of mean recruitment (1970-98) and SPR at F=0.

Fishing Rate	Year	Age 3+ Biomass	Spawning Output	Recruits (Age 1)	Exploitation Rate	Total Yield (mt)
F35%	1999	29,622	25,934	21,000	17.4%	5,147
	2000	24,997	21,164	21,000	17.0%	4,243
	2001	21,639	17,443	21,000	16.6%	3,592
	2002	19,373	14,781	21,000	16.3%	3,157
	2003	17,886	12,967	21,000	16.1%	2,875
	% reduction after 3 years:		**40%**	3 Year ABC	(1999-2001):	4,327
	% reduction after 5 years:		**30%**	5 Year ABC	(1999-2003):	3,803
F40%	1999	29,622	25,934	21,000	14.6%	4,316
	2000	25,728	21,951	21,000	14.3%	3,670
	2001	22,789	18,697	21,000	14.0%	3,187
	2002	20,733	16,271	21,000	13.8%	2,853
	2003	19,335	14,551	21,000	13.6%	2,629
	% reduction after 3 years:		**43%**	3 Year ABC	(1999-2001):	3,724
	% reduction after 5 years:		**33%**	5 Year ABC	(1999-2003):	3,331
F50%	1999	29,622	25,934	21,000	10.3%	3,057
	2000	26,839	23,151	21,000	10.1%	2,721
	2001	24,608	20,700	21,000	10.0%	2,455
	2002	22,969	18,758	21,000	9.8%	2,262
	2003	21,798	17,303	21,000	9.8%	2,127
	% reduction after 3 years:		**48%**	3 Year ABC	(1999-2001):	2,744
	% reduction after 5 years:		**40%**	5 Year ABC	(1999-2003):	2,525
F60%	1999	29,622	25,934	21,000	7.2%	2,141
	2000	27,650	24,032	21,000	7.1%	1,967
	2001	25,992	22,238	21,000	7.0%	1,825
	2002	24,737	20,754	21,000	6.9%	1,719
	2003	23,816	19,602	21,000	6.9%	1,643
	% reduction after 3 years:		**51%**	3 Year ABC	(1999-2001):	1,978
	% reduction after 5 years:		**45%**	5 Year ABC	(1999-2003):	1,859

Table 22. Decision table highlighting the repercussions of uncertainty in chilipepper model specification. Presented as different "states of nature" are models with different emphases on the AFSC triennial shelf trawl survey and the California trawl logbook index. The impact of incorrect model specification is measured by the effect on spawning output, expressed as the ratio of spawning output in the year 2001 to that in 1995. Note that current harvest levels (~1,500 mt) are substantially less than any of the calculated ABCs. See text for further discussion.

	State of Nature		
Model ⟶	No Triennial	Base Model	No Logbook
California trawl logbook emphasis	1.000	1.000	0.001
AFSC triennial survey biomass emphasis	0.001	1.000	1.000
Ending Summary Biomass [mt]	33,480	31,965	35,194
Average recruitment age-1 fish (1993-98)	24,298	21,193	23,174
F40% ABC	4,074	3,726	4,110

Management Action		2001 Spawning Output / 1995 Spawning Output		
ABC:	4,074	63%	67%	73%
ABC:	3,726	65%	69%	75%
ABC:	4,110	63%	66%	73%

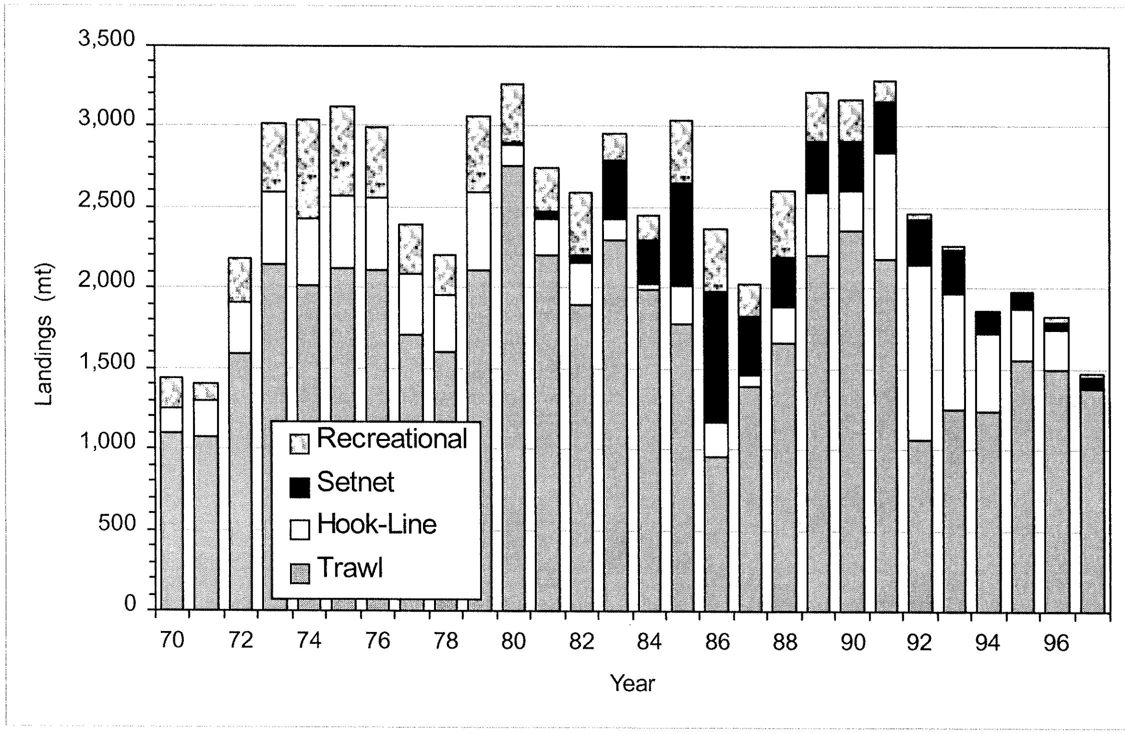
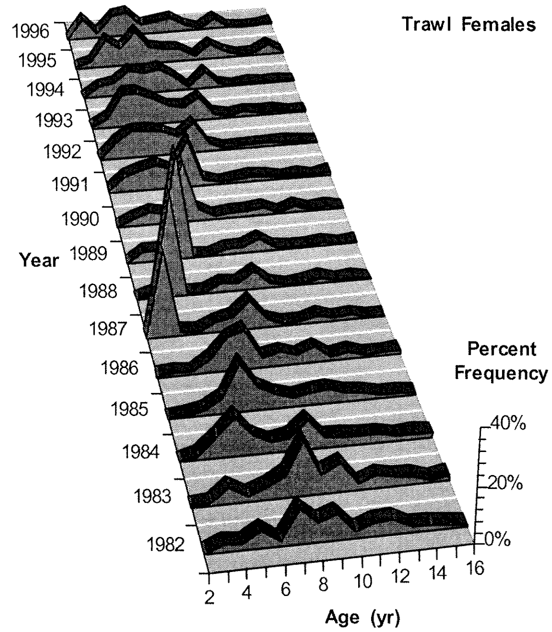


Figure 1. Estimated landings of chilipepper rockfish by the trawl, hook-and-line, setnet, and recreational fisheries over the 1970-98 time period.



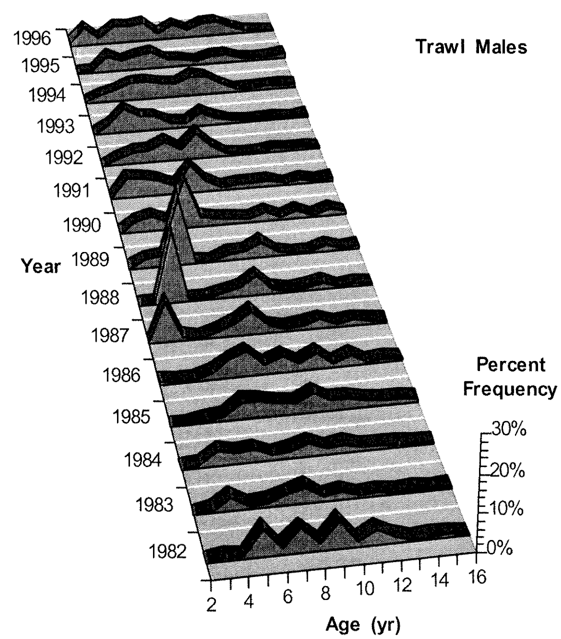


Figure 2. Age compositions of female and male chilipepper rockfish sampled from the trawl fishery (1982-96).

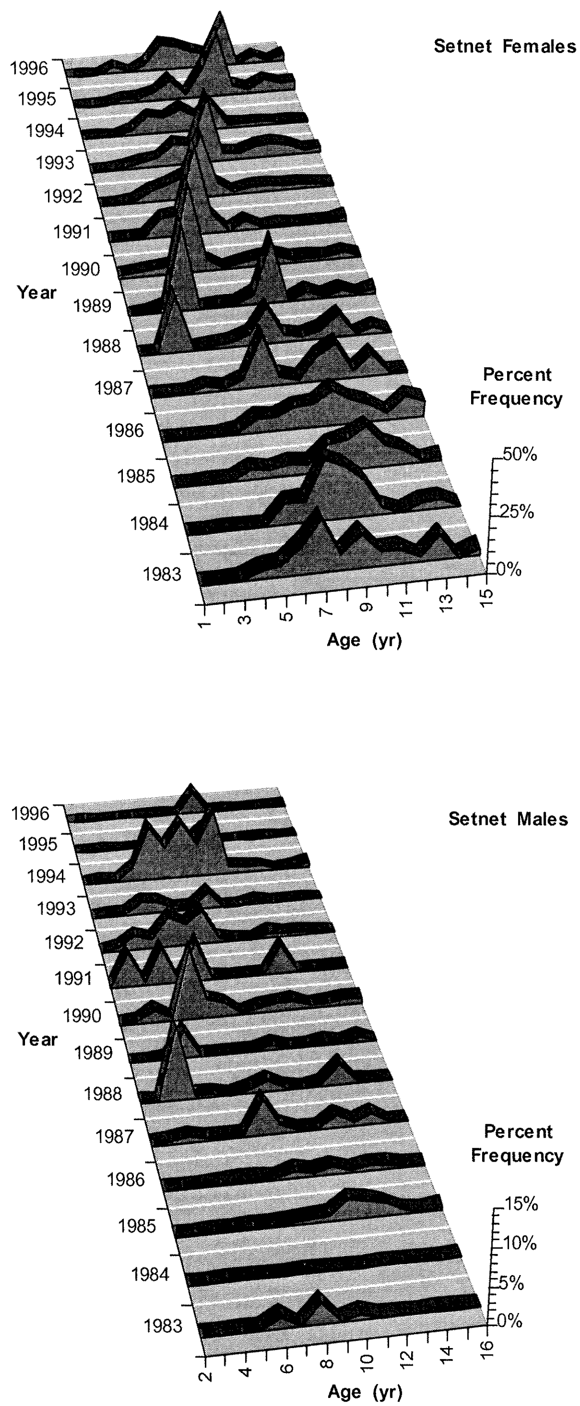
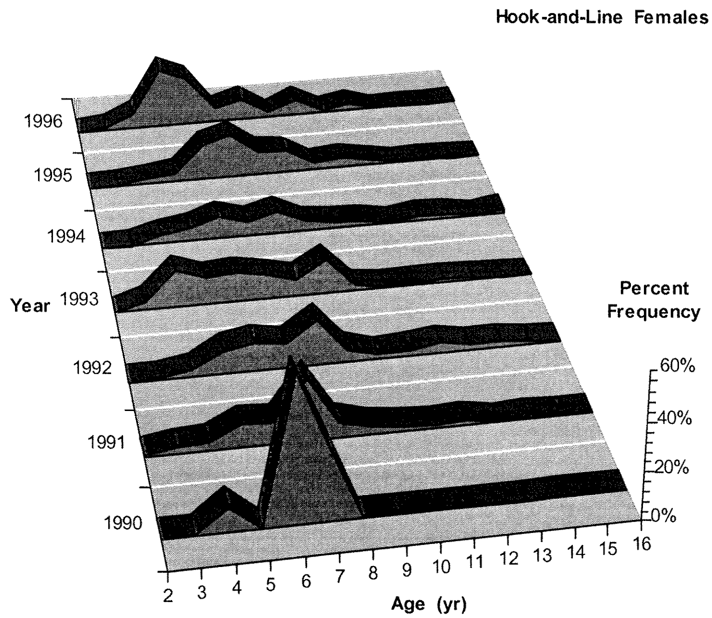


Figure 3. Age compositions of female and male chilipepper rockfish sampled from the setnet fishery (1983-96).



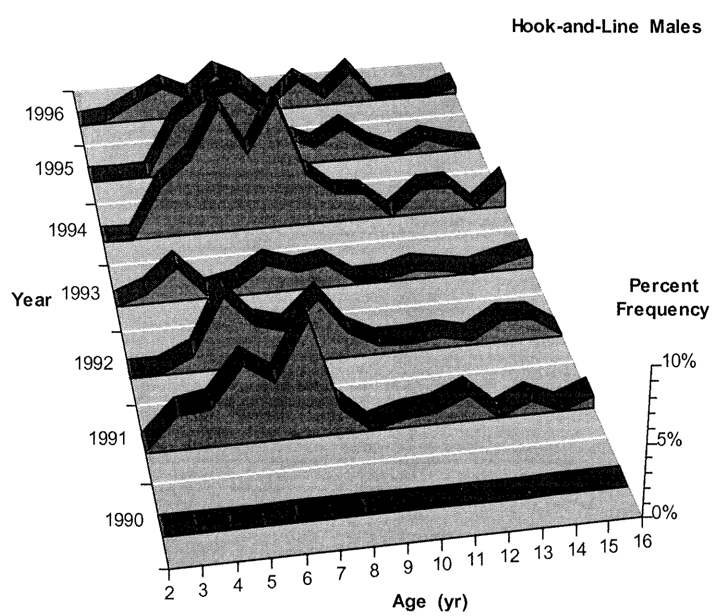
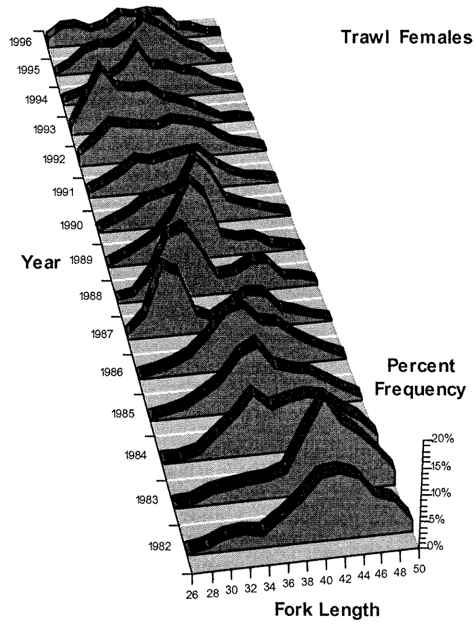


Figure 4. Age compositions of female and male chilipepper rockfish sampled from the hook-and-line fishery (1990-96).



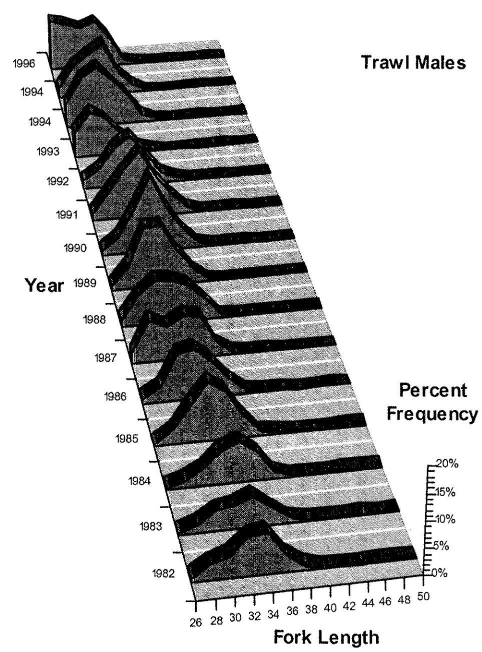
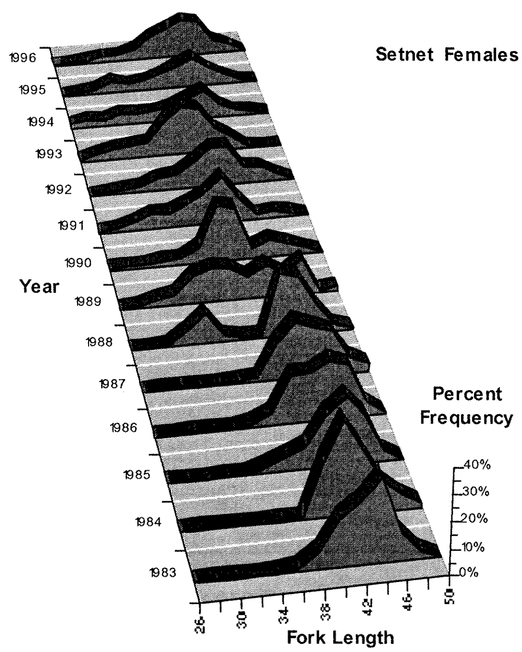


Figure 5. Length compositions of female and male chilipepper rockfish sampled from the trawl fishery (1982-96).



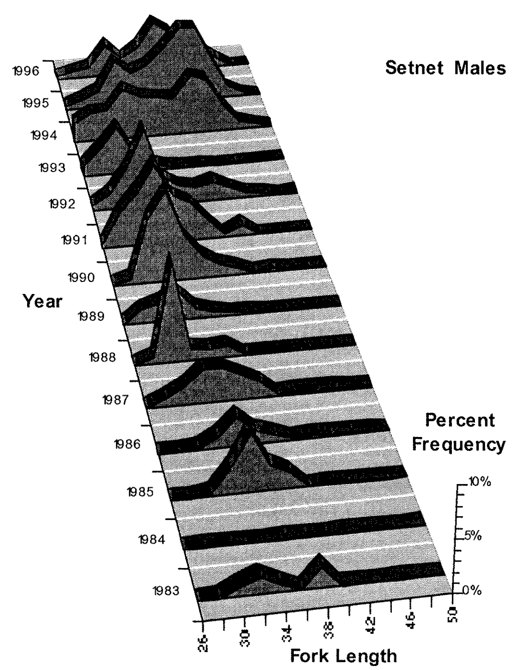
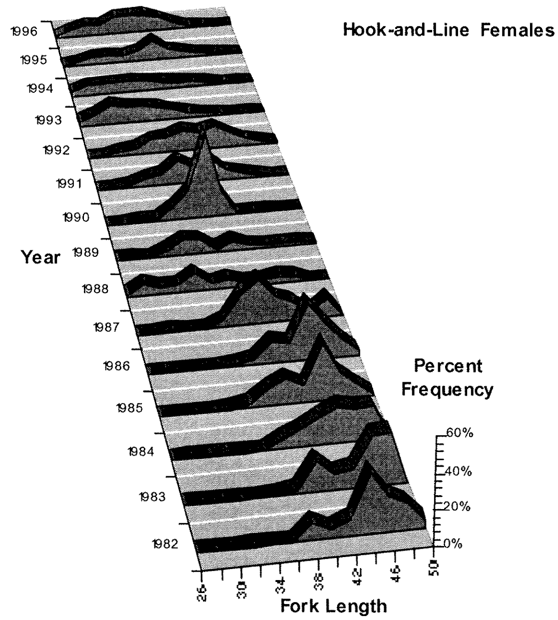


Figure 6. Length compositions of female and male chilipepper rockfish sampled from the setnet fishery (1983-96).



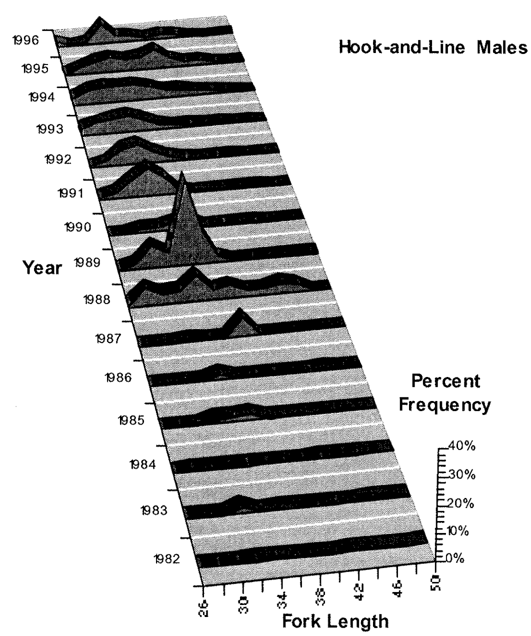


Figure 7. Length compositions of female and male chilipepper rockfish sampled from the hook-and-line fishery (1982-96).

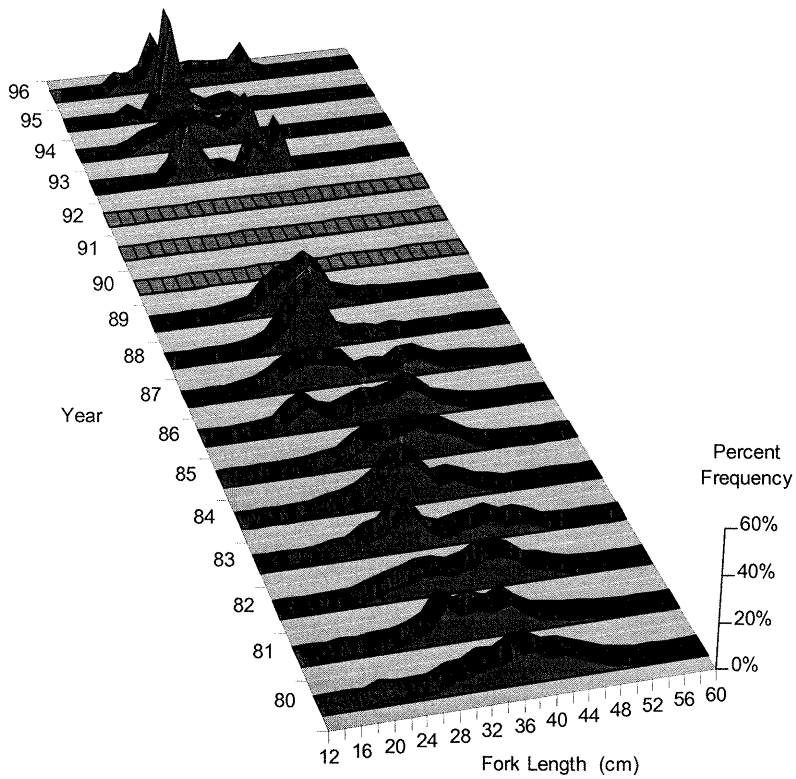


Figure 8. Length compositions of chilipepper rockfish (sexes combined) sampled from the recreational fishery (1980-96).

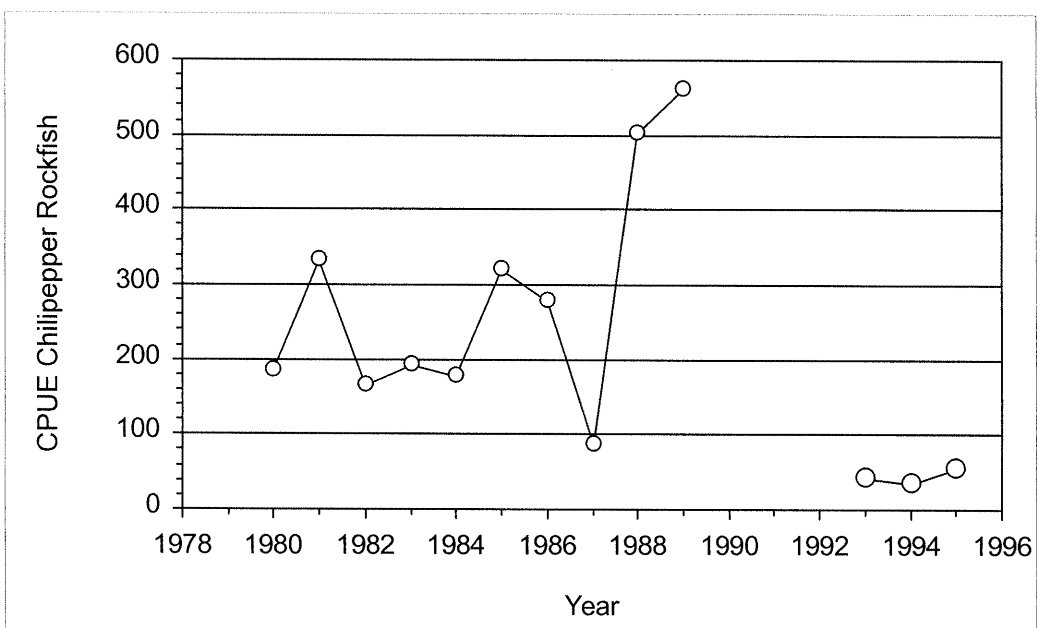


Figure 9. Catch per unit of effort (CPUE) of chilipepper rockfish in the recreational fishery. Data were extracted from the Marine Recreational Fisheries Survey Statistics (MRFSS) data base, but were not used in the assessment.

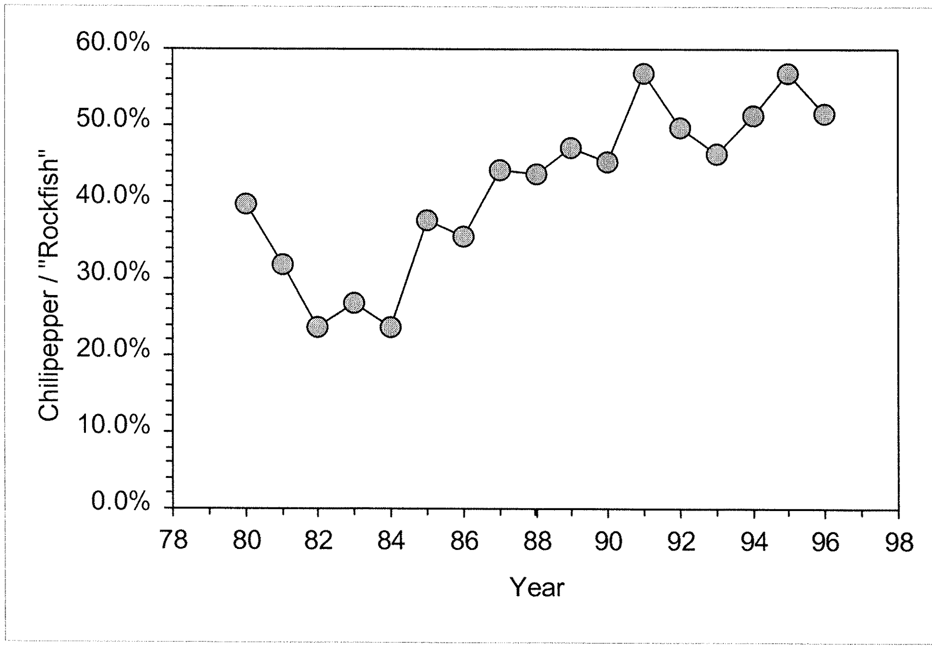


Figure 10. Annual proportion of chilipepper rockfish in the combined catch of rockfish from central California ports (Monterey - Fort Bragg).

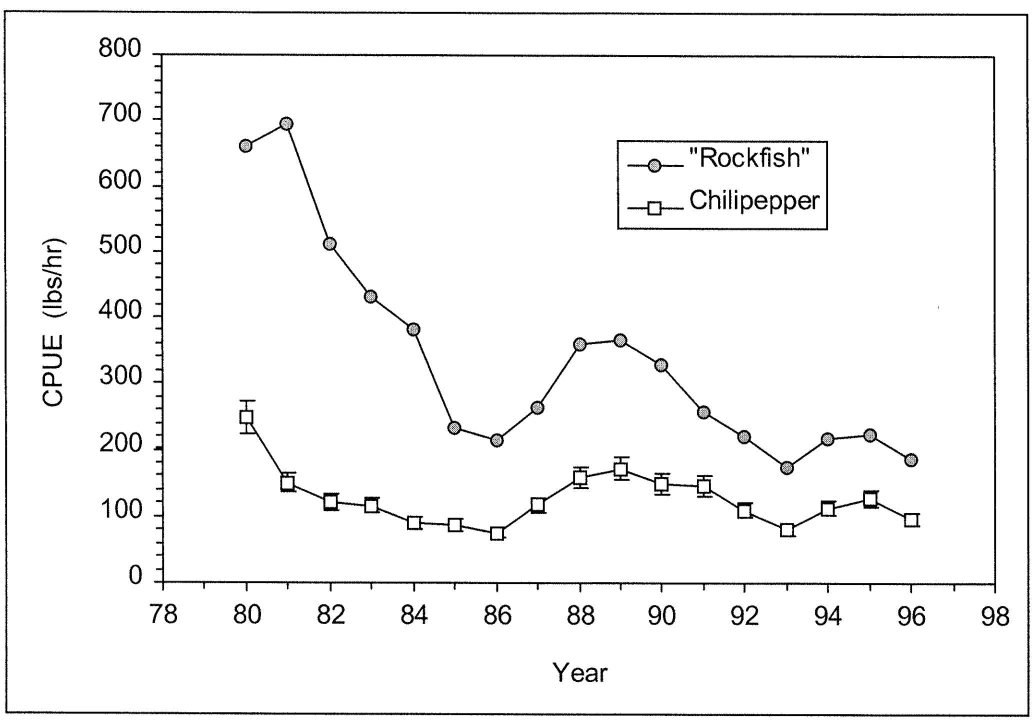


Figure 11. Annual estimates of rockfish and chilipepper catch rates based on the analysis of California trawl logbook data with a GLM model that included terms for year, month, area, and fishing vessel.

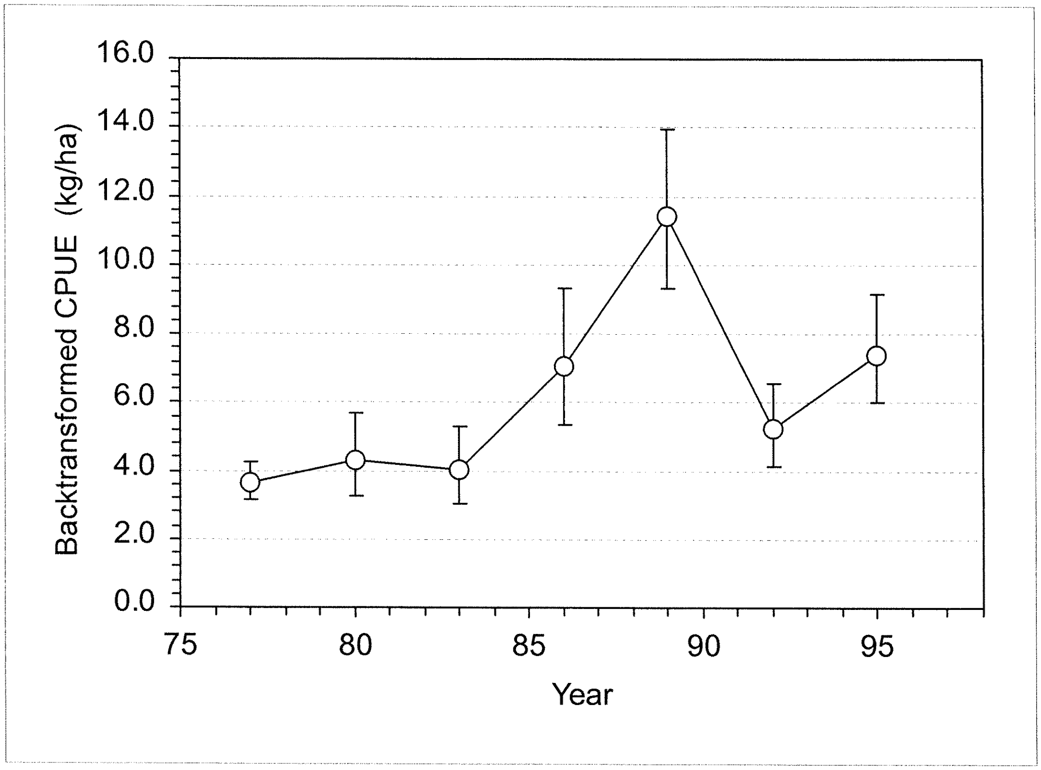


Figure 12. Annual estimates of chilipepper rockfish catch rate based on the analysis of AFSC triennial bottom trawl survey data using a GLM model that included terms for year and area fished.

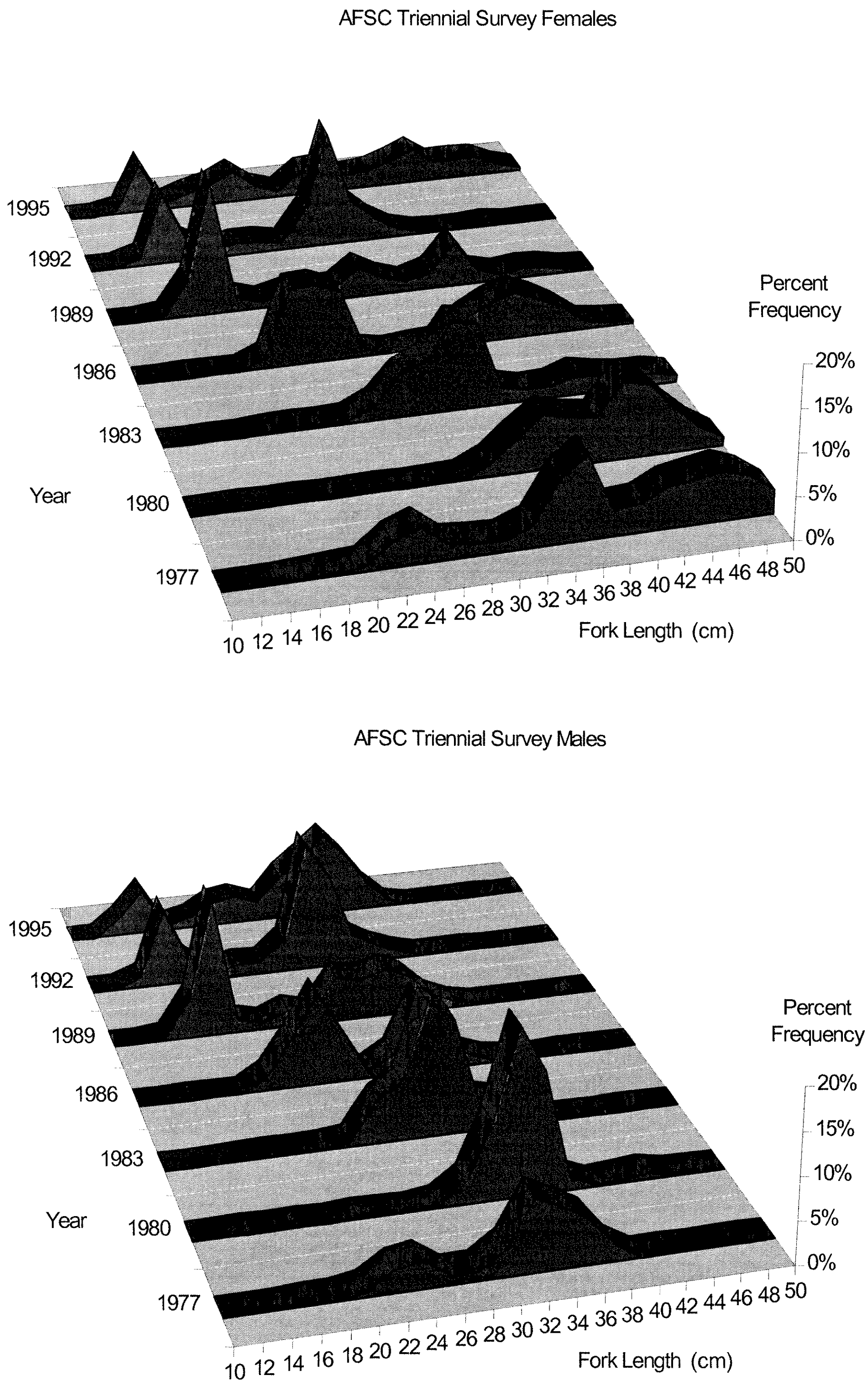


Figure 13. Length compositions of female and male chilipepper rockfish captured in AFSC triennial bottom trawl surveys (1977-95).

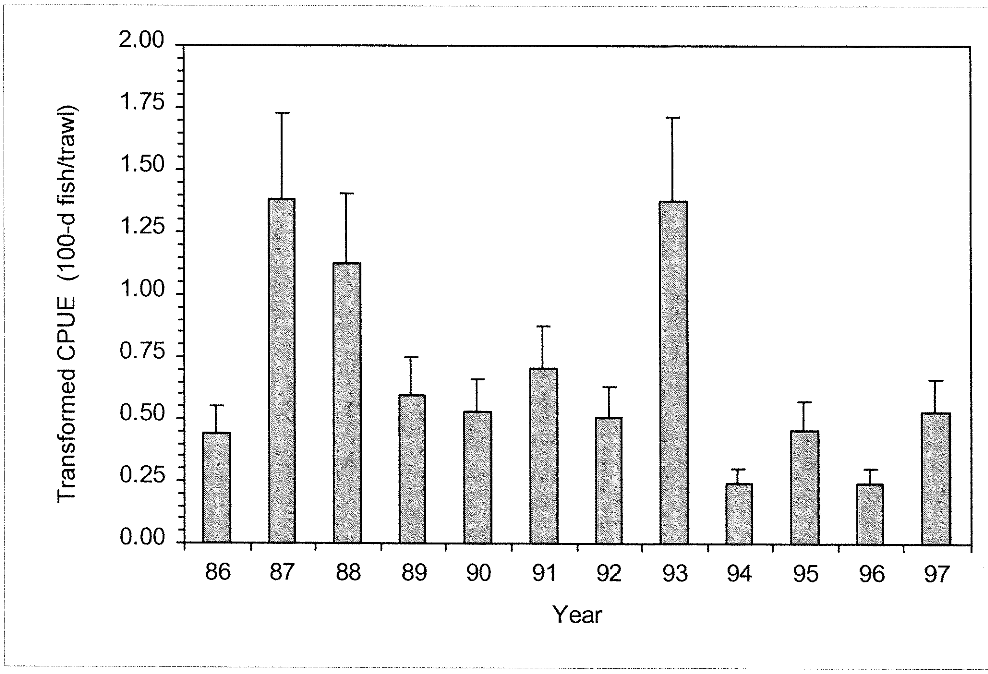


Figure 14. Time series of age-0 pelagic juvenile chilipepper in the SWFSC Tiburon Laboratory midwater trawl survey of pre-recruit abundance. Indices were transformed to ensure similarity of variance with fishery recruitments.

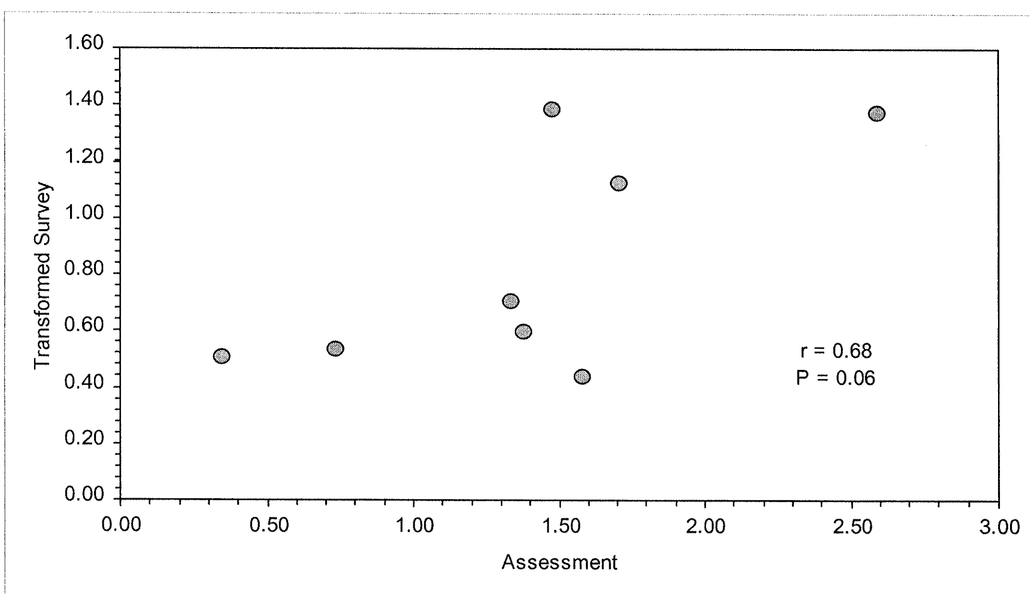


Figure 15. Verification of the SWFSC midwater trawl survey of pre-recruit abundance. Presented is a scattergram, with correlation statistics, of survey estimates of year-class strength (ordinate) with recruitments estimated by the Stock Synthesis model when nil emphasis is placed on the midwater trawl survey.

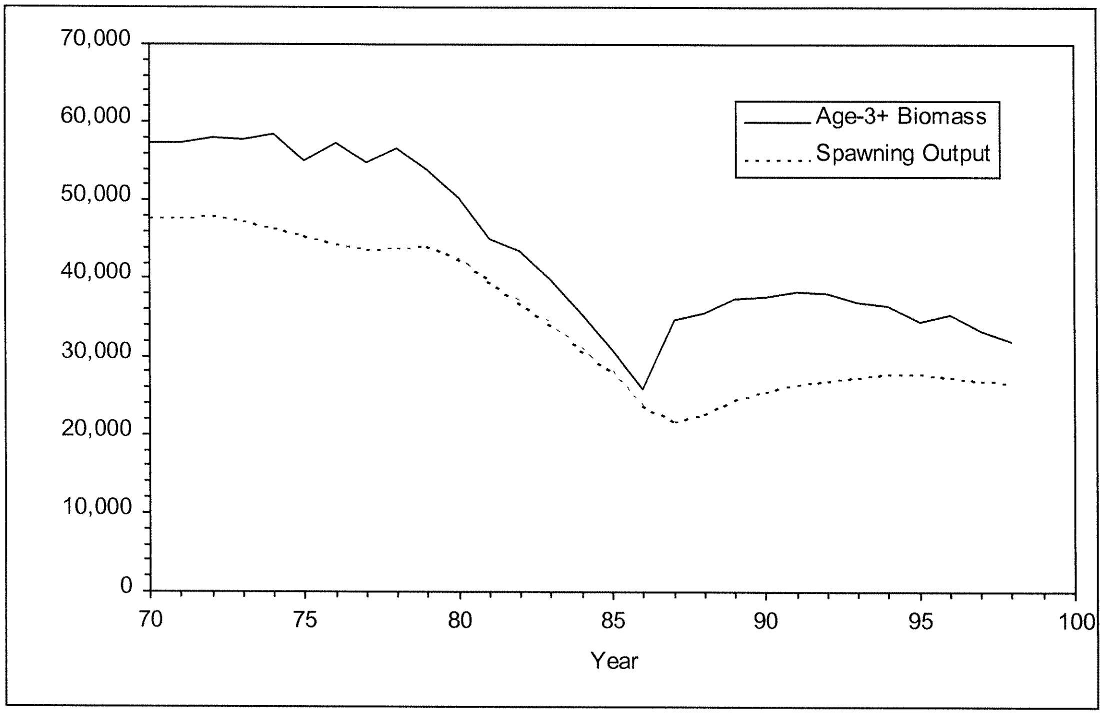


Figure 16. Trends in exploitable biomass (age-3+) and spawning output of chilipepper rockfish from the base model.

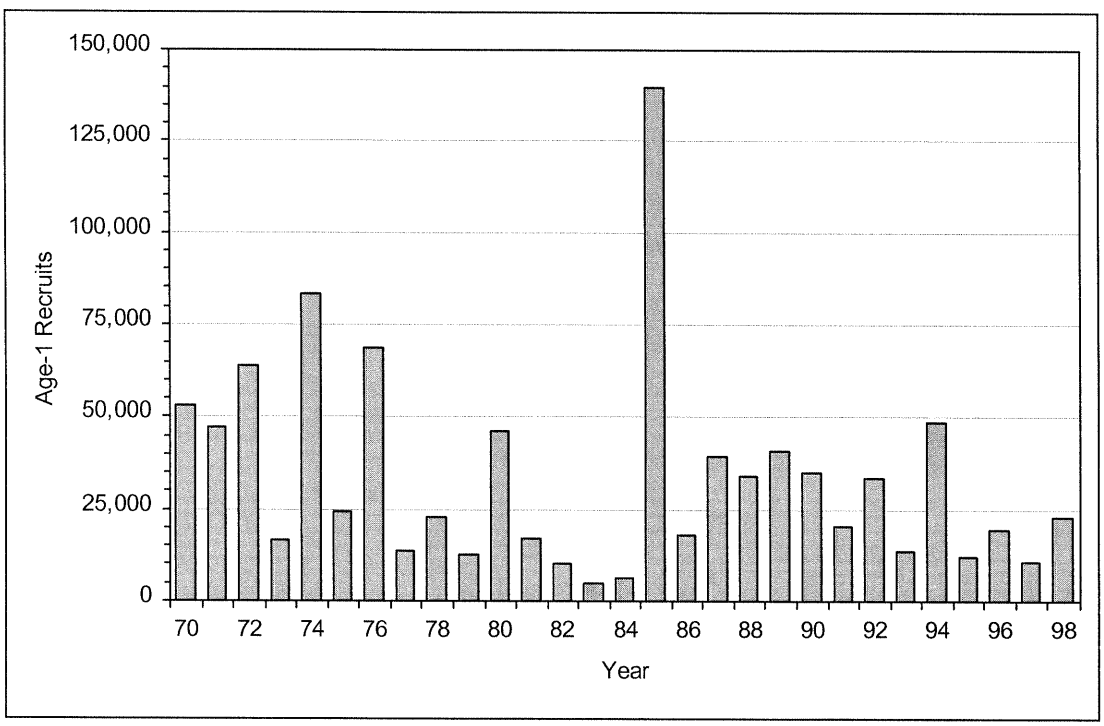


Figure 17. Trend in the recruitment of age-1 chilipepper rockfish from the base model.

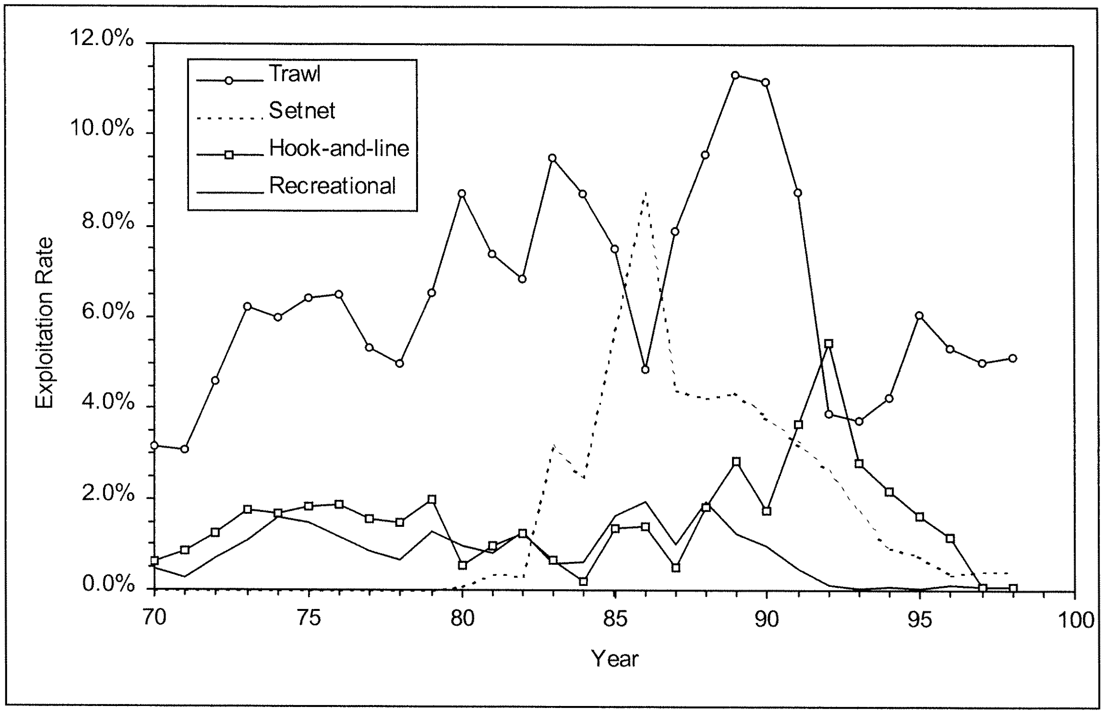


Figure 18. Trends in the exploitation rates of four fisheries for chilipepper rockfish, as estimated by the base model.

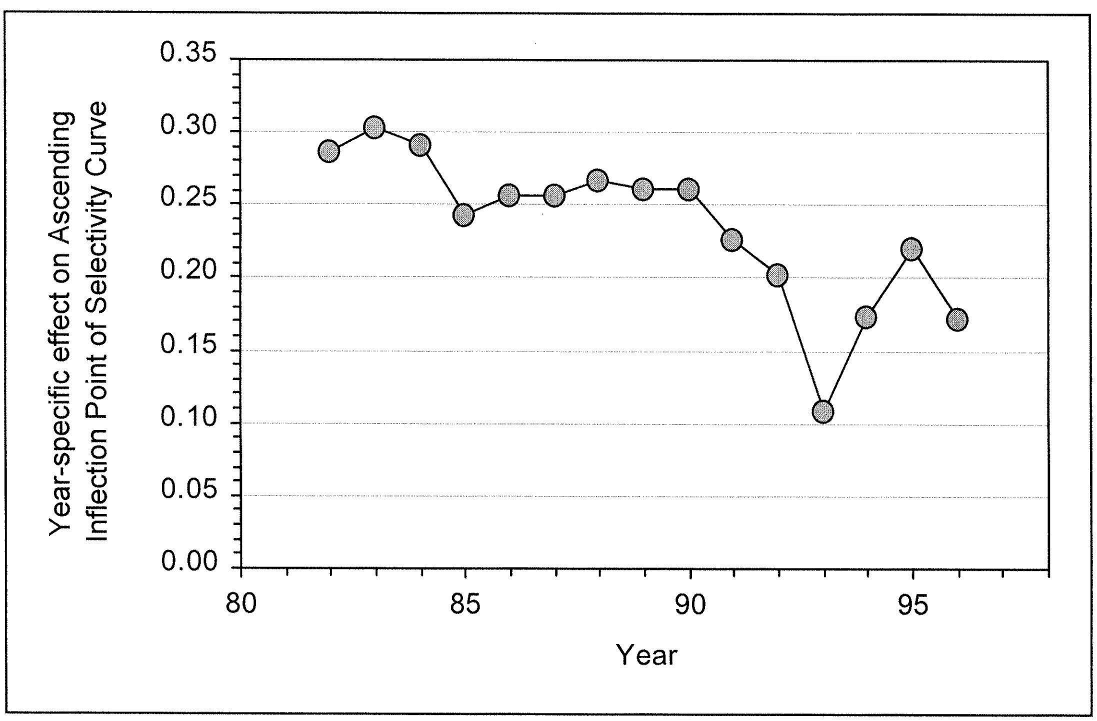


Figure 19. Interannual variability in the availability/selectivity patterns of the four defined fisheries. Note that the year-specific signal was linked among the fisheries.

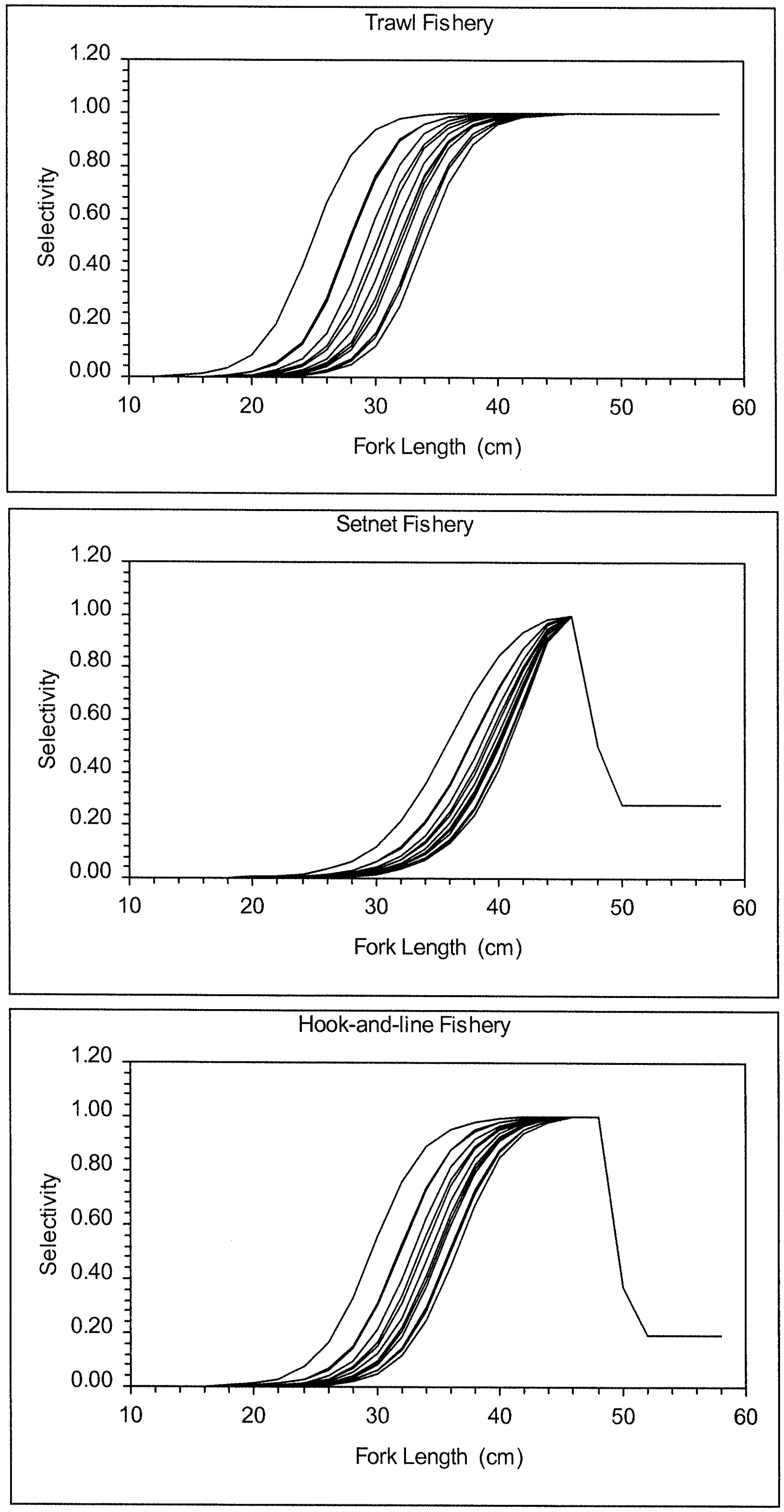


Figure 20. Estimated selectivity patterns of the 3 commercial fisheries. The multiple ascending limbs reflect the interannual signal present in Figure 19.

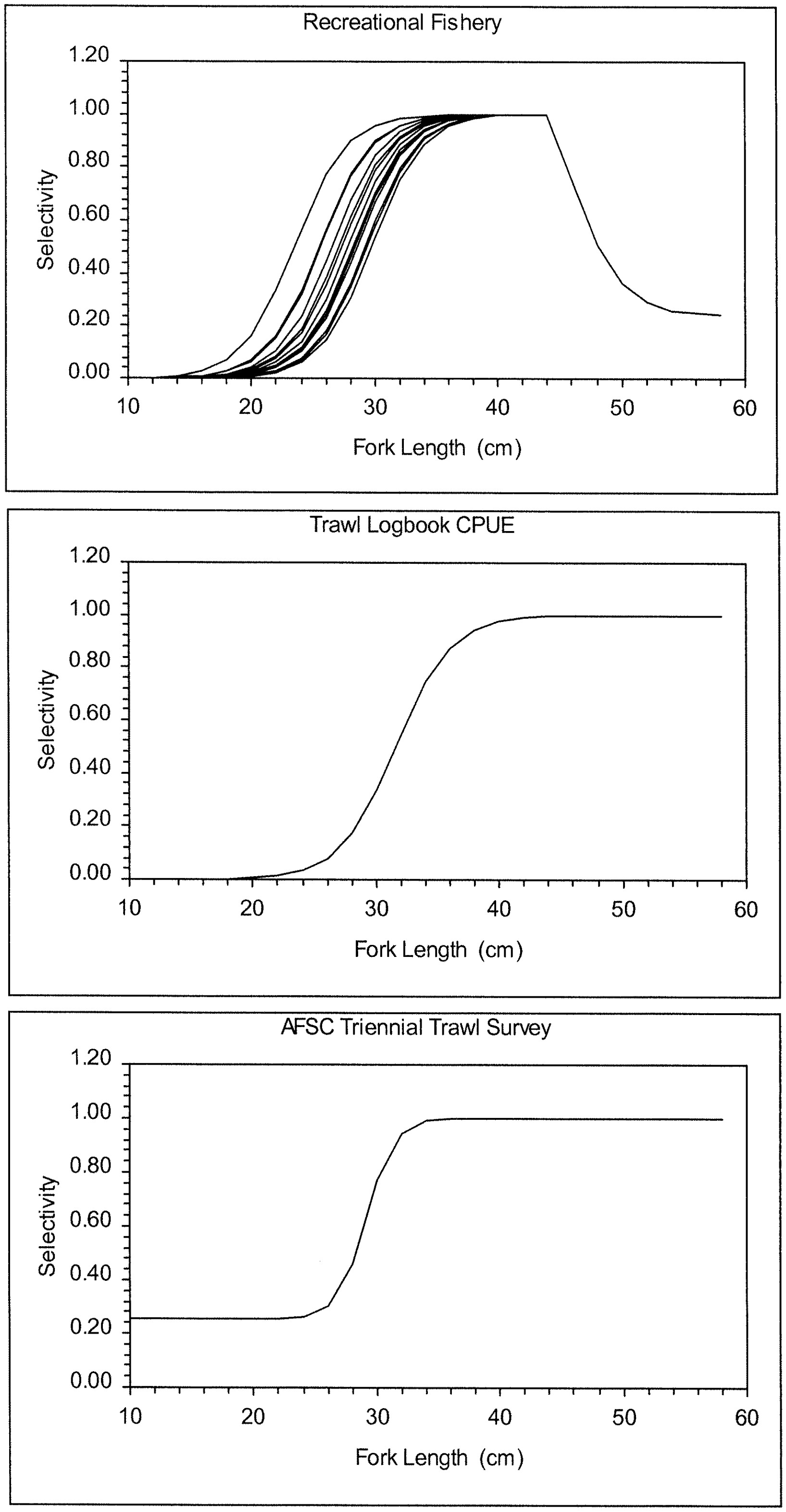


Figure 21. Estimated selectivity patterns of the recreational fishery and the two surveys from the base model.

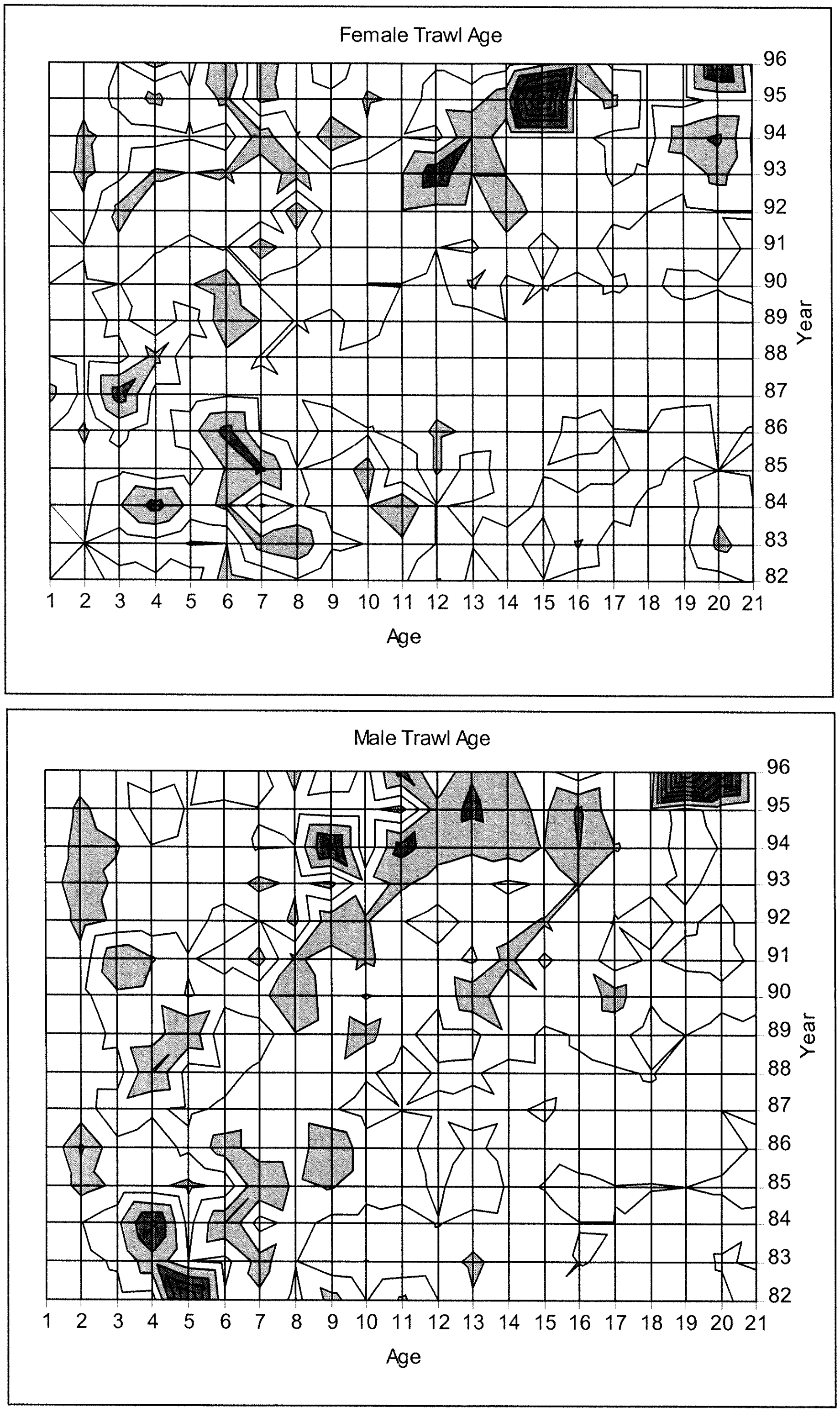


Figure 22. Residual plot of the fit of the base model to the trawl age composition data. Shown is a contour plot of standardized residuals (r_s), where $|r_s| < 1$ is shown in white, $1 \le |r_s| < 2$ is shown in light grey, and $|r_s| \ge 2$ is shown in dark grey.

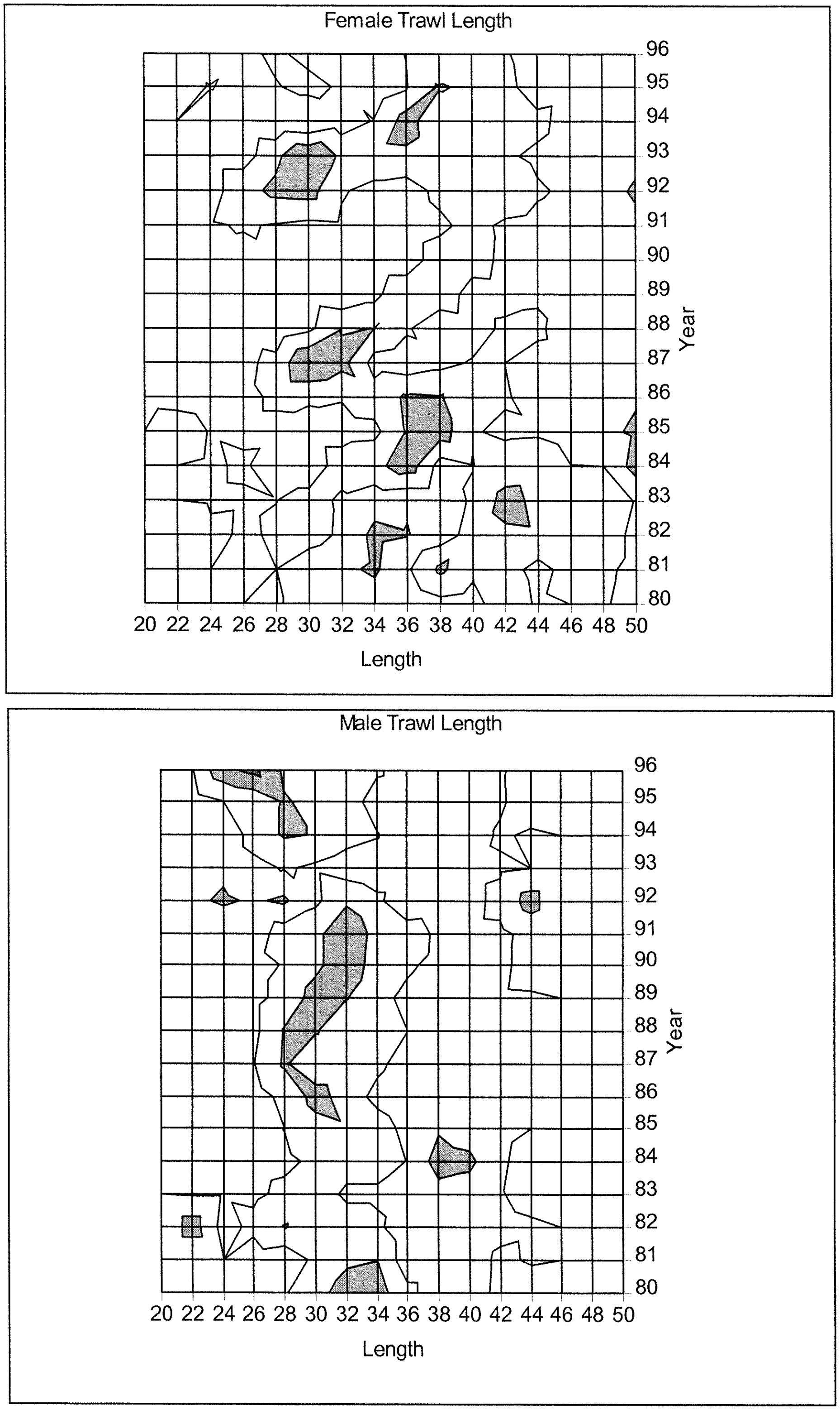
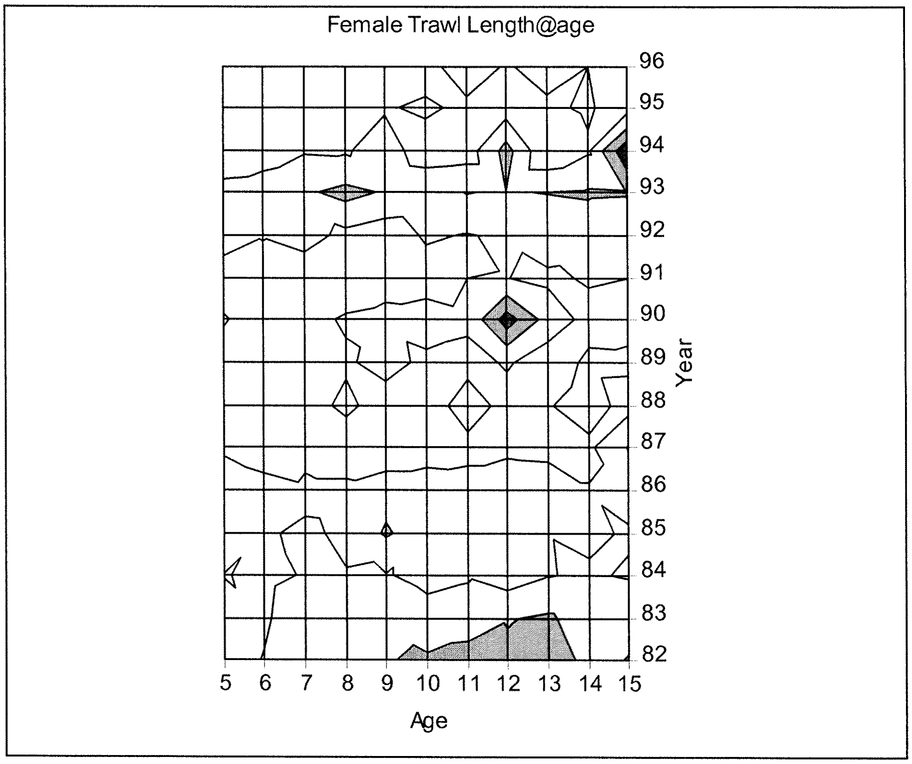


Figure 23. Residual plot of the fit of the base model to the trawl length composition data. Shown is a contour plot of standardized residuals (r_s), where $|r_s| < 1$ is shown in white, $1 \leq |r_s| < 2$ is shown in light grey, and $|r_s| \geq 2$ is shown in dark grey.



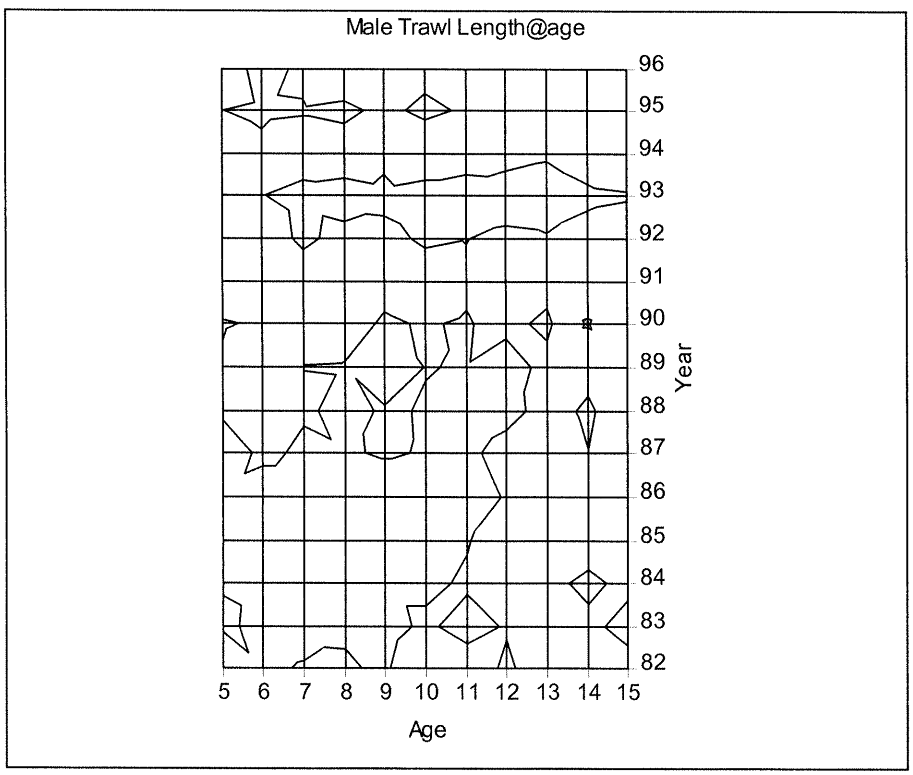


Figure 24. Residual plot of the fit of the base model to the trawl length-at-age composition data. Shown is a contour plot of residuals [r = (obs-exp)], where |r| < 2 cm is shown in white, 2 ≤ |r| < 4 cm is shown in light grey, and |r| ≥ 4 cm is shown in dark grey.

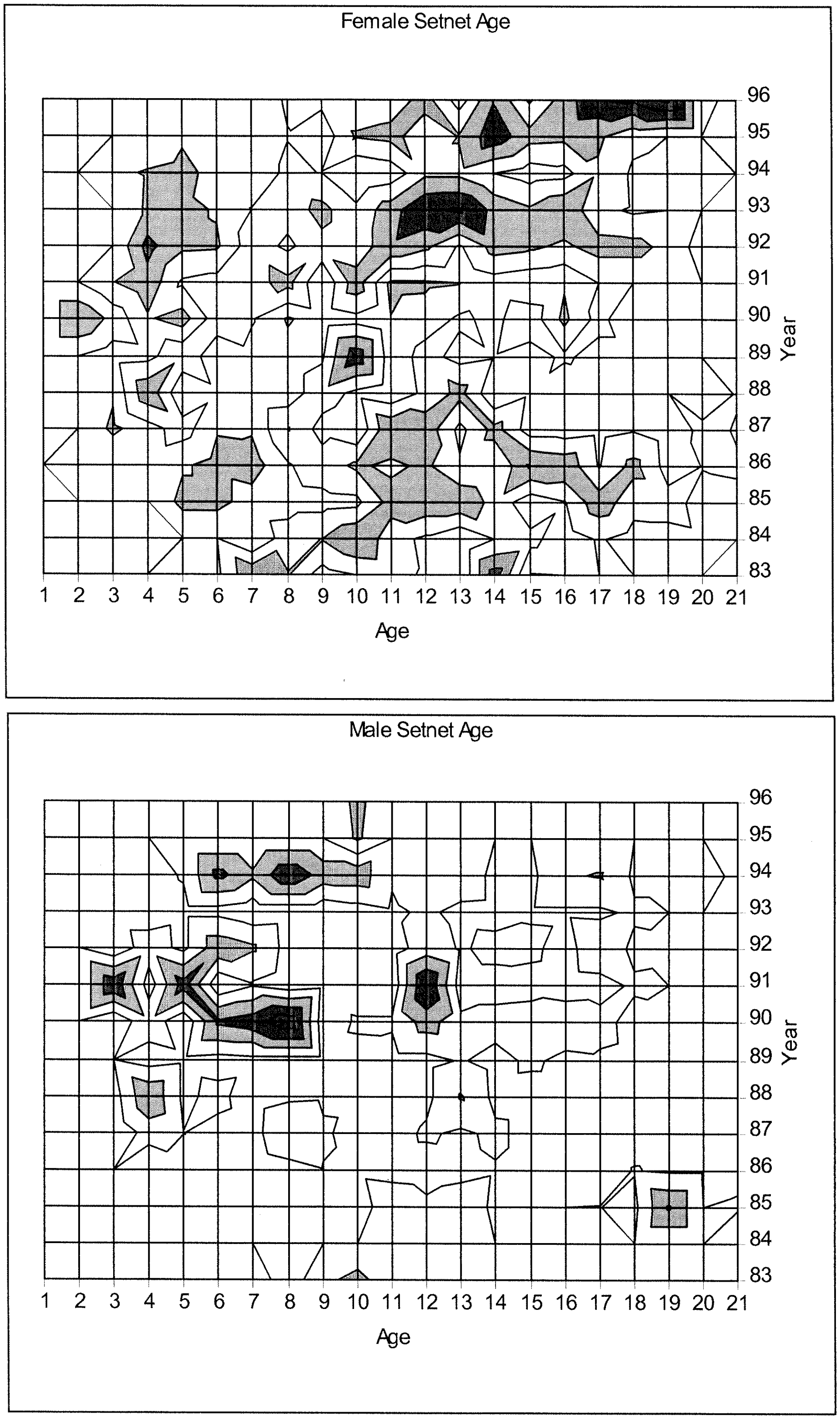
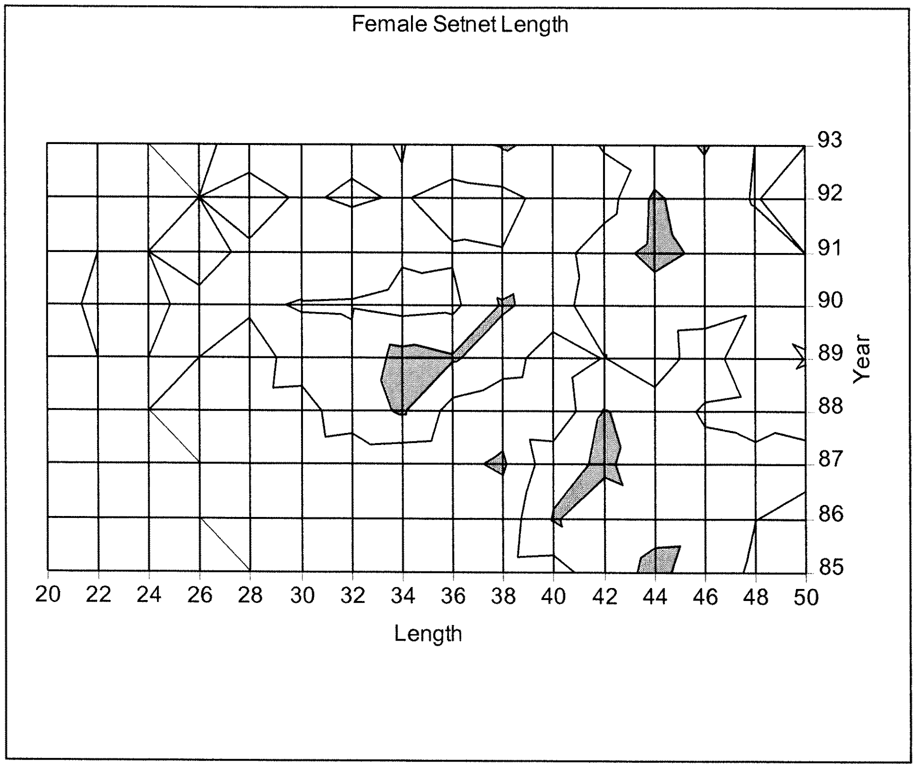


Figure 25. Residual plot of the fit of the base model to the setnet age composition data. Shown is a contour plot of standardized residuals (r_s), where $|r_s| < 1$ is shown in white, $1 \leq |r_s| < 2$ is shown in light grey, and $|r_s| \geq 2$ is shown in dark grey.



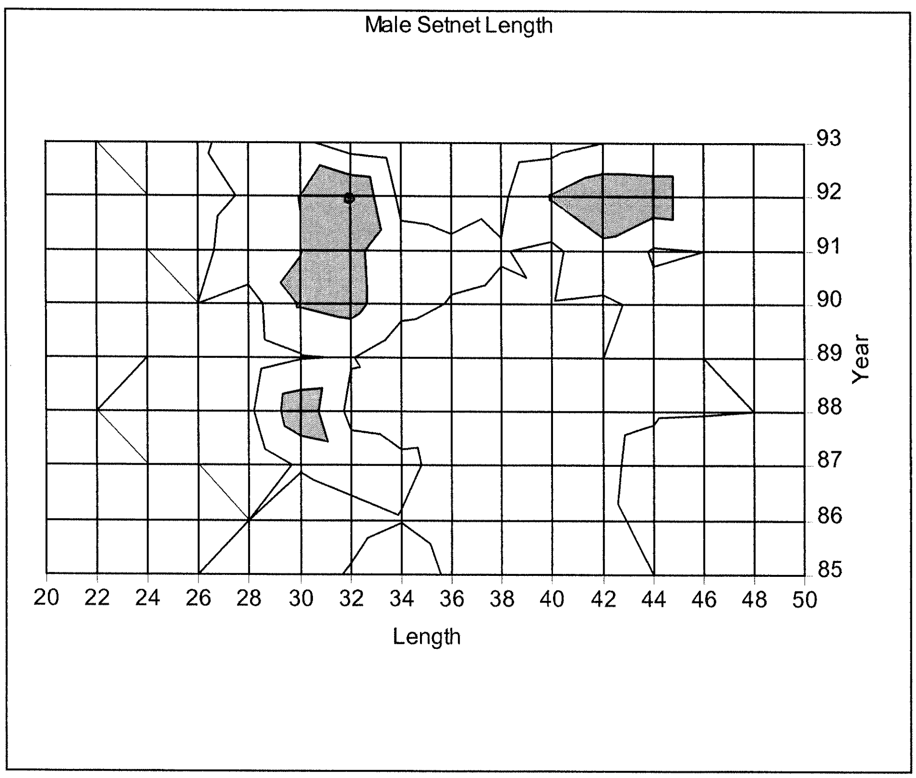
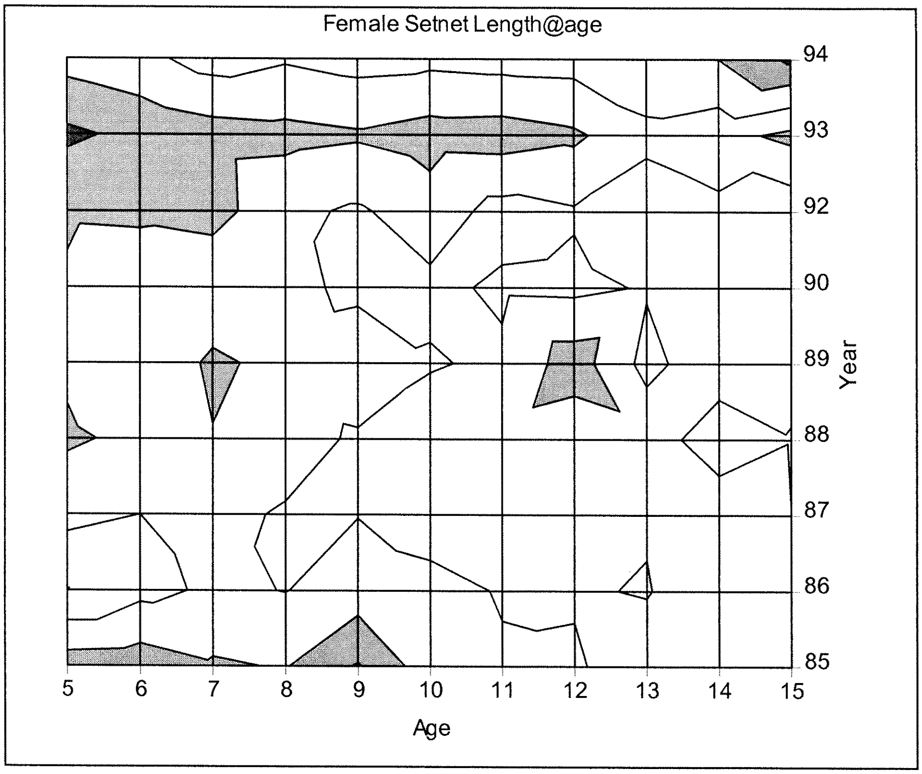


Figure 26. Residual plot of the fit of the base model to the setnet length composition data. Shown is a contour plot of standardized residuals (r_s), where $|r_s| < 1$ is shown in white, $1 \leq |r_s| < 2$ is shown in light grey, and $|r_s| \geq 2$ is shown in dark grey.



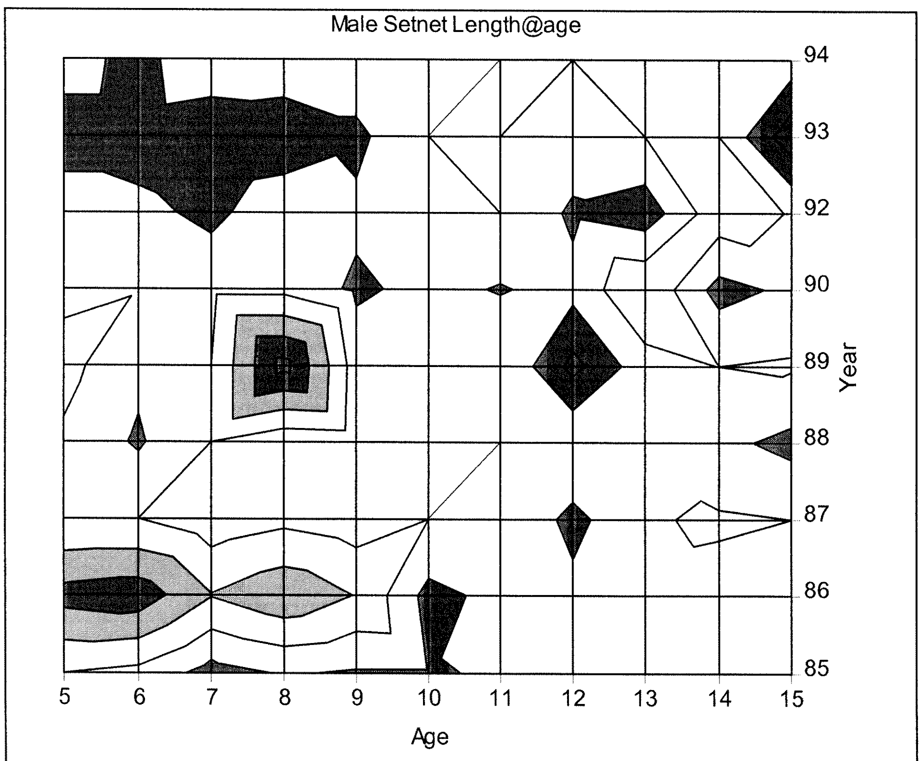
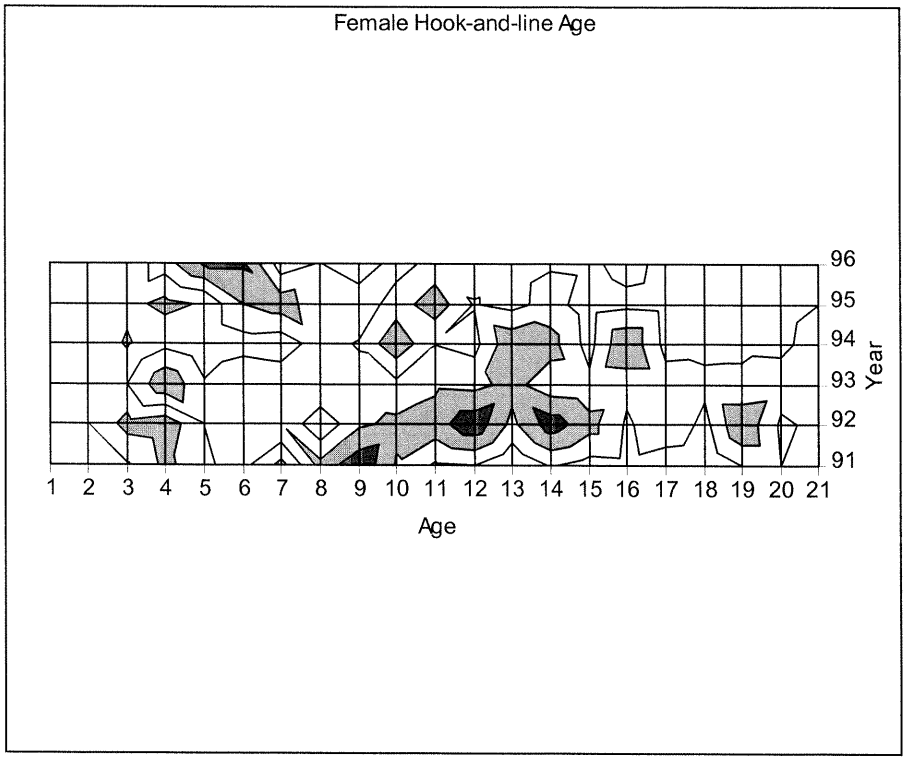


Figure 27. Residual plot of the fit of the base model to the setnet length-at-age composition data. Shown is a contour plot of residuals [r = (obs-exp)], where $|r| < 2$ cm is shown in white, $2 \leq |r| < 4$ cm is shown in light grey, and $|r| \geq 4$ cm is shown in dark grey.



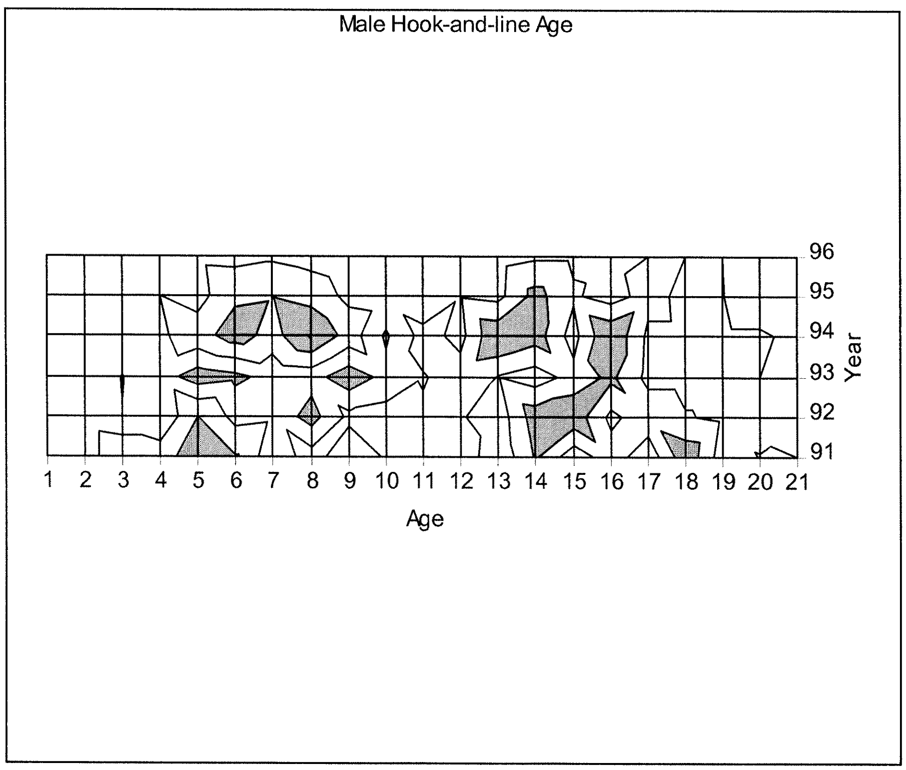


Figure 28. Residual plot of the fit of the base model to the hook-and-line age composition data. Shown is a contour plot of standardized residuals (r_s), where $|r_s| < 1$ is shown in white, $1 \leq |r_s| < 2$ is shown in light grey, and $|r_s| \geq 2$ is shown in dark grey.

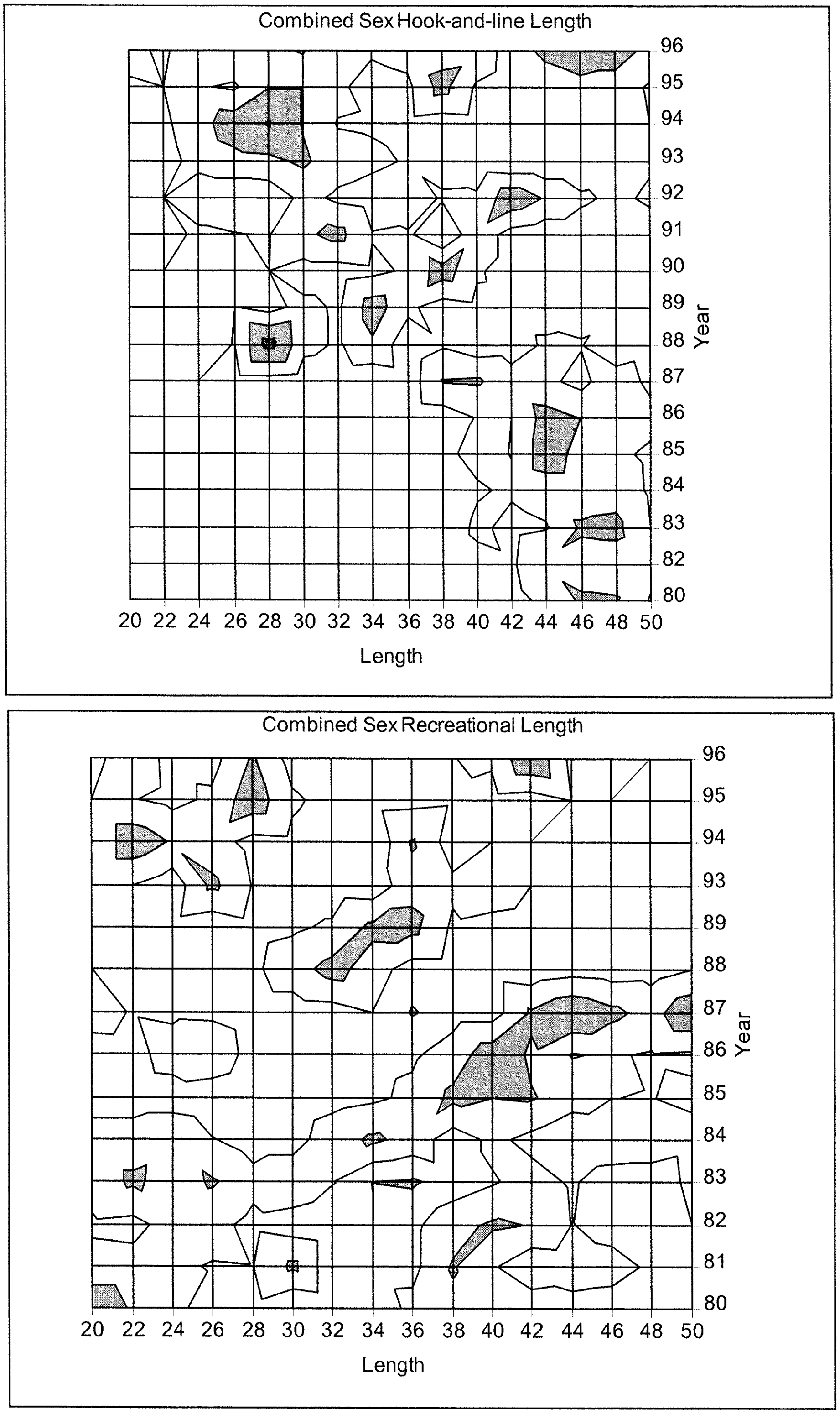


Figure 29. Residual plot of the fit of the base model to the hook-and-line and recreational length composition data. Shown is a contour plot of standardized residuals (r_s), where $|r_s| < 1$ is shown in white, $1 \le |r_s| < 2$ is shown in light grey, and $|r_s| \ge 2$ is shown in dark grey.

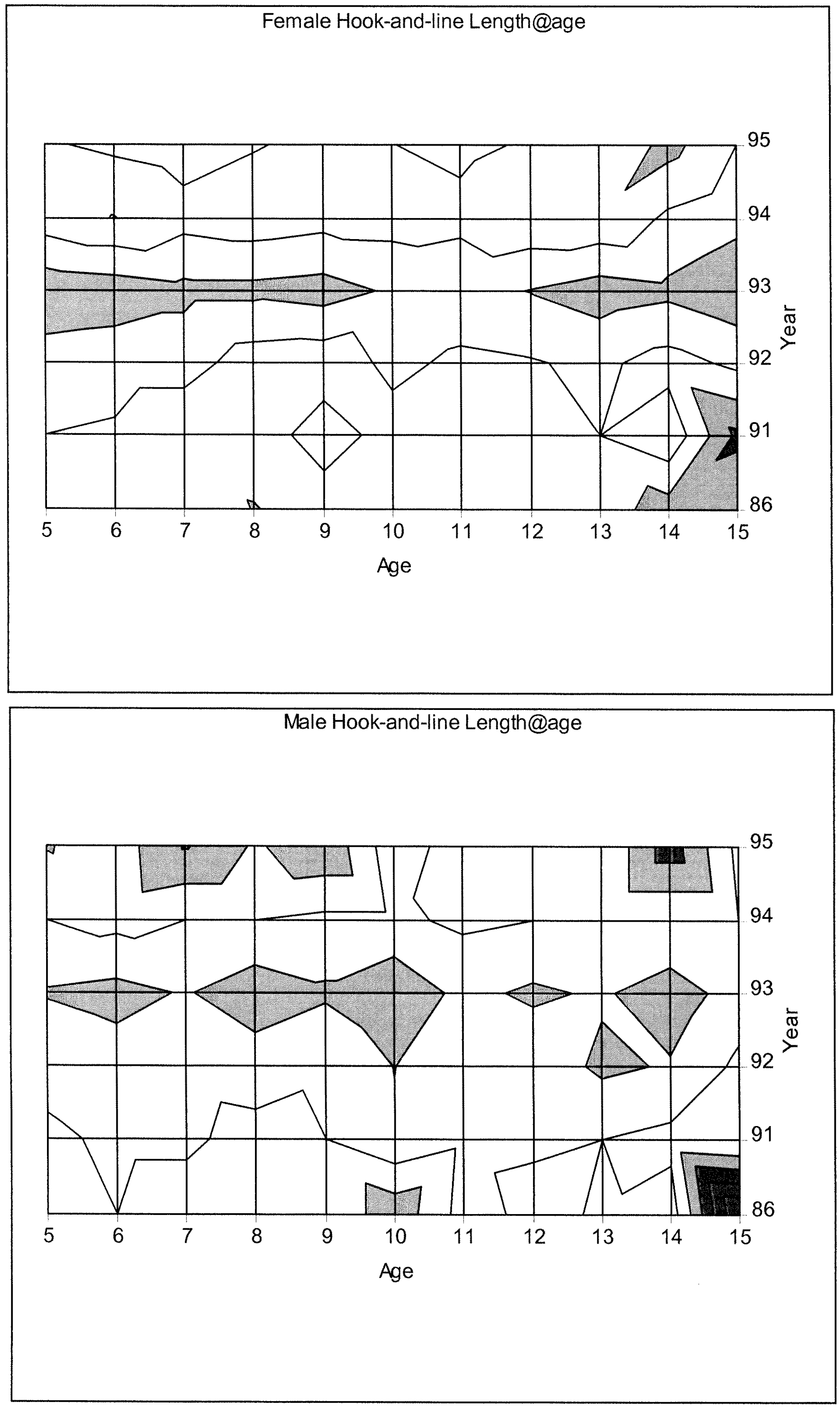


Figure 30. Residual plot of the fit of the base model to the hook-and-line length-at-age composition data. Shown is a contour plot of residuals [r = (obs-exp)], where |r| < 2 cm is shown in white, 2 ≤ |r| < 4 cm is shown in light grey, and |r| ≥ 4 cm is shown in dark grey.

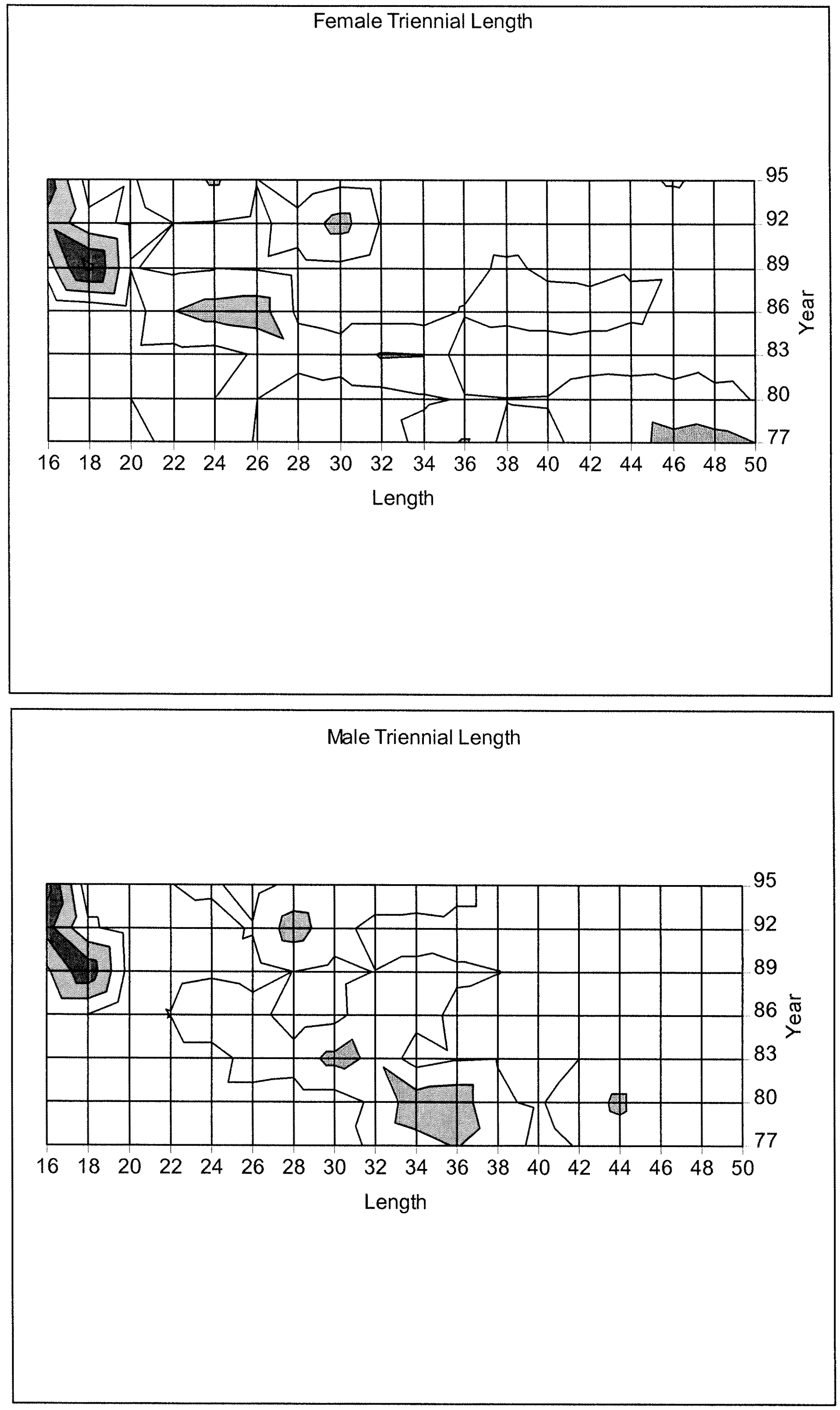


Figure 31. Residual plot of the fit of the base model to the AFSC triennial survey length composition data. Shown is a contour plot of standardized residuals (r_s), where $|r_s| < 1$ is shown in white, $1 \leq |r_s| < 2$ is shown in light grey, and $|r_s| \geq 2$ is shown in dark grey.

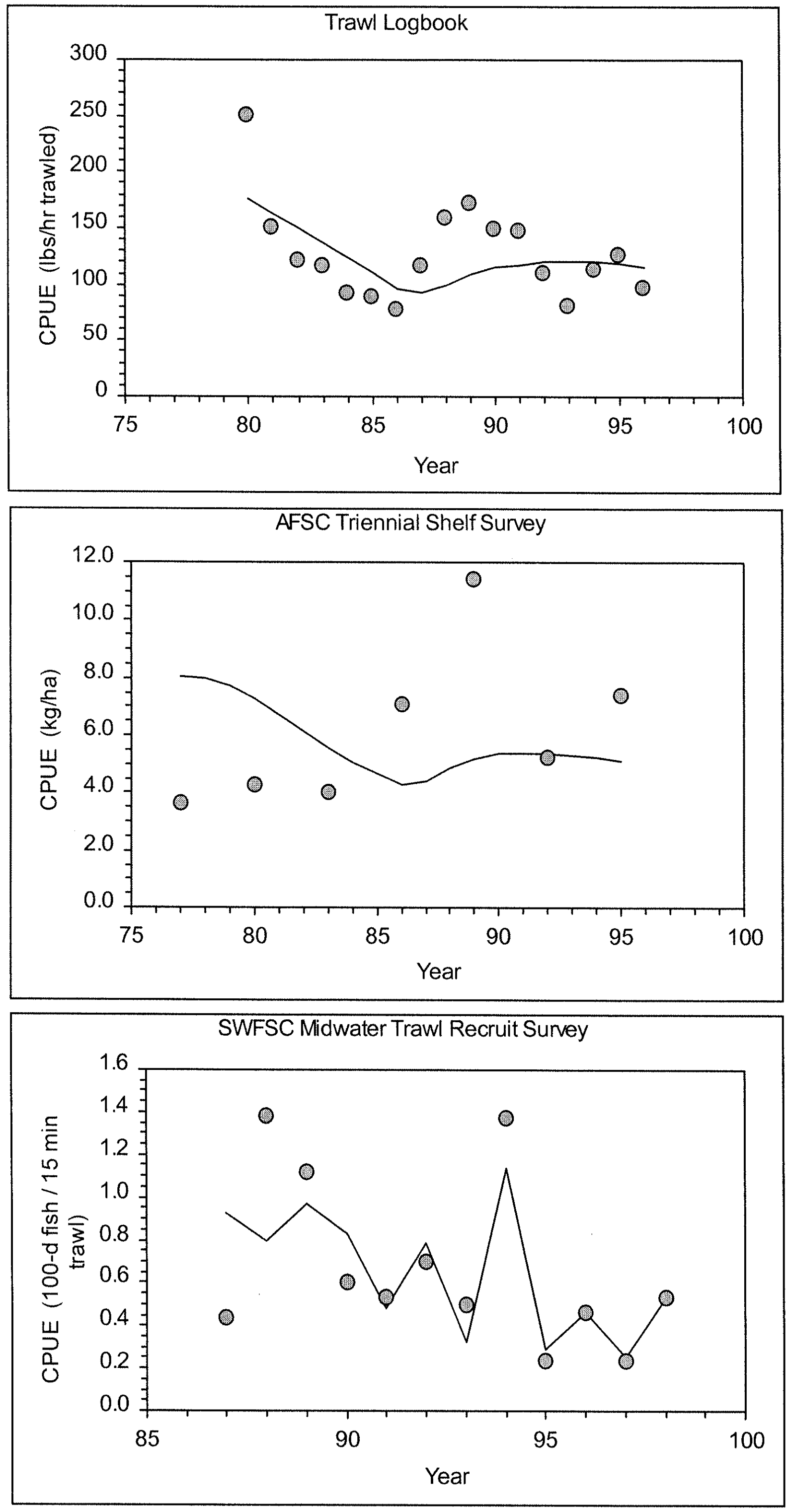


Figure 32. Fits of the base model to the three survey indices. The data are shown as symbols and the estimated population trend, as filtered by the selectivity curve, is shown as a solid line.

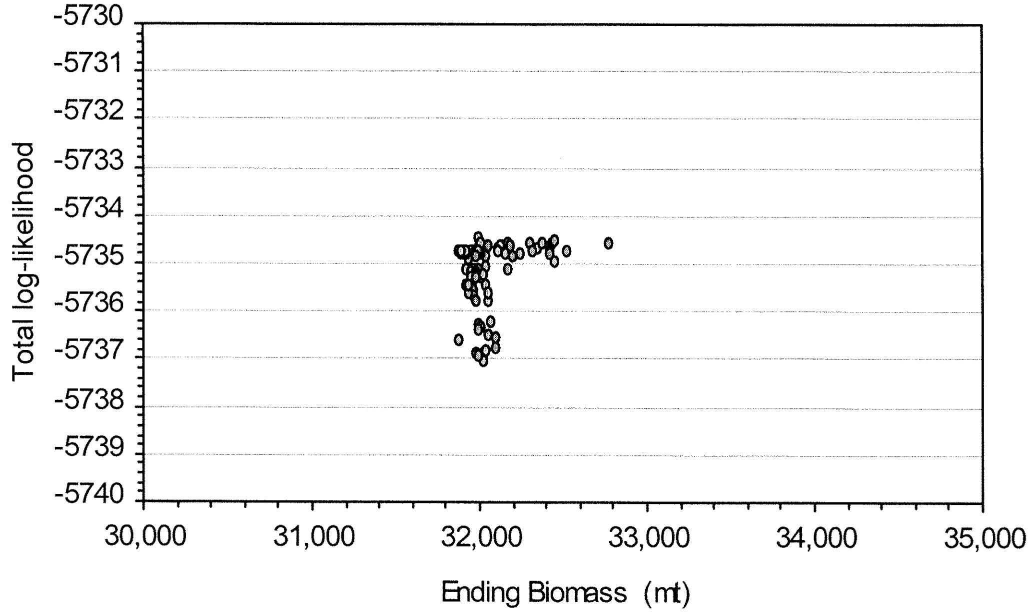


Figure 33. Test for convergence of the base model. Shown is a scattergram of the final converged total log-likelihood of the model against the estimated summary biomass in 1998 for 100 simultaneous randomizations of the estimated parameters in the base model. For each randomization the convergence criterion was 0.001.

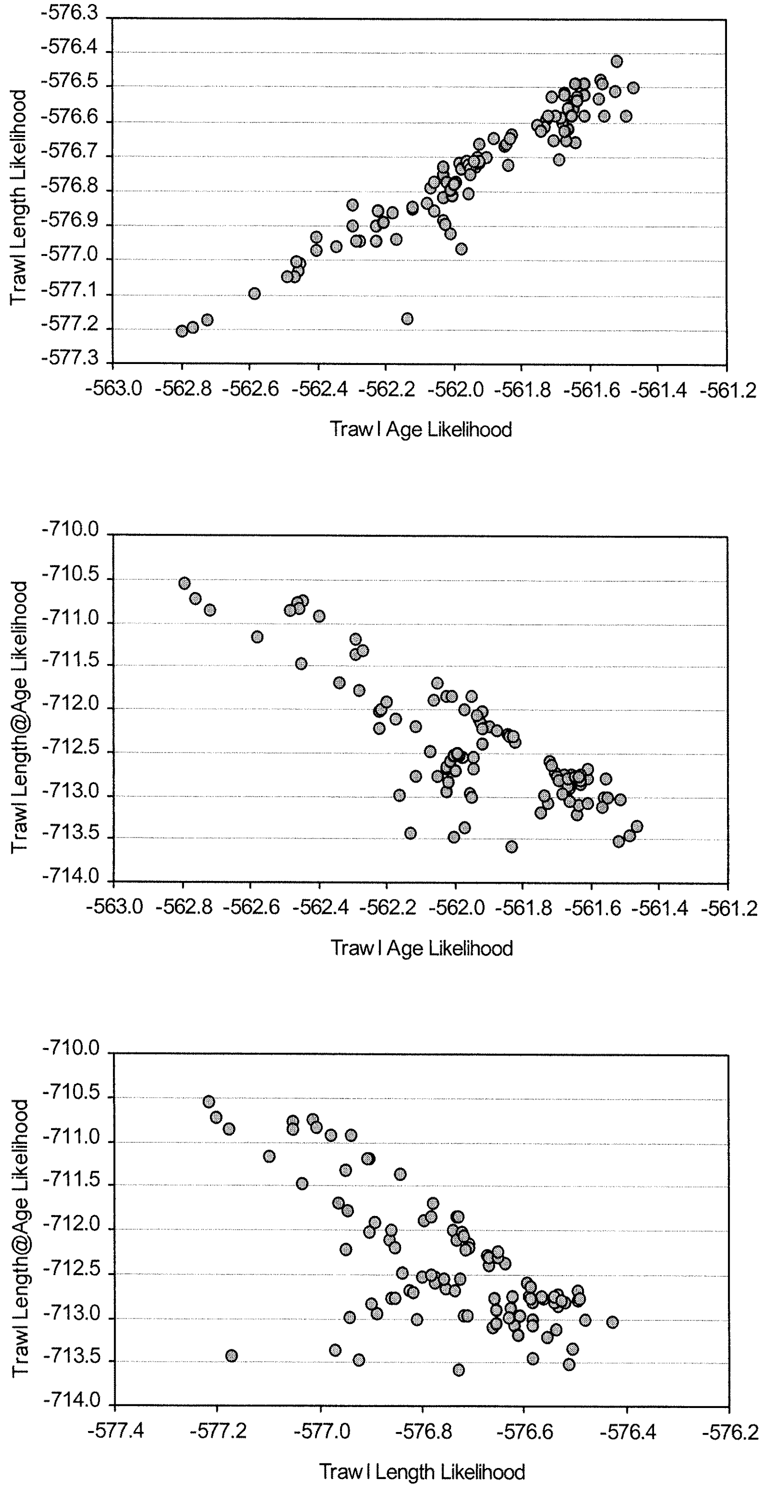


Figure 34. Relationship of the fits of the three trawl fishery likelihood components (i.e., age, length, and length@age) to each other based on results of the 100 randomizations presented in Figure 33.

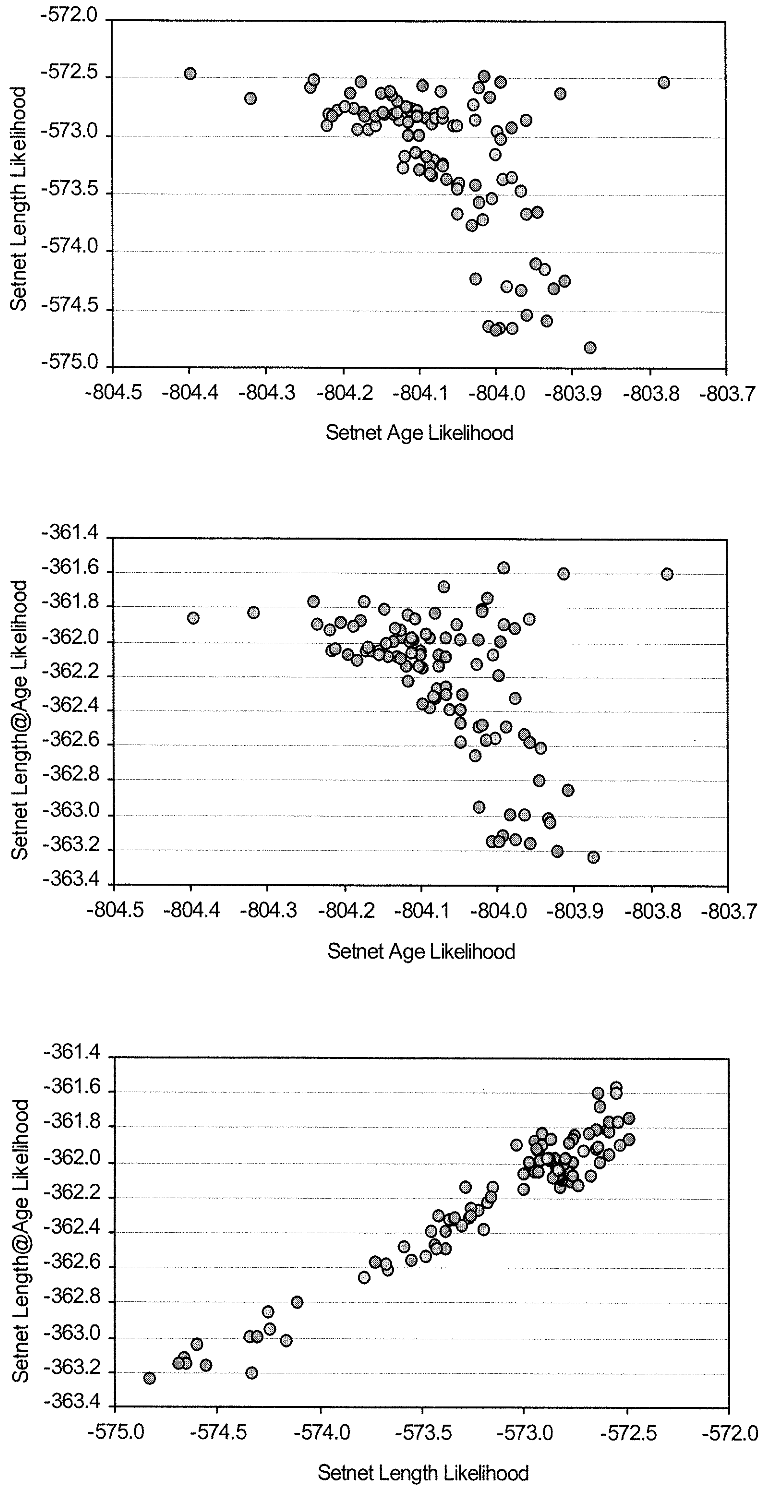


Figure 35. Relationship of the fits of the three setnet fishery likelihood components (i.e., age, length, and length@age) to each other based on results of the 100 randomizations presented in Figure 33.

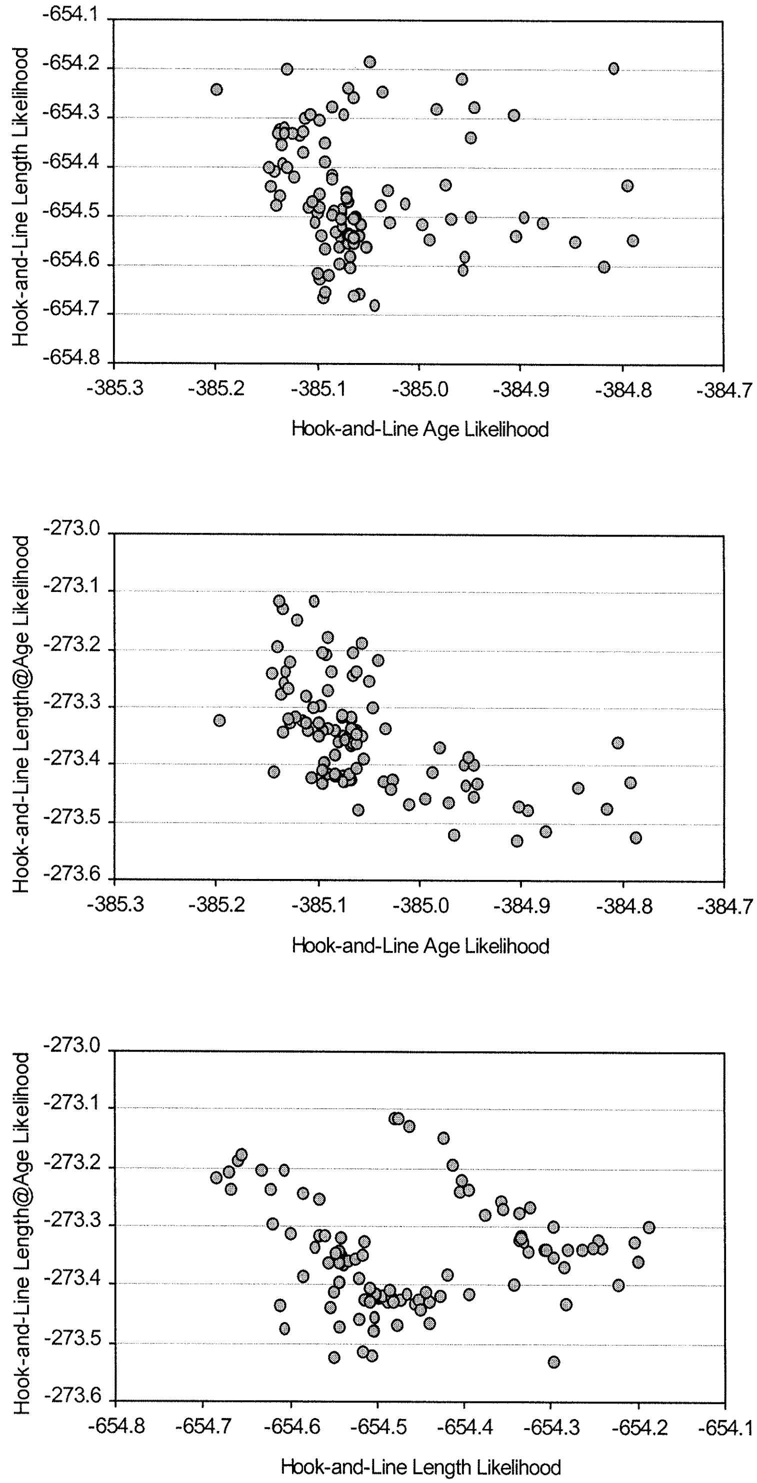
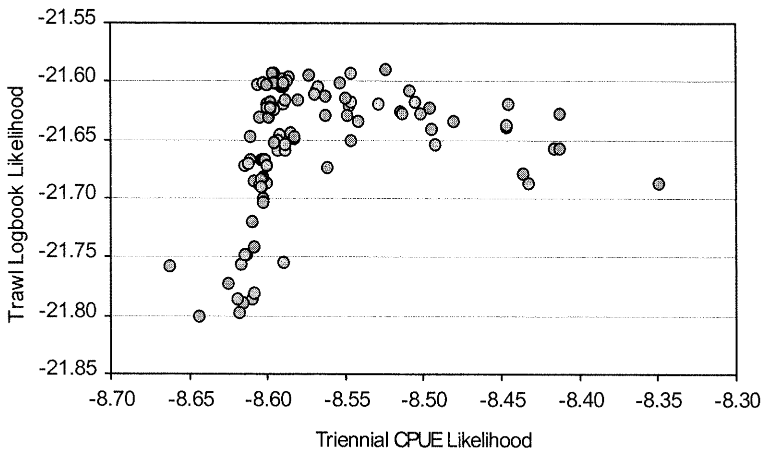
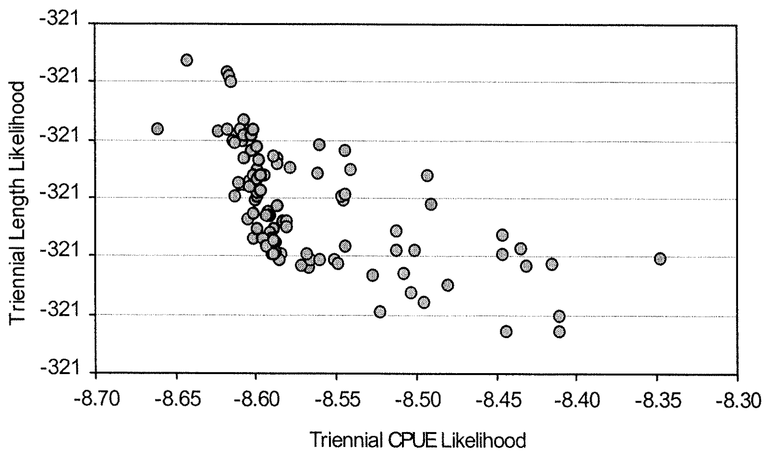


Figure 36. Relationship of the fits of the three hook-and-line fishery likelihood components (i.e., age, length, and length @ age) to each other based on results of the 100 randomizations presented in Figure 33.





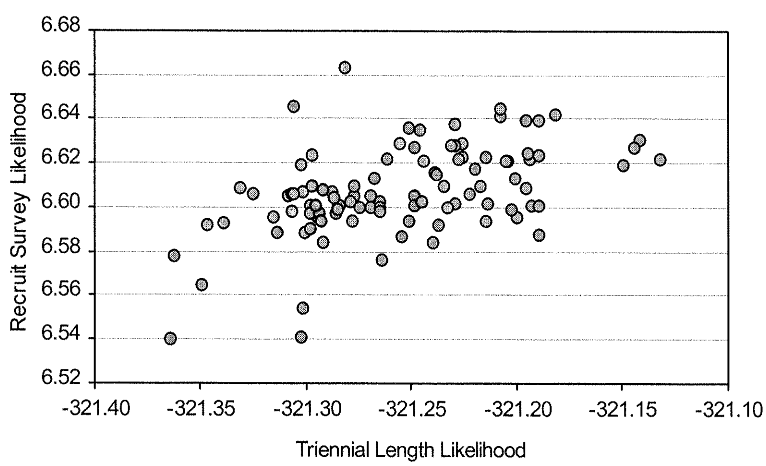


Figure 37. Relationship of the fits of several of the survey log-likelihood components to one another, based on results of the 100 randomizations presented in Figure 33.

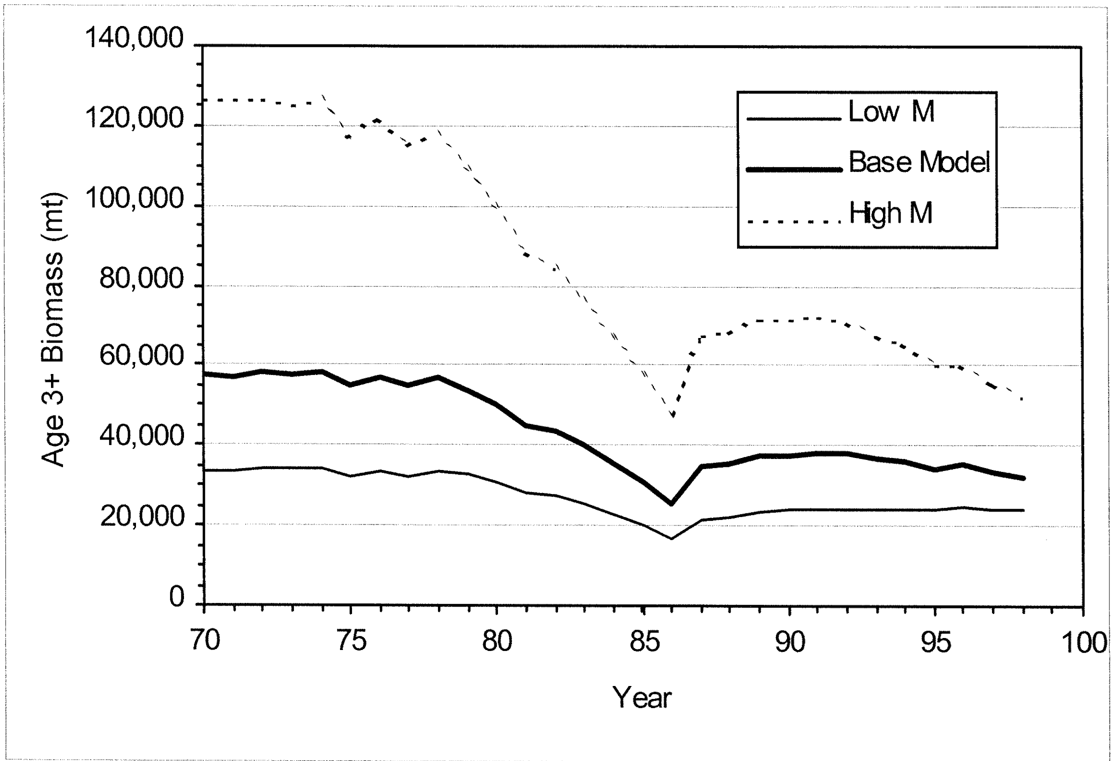


Figure 38. Trends in chilipepper summary biomass (age 3+) under differing natural mortality scenarios. The "Low M" result is base on $M_♀ = 0.16$ and $M_♂ = 0.20$. The "High M" result is based on $M_♀ = 0.28$ and $M_♂ = 0.30$ (see also Table 19).

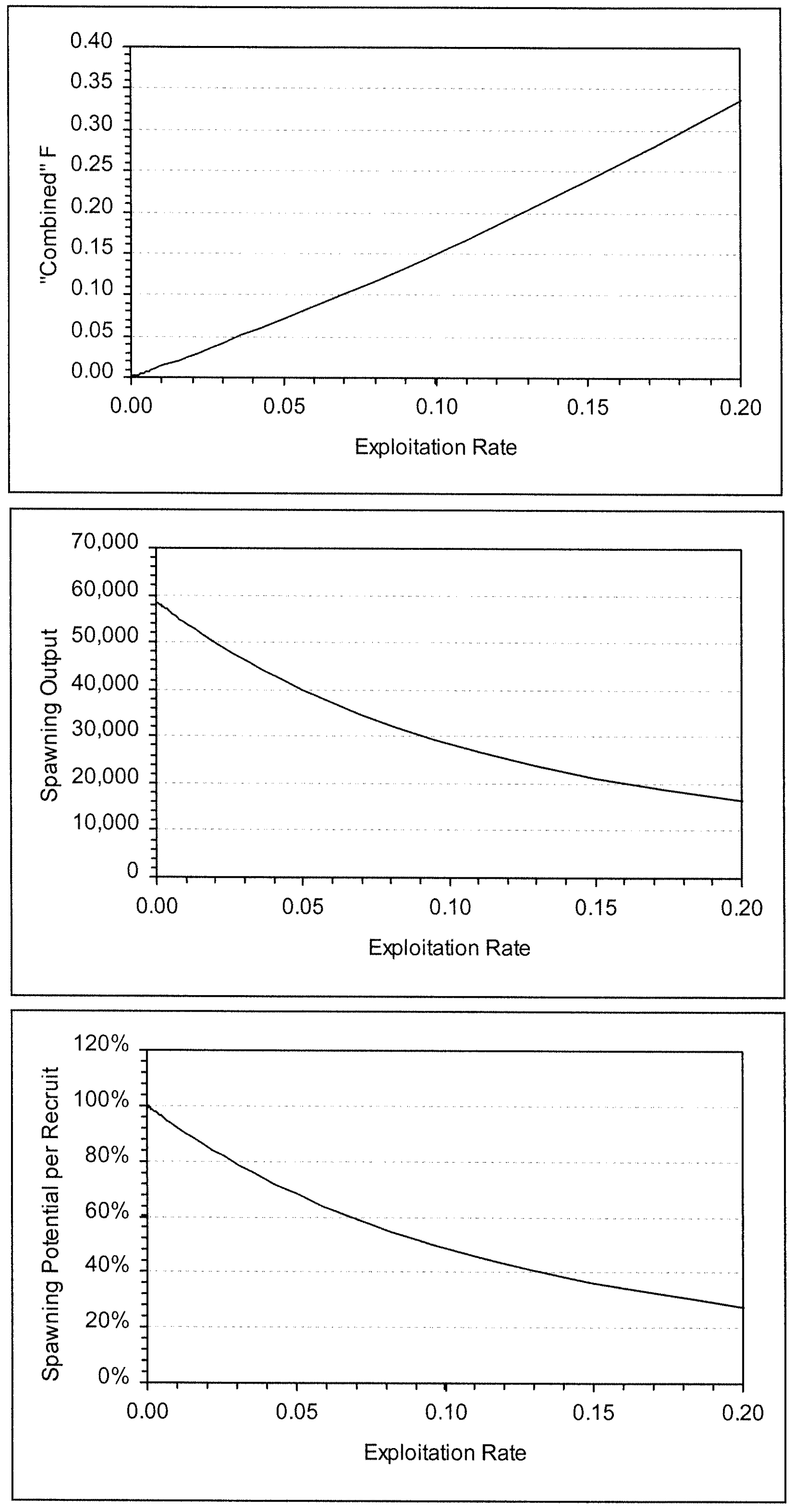


Figure 39. Relationship of "combined" fishing mortality, the spawning output of the stock, and the spawning potential per recruit (SPR) to the stock exploitation rate. Selectivities and relative fishing mortality rates of the four fisheries predicated on base model estimates for 1998.

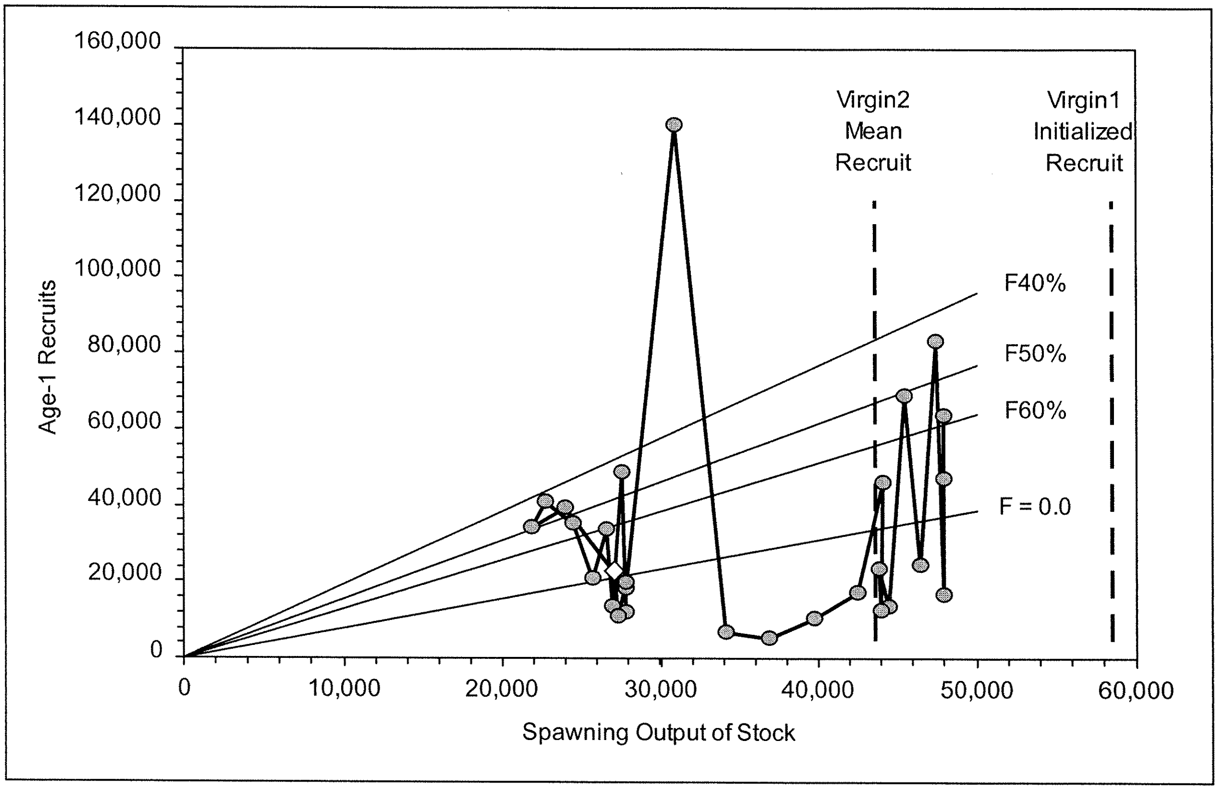


Figure 40. Relationship of recruitment and spawning output. Replacement lines under several constant rate harvest policies are shown. Also shown are two estimates of virgin spawning output; one based on the level of recruitment required to initialize the model at an equilibrium in 1970 and one based on the mean of observed recruitments from 1970-98. The observed recruitment and spawning output in the terminal year of the simulation (1998) is shown as an open diamond symbol.

Appendix A. Stock synthesis parameter file for the base run chilipepper model.

```
chili98.dat       LOOP1: 10  LIKE:-5735.23  DELTA LIKE:     .00 ENDBIO:    31963.
chili98.run
chili98.par
Base Run Model
   100.000      .001       BEGIN AND END DELTA F PER LOOP1
   3   .95                 FIRST LOOP1 FOR LAMBDA & VALUE
   1.200                   MAX VALUE FOR CROSS DERIVATIVE
   1 READ HESSIAN
chili98.hes
   1 WRITE HESSIAN
chili98.hes
    .000                   MIN SAMPLE FRAC. PER AGE
  1  21    3  21           MINAGE, MAXAGE,  SUMMARY AGE RANGE
 70  98                    BEGIN YEAR, END YEAR
 1       12  0  0  0       NPER, MON/PER
 1.00                      SPAWNMONTH
 4  3 NFISHERY, NSURVEY
 2 N SEXES
  25000.  REF RECR LEVEL
 0 MORTOPT
    .223451    .010000    1.000000 'Natural Mortalit'  0   1 !   1 NO PICK    .000       -1.       .0000000
    .253432    .010000    1.000000 'Male same as Fem'  0   1 !   2 NO PICK    .000       -1.       .0000000
 TRAWL:1     TYPE:  1
  7 SELECTIVITY PATTERN
   0   2   0   3   4   0    0  AGE TYPES USED
    1.00000        .02 'TRAWL CATCH BIOMASS '  ! # =  1 VALUE:       .00
    1.00000        .30 'TRAWL AGE COMPS     '  ! # =  2 VALUE:   -561.83
    1.00000        .30 'TRAWL LENGTH COMPS  '  ! # =  3 VALUE:   -576.66
    1.00000      -1.00 'TRAWL LENGTH@AGE    '  ! # =  4 VALUE:   -712.25
  1  0  0  0   0  0  SEL. COMPONENTS
    .000000    .000000    1.000000 'Min size selecti'  0  70 !   3 NO PICK    .000       -1.       .0000000
    .196795    .050000     .950000 'Size@ascend infl'  2  70 !   4 OK         .000 -930063.       .0000000
    .505125    .010000    4.000000 'Ascending slope '  2  70 !   5 OK         .000  -41552.       .0000000
 SETNET2     TYPE:  2
  7 SELECTIVITY PATTERN
   0   6   0   7   8   0    0  AGE TYPES USED
    1.00000        .02 'SETNET CATCH BIOMASS'  ! # =  5 VALUE:       .00
    1.00000        .30 'SETNET AGE COMPS    '  ! # =  6 VALUE:   -804.03
    1.00000        .30 'SETNET LENGTH COMPS '  ! # =  7 VALUE:   -573.49
    1.00000      -1.00 'SETNET LENGTH@AGE   '  ! # =  8 VALUE:   -362.19
  1  1  0  0   0  0  SEL. COMPONENTS
  43.872939  20.000000   45.000000 'Transition lengt'  2  70 !   6 OK        -.003     -187.       .0000000
    .000000    .000000    1.000000 'Min size selecti'  0  70 !   7 NO PICK    .000       -1.       .0000000
    .632309    .050000     .950000 'Size@ascend infl'  2  70 !   8 OK         .000  -61897.       .0000000
    .351337    .010000    4.000000 'Ascending slope '  2  70 !   9 OK         .000  -75032.       .0000000
    .281843    .001000     .990000 'F-max size selec'  2  70 !  10 OK        -.001    -1447.       .0000000
    .079549    .050000     .850000 'F-descend inflec'  2  70 !  11 OK        -.001   -12608.       .0000000
   3.594562    .010000    5.000000 'F-descend slope '  2  70 !  12 BAD DX2    .000       -1.       .0000000
 RECREATI    TYPE:  3
  7 SELECTIVITY PATTERN
   0   0   0  10   0   0    0  AGE TYPES USED
    1.00000        .02 'RECREATIONAL CATCH B'  ! # =  9 VALUE:       .00
    1.00000        .30 'RECREATIONAL LENGTH '  ! # = 10 VALUE:   -478.31
  1  1  0  0   0  0  SEL. COMPONENTS
  41.460563  20.000000   45.000000 'Transition lengt'  2  70 !  13 OK         .001      -20.       .0000000
    .000000    .000000    1.000000 'Min size selecti'  0  70 !  14 NO PICK    .000       -1.       .0000000
    .304450    .050000     .950000 'Size@ascend infl'  2  70 !  15 OK         .000  -47667.       .0000000
    .478586    .010000    4.000000 'Ascending slope '  2  70 !  16 OK         .000   -4347.       .0000000
    .244521    .001000     .990000 'F-max size selec'  2  70 !  17 OK         .000    -216.       .0000000
    .050000    .050000     .850000 'F-descend inflec'  2  70 !  18 BOUND      .000       -1.       .0000000
    .474541    .010000    3.000000 'F-descend slope '  2  70 !  19 OK         .000      -94.       .0000000
 HOOKLINE    TYPE:  4
  7 SELECTIVITY PATTERN
   0  12   0  13  14   0    0  AGE TYPES USED
    1.00000        .02 'HOOK CATCH BIOMASS  '  ! # = 11 VALUE:       .00
    1.00000        .30 'HOOK AGE COMPS      '  ! # = 12 VALUE:   -385.14
    1.00000        .30 'HOOK LENGTH COMPS   '  ! # = 13 VALUE:   -654.55
    1.00000      -1.00 'HOOK LENGTH@AGE     '  ! # = 14 VALUE:   -273.34
  1  1  0  0   0  0  SEL. COMPONENTS
  45.000000  20.000000   45.000000 'Transition lengt'  2  70 !  20 BOUND      .000       -1.       .0000000
    .000000    .000000    1.000000 'Min size selecti'  0  70 !  21 NO PICK    .000       -1.       .0000000
    .432444    .050000     .950000 'Size@ascend infl'  2  70 !  22 OK         .000 -105132.       .0000000
    .461634    .010000    4.000000 'Ascending slope '  2  70 !  23 OK         .000  -13118.       .0001621
    .191393    .001000     .990000 'F-max size selec'  2  70 !  24 OK         .000    -371.       .0039556
    .153346    .050000     .850000 'F-descend inflec'  2  70 !  25 OK         .000   -1932.       .0000000
   2.707711    .010000    5.000000 'F-descend slope '  2  70 !  26 BAD DX2    .000       -1.       .0000000
 TRITRAWL    TYPE:  5
  7 SELECTIVITY PATTERN
   0   0   0  16   0   0    0  AGE TYPES USED
    .000175   0  1   1 Q, QUANT, LOGERROR=1, BIO=1 or NUM=2
    1.00000        .16 'TRI SURVEY BIO      '  ! # = 15 VALUE:     -8.59
    1.00000        .30 'TRI LENGTH COMPS    '  ! # = 16 VALUE:   -321.27
  1  0  0  0   0  0  SEL. COMPONENTS
    .254527    .001000     .990000 'Min size selecti'  2  77 !  27 OK         .000   -1829.       .0000000
```

```
     .397340      .010000       .950000 'Size@ascend infl'   2  77 !  28 OK         .000  -12228.       .0000776
     .877919      .010000      4.000000 'Ascending slope '   2  77 !  29 OK         .001     -18.       .0752840
 MWTRAWL     TYPE:  6
  3 SELECTIVITY PATTERN
   0   0   0   0   0   0   0  AGE TYPES USED
     .000026  0  1  2 Q, QUANT, LOGERROR=1, BIO=1 or NUM=2
     1.00000        .01 'MWT RECRUIT SURVEY  '  ! # = 17 VALUE:      6.60
    1.000000    1.000000    1.000000 'MWT SURVEY AGE  '   0  87 !  30 NO PICK   .000      -1.       .0000000
    1.000000    1.000000    1.000000 'MWT-M SELECTIVIT'   0  87 !  31 NO PICK   .000      -1.       .0000000
 LOGBOOK     TYPE:  7
  7 SELECTIVITY PATTERN
   0   0   0   0   0   0   0  AGE TYPES USED
     .005235  0  1  1 Q, QUANT, LOGERROR=1, BIO=1 or NUM=2
     1.00000        .16 'LOGBOOK CPUE        '  ! # = 18 VALUE:    -21.64
  1  0  0  0  0  0  SEL. COMPONENTS
     .000000      .000000    1.000000 'Min size selecti'   0  78 !  32 NO PICK   .000      -1.       .0000000
     .449565      .050000     .950000 'Size@ascend infl'   0  78 !  33 NO PICK   .000      -1.       .0000000
     .439527      .010000    4.000000 'Ascending slope '   0  78 !  34 NO PICK   .000      -1.       .0000000
  1 AGEERR: 1: MULTINOMIAL,  0: S(LOG(P))=CONSTANT,  -1: S=P*Q/N
 300.000 : MAX N FOR MULTINOMIAL
  3 1=%CORRECT, 2=C.V., 3=%AGREE, 4=READ %AGREE @AGE
     .900000      .300000     .950000 '%AGREE @ 1 (MIN)'   0  80 !  35 NO PICK   .000      -1.       .0000000
     .300000      .100000     .900000 '%AGREE @ 21(MAX)'   0  80 !  36 NO PICK   .000      -1.       .0000000
    1.000000      .001000    4.000000 'POWER           '   0  80 !  37 NO PICK   .000      -1.       .0000000
     .150000      .010000     .300000 'OLD DISCOUNT    '   0  80 !  38 NO PICK   .000      -1.       .0000000
     .000000      .001000     .100000 '%MIS-SEXED      '   0  80 !  39 NO PICK   .000      -1.       .0000000
 -1 CPUE FOR TYPE:   1
      .00100       -.28 'TRAWL CPUE  EST      '  ! # = 19 VALUE:      15.17
     .007510      .000100   10.000000 'Q-MEAN TRAWL    '   0  78 !  40 NO PICK   .000      -1.       .0000000
     .000000      .000000   10.000000 'Q-SLP TRAWL     '   0  78 !  41 NO PICK   .000      -1.       .0000000
 -3 CPUE FOR TYPE:   3
      .00100       -.98 'REC. CPUE   EST      '  ! # = 20 VALUE:      -5.78
     .006397      .000100   10.000000 'Q-MEAN RECREATIO'   0  80 !  42 NO PICK   .000      -1.       .0000000
     .000000      .000000   10.000000 'Q-SLP RECREATION'   0  80 !  43 NO PICK   .000      -1.       .0000000
  0 END OF EFFORT
  0 FIX n FMORTs
  0  CANNIBALISM
  1  GROWTH: 1=CONSTANT, 2=MORT. INFLUENCE
  1.5000 20.5000  AGE AT WHICH L1 AND L2 OCCUR
  1 1=NORMAL, 2=LOGNORMAL
   12.885492   10.000000   40.000000 'FEMALE L1       '   0  70 !  44 NO PICK   .000      -1.       .0000000
   47.478859   40.000000   70.000000 'FEMALE L2       '   0  70 !  45 NO PICK   .000      -1.       .0000000
     .191926     .100000     .300000 'FEMALE K        '   0  70 !  46 NO PICK   .000      -1.       .0000000
     .230626     .010000     .990000 'FEMALE CV1      '   0  70 !  47 NO PICK   .000      -1.       .0000000
     .084573     .010000     .990000 'FEMALE CV21     '   0  70 !  48 NO PICK   .000      -1.       .0000000
   18.229417   10.000000   30.000000 'MALE L1         '   0  70 !  49 NO PICK   .000      -1.       .0000000
   33.523334   20.000000   50.000000 'MALE L2         '   0  70 !  50 NO PICK   .000      -1.       .0000000
     .233312     .100000     .400000 'MALE K          '   0  70 !  51 NO PICK   .000      -1.       .0000000
     .156862     .010000     .990000 'MALE CV1        '   0  70 !  52 NO PICK   .000      -1.       .0000000
     .102252     .010000     .990000 'MALE CV21       '   0  70 !  53 NO PICK   .000      -1.       .0000000
          0  DEFINE MARKET CATEGORIES
  4 ENVIRONMENTAL FXN
 chili98.env
  4  1  1 PARM AFFECTED, FXN TYPE, ENVVAR USED
    1.000000     .010000   10.000000 'TRAWL ASC INFLC '   0   1 !  54 NO PICK   .000      -1.       .0000000
  8  1  1 PARM AFFECTED, FXN TYPE, ENVVAR USED
    1.000000     .010000   10.000000 'SETNET ASC INFLC'   0   1 !  55 NO PICK   .000      -1.       .0000000
 15  1  1 PARM AFFECTED, FXN TYPE, ENVVAR USED
    1.000000     .010000   10.000000 'RECREA ASC INFLC'   0   1 !  56 NO PICK   .000      -1.       .0000000
 22  1  1 PARM AFFECTED, FXN TYPE, ENVVAR USED
    1.000000     .010000   10.000000 'HOOK  ASC INFLC'    0   1 !  57 NO PICK   .000      -1.       .0000000
 15 ESTIMATE N ENVIRON VALUES
-70  1  YEAR,PARM.
 82  YEAR-END
     .286349     .010000     .900000 '1970-82 ENV     '   2  70 !  58 OK        .000  -70834.       .0000000
 83  1  YEAR,PARM.
     .302838     .010000     .900000 '1983 ENV        '   2  82 !  59 OK        .000  -53958.       .0000000
 84  1  YEAR,PARM.
     .290680     .010000     .900000 '1984 ENV        '   2  83 !  60 OK        .000 -106079.       .0000000
 85  1  YEAR,PARM.
     .242711     .010000     .900000 '1985 ENV        '   2  84 !  61 OK        .000  -85981.       .0000000
 86  1  YEAR,PARM.
     .255920     .010000     .900000 '1986 ENV        '   2  85 !  62 OK        .000  -84311.       .0000000
 87  1  YEAR,PARM.
     .255824     .010000     .900000 '1987 ENV        '   2  86 !  63 OK        .000 -102129.       .0000000
 88  1  YEAR,PARM.
     .266622     .010000     .900000 '1988 ENV        '   2  87 !  64 OK        .000 -112619.       .0000000
 89  1  YEAR,PARM.
     .260796     .010000     .900000 '1989 ENV        '   2  88 !  65 OK        .000 -108922.       .0000000
 90  1  YEAR,PARM.
     .260461     .010000     .900000 '1990 ENV        '   2  89 !  66 OK        .000  -68459.       .0000000
 91  1  YEAR,PARM.
     .226894     .010000     .900000 '1991 ENV        '   2  90 !  67 OK        .000  -74360.       .0000000
 92  1  YEAR,PARM.
     .202512     .010000     .900000 '1992 ENV        '   2  91 !  68 OK        .000  -77640.       .0000000
 93  1  YEAR,PARM.
     .109281     .010000     .900000 '1993 ENV        '   2  92 !  69 OK        .000  -55781.       .0000000
```

```
 94  1  YEAR,PARM.
     .174114     .010000     .900000 '1994 ENV        '  2  93 !  70 OK          .000  -36976.        .0000000
 95  1  YEAR,PARM.
     .219588     .010000     .900000 '1995 ENV        '  2  94 !  71 OK          .000  -61197.        .0000000
-96  1  YEAR,PARM.
 98  YEAR-END
     .171521     .010000     .900000 '1996-98 ENV     '  2  95 !  72 OK          .000  -43250.        .0000000
  0 PENALTIES: PARM, PRIOR, SD or CV, PICK, LABEL, X, PENALTY
 21  STOCK-RECR
  1 1=B-H, 2=RICKER
  1 0=USE S-R CURVE, 1=SCALE CURVE
    1.00000      -1.00 ' SPAWN-RECRUIT indiv'  ! # = 21 VALUE:     -8.55
     .00000       -.20 ' SPAWN-RECRUIT mean '  ! # = 22 VALUE:    -13.34
   1.800677     .200000    9.000000 'VIRGIN RECR MULT'  2  70 !  73 OK          .000     -240.      .0000000
   1.000000     .500000    3.000000 'B/H  S/R PARAM  '  0  70 !  74 NO PICK     .000       -1.      .0000000
    .000000    -.200000     .200000 'BACKG. RECRUIT  '  0  70 !  75 NO PICK     .000       -1.      .0000000
   1.000000     .200000    1.500000 'S/R STD.DEV.    '  0  70 !  76 NO PICK     .000       -1.      .0000000
    .000000    -.200000     .200000 'RECR TREND      '  0  70 !  77 NO PICK     .000       -1.      .0000000
   1.000000     .500000    3.000000 'RECR. MULT.     '  0  70 !  78 NO PICK     .000       -1.      .0000000
 -1 INIT AGE COMP
   2.132799     .000100   30.000000 'RECRUIT 70      '  2  70 !  79 OK         -.001      -13.      .1297864
   1.882456     .000100   30.000000 'RECRUIT 71      '  2  71 !  80 OK         -.001      -18.      .0493292
   2.545143     .000100   30.000000 'RECRUIT 72      '  2  72 !  81 OK          .000      -25.      .0000000
    .660469     .000100   30.000000 'RECRUIT 73      '  2  73 !  82 OK          .000      -48.      .0338100
   3.328384     .000100   30.000000 'RECRUIT 74      '  2  74 !  83 OK          .000      -39.      .0000000
    .967300     .001000   30.000000 'RECRUIT 75      '  2  75 !  84 OK          .000      -77.      .0000000
   2.739163     .001000   30.000000 'RECRUIT 76      '  2  76 !  85 OK          .000      -74.      .0000000
    .539987     .001001   30.000000 'RECRUIT 77      '  2  77 !  86 OK          .000     -246.      .0000000
    .921010     .001000   30.000000 'RECRUIT 78      '  2  78 !  87 OK          .000     -274.      .0000000
    .500504     .001000   30.000000 'RECRUIT 79      '  2  79 !  88 OK          .000     -393.      .0000000
   1.841837     .001000   10.000000 'RECRUIT 80      '  2  80 !  89 OK          .000     -204.      .0000000
    .685874     .001000   10.000000 'RECRUIT 81      '  2  81 !  90 OK          .000     -446.      .0000000
    .406004     .001000   10.000000 'RECRUIT 82      '  2  82 !  91 OK          .000     -878.      .0000000
    .196333     .001000   10.000000 'RECRUIT 83      '  2  83 !  92 OK          .000    -1307.      .0000000
    .259965     .001000   10.000000 'RECRUIT 84      '  2  84 !  93 OK          .000     -551.      .0021591
   5.587173     .001000   20.000000 'RECRUIT 85      '  2  85 !  94 OK         -.001      -63.      .0000000
    .717521     .001000   10.000000 'RECRUIT 86      '  2  86 !  95 OK          .000     -271.      .0000000
   1.572505     .001000   10.000000 'RECRUIT 87      '  2  87 !  96 OK          .000     -221.      .0000000
   1.354492     .001000   10.000000 'RECRUIT 88      '  2  88 !  97 OK          .000     -188.      .0000000
   1.639672     .001000   10.000000 'RECRUIT 89      '  2  89 !  98 OK          .001     -149.      .0000000
   1.401942     .001000   10.000000 'RECRUIT 90      '  2  90 !  99 OK          .000     -187.      .0000000
    .823277     .001000   10.000000 'RECRUIT 91      '  2  91 ! 100 OK          .000     -211.      .0000000
   1.341798     .001000   10.000000 'RECRUIT 92      '  2  92 ! 101 OK          .001     -116.      .0133014
    .546202     .001000   10.000000 'RECRUIT 93      '  2  93 ! 102 OK          .000     -119.      .0000000
   1.939293     .001000   10.000000 'RECRUIT 94      '  2  94 ! 103 OK         -.004      -24.      .0000000
    .484550     .001000   10.000000 'RECRUIT 95      '  2  95 ! 104 OK          .000      -95.      .0096327
    .774794     .001000   10.000000 'RECRUIT 96      '  2  96 ! 105 OK          .000      -36.      .0000000
    .430403     .001000   10.000000 'RECRUIT 97      '  2  97 ! 106 OK          .000      -87.      .0000000
    .907738     .001000   10.000000 'RECRUIT 98      '  2  98 ! 107 OK          .001      -20.      .0000000
  .0322  .0000  .0048  .0063
  .0315  .0000  .0029  .0089
  .0471  .0000  .0071  .0127
  .0646  .0000  .0113  .0180
  .0618  .0000  .0163  .0172
  .0661  .0000  .0151  .0187
  .0669  .0000  .0119  .0192
  .0545  .0000  .0086  .0159
  .0506  .0000  .0067  .0151
  .0674  .0000  .0132  .0203
  .0912  .0008  .0104  .0059
  .0777  .0036  .0087  .0104
  .0724  .0032  .0136  .0134
  .1013  .0340  .0064  .0072
  .0927  .0265  .0067  .0022
  .0819  .0625  .0180  .0147
  .0526  .0945  .0206  .0154
  .0814  .0474  .0102  .0055
  .0949  .0441  .0189  .0186
  .1120  .0438  .0125  .0279
  .1119  .0374  .0099  .0172
  .0890  .0323  .0046  .0371
  .0395  .0263  .0011  .0551
  .0384  .0175  .0005  .0286
  .0436  .0096  .0008  .0225
  .0627  .0079  .0004  .0171
  .0550  .0035  .0014  .0122
  .0517  .0042  .0009  .0009
  .0536  .0043  .0010  .0010
  CONVERGENCE
 LIKE CHANGE:      .0000  MAX PARM CHANGE:  11    F-descend inflec  .00046
 CONVERGENCE PATH (LIKE, BIOMASS)
  -5735.2940     31682.4
  -5735.2927     31686.8
  -5735.2893     31706.7
  -5735.2890     31720.6
  -5735.2885     31738.4
  -5735.2707     32071.5
```

```
-5735.2595     31986.7
-5735.2398     31939.2
-5735.2314     31964.1
-5735.2314     31963.4
NUMBER OF ESTIMATED PARAMETERS =          68
N CATCHES WITH F ESTIMATED     =         106
N SURV OBS WITH EMPH > 0.001   =          36
N EFFORT OBS WITH EMPH > 0.001 =           0
N COMPOSITION OBS WITH NAGES>1 =         129
N COMPOSITION BINS WITH DATA   =        3681
```

Appendix B. Stock synthesis data file used in the base run chilipepper model.

```
chilipepper data file for 1998 assessment, assembled by Steve Ralston
    1238       1trawl   setnet  recrea  hkline
      70        1    1096       0     184     159
      71        1    1071       0     109     226
      72        1    1592       0     272     319
      73        1    2146       0     426     445
      74        1    2016       0     610     415
      75        1    2121       0     560     445
      76        1    2111       0     436     450
      77        1    1711       0     316     371
      78        1    1598       0     248     353
      79        1    2115       0     477     474
      80        1    2758      11     356     133
      81        1    2204      48     272     222
      82        1    1895      40     389     265
      83        1    2299     372     162     124
      84        1    1989     268     156      36
      85        1    1779     631     395     239
      86        1     959     807     395     210
      87        1    1396     358     203      68
      88        1    1660     305     415     224
      89        1    2209     319     308     379
      90        1    2352     300     256     257
      91        1    2184     314     128     657
      92        1    1059     291      32    1083
      93        1    1249     269      17     723
      94        1    1238     123      23     484
      95        1    1557      88      11     319
      96        1    1496      44      37     250
      97        1    1375      52      24      19
      98        1    1375      52      24      19
      -1        1       1       1       1       1       1END     OF      CATCH   DATA
      78        1       1     290                        Trawl logbook CPUE
      79        1       1     266                        Trawl logbook CPUE
      80        1       1     228                        Trawl logbook CPUE
      81        1       1     260                        Trawl logbook CPUE
      82        1       1     207                        Trawl logbook CPUE
      83        1       1     187                        Trawl logbook CPUE
      84        1       1     178                        Trawl logbook CPUE
      85        1       1     115                        Trawl logbook CPUE
      86        1       1     113                        Trawl logbook CPUE
      87        1       1     146                        Trawl logbook CPUE
      88        1       1     211                        Trawl logbook CPUE
      89        1       1     225                        Trawl logbook CPUE
      90        1       1     213                        Trawl logbook CPUE
      91        1       1     174                        Trawl logbook CPUE
      92        1       1     155                        Trawl logbook CPUE
      93        1       1     128                        Trawl logbook CPUE
      94        1       1     168                        Trawl logbook CPUE
      95        1       1     177                        Trawl logbook CPUE
      96        1       1     153                        Trawl logbook CPUE
      80        1       3     184                        MRFSS recreational CPUE
      81        1       3     331                        MRFSS recreational CPUE
      82        1       3     165                        MRFSS recreational CPUE
      83        1       3     192                        MRFSS recreational CPUE
      84        1       3     177                        MRFSS recreational CPUE
      85        1       3     320                        MRFSS recreational CPUE
      86        1       3     279                        MRFSS recreational CPUE
      87        1       3      87                        MRFSS recreational CPUE
      88        1       3     502                        MRFSS recreational CPUE
      89        1       3     560                        MRFSS recreational CPUE
      90        1       3      -1                           placeholder
      91        1       3      -1                           placeholder
      92        1       3      -1                           placeholder
      93        1       3      43                        MRFSS recreational CPUE
      94        1       3      34                        MRFSS recreational CPUE
      95        1       3      55                        MRFSS recreational CPUE
      -1        1       1       1                        END     OF      EFFORT  AND     CPUE    DATA
      77        1       8       5    3.66    0.86        Triennial shelf trawl survey
      78        1       8       5      -1      -1        Placeholder
      79        1       8       5      -1      -1        Placeholder
      80        1       8       5    4.29    1.01        Triennial shelf trawl survey
      81        1       8       5      -1      -1        Placeholder
      82        1       8       5      -1      -1        Placeholder
```

```
83 1 8 5 4.01 0.94 Triennial shelf trawl survey
84 1 8 5 -1 -1 Placeholder
85 1 8 5 -1 -1 Placeholder
86 1 8 5 7.06 1.66 Triennial shelf trawl survey
87 1 8 5 -1 -1 Placeholder
88 1 8 5 -1 -1 Placeholder
89 1 8 5 11.41 2.68 Triennial shelf trawl survey
90 1 8 5 -1 -1 Placeholder
91 1 8 5 -1 -1 Placeholder
92 1 8 5 5.21 1.22 Triennial shelf trawl survey
93 1 8 5 -1 -1 Placeholder
94 1 8 5 -1 -1 Placeholder
95 1 8 5 7.41 1.74 Triennial shelf trawl survey
87 1 6 6 0.44 0.11 MWT Survey
88 1 6 6 1.38 0.35 MWT Survey
89 1 6 6 1.12 0.28 MWT Survey
90 1 6 6 0.6 0.15 MWT Survey
91 1 6 6 0.53 0.13 MWT Survey
92 1 6 6 0.7 0.18 MWT Survey
93 1 6 6 0.5 0.13 MWT Survey
94 1 6 6 1.37 0.34 MWT Survey
95 1 6 6 0.24 0.06 MWT Survey
96 1 6 6 0.46 0.11 MWT Survey
97 1 6 6 0.24 0.06 MWT Survey
98 1 6 6 0.53 0.13 MWT Survey
80 1 7 7 249 25 Trawl logbook as a survey
81 1 7 7 150 15 Trawl logbook as a survey
82 1 7 7 121 12 Trawl logbook as a survey
83 1 7 7 116 12 Trawl logbook as a survey
84 1 7 7 91 9 Trawl logbook as a survey
85 1 7 7 88 9 Trawl logbook as a survey
86 1 7 7 76 8 Trawl logbook as a survey
87 1 7 7 116 12 Trawl logbook as a survey
88 1 7 7 158 16 Trawl logbook as a survey
89 1 7 7 172 17 Trawl logbook as a survey
90 1 7 7 149 15 Trawl logbook as a survey
91 1 7 7 146 15 Trawl logbook as a survey
92 1 7 7 109 11 Trawl logbook as a survey
93 1 7 7 80 8 Trawl logbook as a survey
94 1 7 7 112 11 Trawl logbook as a survey
95 1 7 7 126 13 Trawl logbook as a survey
96 1 7 7 96 10 Trawl logbook as a survey
-1 1 1 1 1 1 END OF SURVEY ABUNDANCDATA
-1 -1(no bins defined for perfect ages)
21 21(for imprecise ages, data vectors contain 21 elements, condense to 21 elements)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 30
-1 -1(no bins defined for biased ages)
25 25(25 2-cm length bins [10-60 cm])
9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 65
28.83 -0.3958 length@50%mature, slope (Echeverria 1987)
5.93E-06 3.2399 female length-weight (alpha & beta) from triennial survey fish
0.92725 0.42783 eggs/kg on weight (intercept & slope) from Phillips (1964)
3.46E-06 3.4144 male length-weight (alpha & beta) from triennial survey fish
BEGINNINOF SIZE AND AGE COMPOSITION DATA
77 1 5 4 3 100 1 1 25 25 0
0 0 0.00011 0.00089 0.00264 0.00552 0.02936 0.04159 0.0171 0.01403 0.01293 0.0256 0.07556 0.09831 0.03131 0.03405 0.04975 0.05438 0.05975 0.0501 0.02822 0.00991 0.0011 0 0.00023
0 0 0 0.00134 0.00247 0.00654 0.02668 0.03277 0.01069 0.01153 0.03267 0.08494 0.0704 0.05356 0.0193 0.00081 0.00102 0.00106 0.00095 0.00085 0 0 0 0 0
80 1 1 4 3 1590 1 1 25 25 0
0 0 0 0 0 0.00054 0.00026 0 0.00214 0.00766 0.00783 0.02913 0.05731 0.07078 0.09657 0.08426 0.11402 0.06747 0.05507 0.0399 0.0154 0.00119 0 0 0
0 0 0 0 0 0 0 0.00192 0.00218 0.0131 0.04992 0.09865 0.10738 0.05332 0.01092 0.00233 0.0031 0.00178 0.0031 0.00186 0.00063 0.00024 0 0 0
80 1 3 4 0 200 1 1 25 25 0
0 0 0 0 0 0.024 0.016 0.0181 0.02 0.0566 0.0624 0.0957 0.0948 0.1338 0.1364 0.0977 0.0967 0.0701 0.046 0.021 0.0107 0 0 0 0
80 1 4 4 0 42 1 1 25 25 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0.00108 0.09676 0.00216 0.00108 0.19568 0.39892 0.30108 0.00216 0.00108 0 0 0
80 1 5 4 3 100 1 1 25 25 0
0 0 0 0 0 0 0 0 0 0.00082 0.00099 0.01557 0.04095 0.06509 0.05713 0.05347 0.09241 0.08526 0.05403 0.02694 0.00963 0.006 0 0 0
0 0 0 0 0 0 0.00139 0.00046 0.00046 0.00426 0.0247 0.0912 0.1975 0.14246 0.01397 0.00193 0.00419 0.0073 0.00138 0.00051 0 0 0 0 0
81 1 1 4 3 958 1 1 25 25 0
0 0 0 0 0 0 0 0 0.0008 0.00548 0.00405 0.01106 0.01788 0.08501 0.16514 0.11645 0.114 0.06216 0.07516 0.04756 0.01637 0.00069 0 0 0
0 0 0 0 0 0 0 0 0.00094 0.00125 0.03902 0.09107 0.10847 0.02701 0.00677 0.00014 0.00345 0 0.00009 0 0 0 0 0 0
81 1 3 4 0 200 1 1 25 25 0
0 0.001 0 0 0.0097 0.0046 0.0098 0.0169 0.0332 0.0701 0.1652 0.1128 0.126 0.1061 0.1323 0.0832 0.0428 0.0371 0.0221 0.0171 0.0092 0.001 0 0 0
82 1 1 2 3 1032 1 1 21 21 0
0 0.00023 0.02877 0.02363 0.06523 0.01829 0.12415 0.06848 0.09223 0.02813 0.05067 0.05613 0.02297 0.02032 0.01387 0.00534 0.00156 0.00066 0 0.0011 0.01704
0 0.00035 0.00848 0.00358 0.07171 0.01591 0.06278 0.01983 0.0709 0.01468 0.04005 0.01666 0.0032 0.00618 0.00619 0.00002 0.00065 0 0 0.00043 0.0196
82 1 1 4 3 1604 1 1 25 25 0
0 0 0 0 0 0 0.00322 0.00197 0.00226 0.00796 0.02149 0.02876 0.02275 0.04751 0.07799 0.11681 0.12278 0.11007 0.07116 0.05954 0.02036 0.00444 0.00578 0 0.00019
0 0 0 0 0 0 0.0057 0.00013 0.00746 0.02846 0.03995 0.07273 0.07597 0.03432 0.00872 0.00086 0.00011 0 0 0.00057 0 0 0 0 0
82 1 1 5 3 1214 1 1 21 21 0 Mean Length @ Age
```

```
 -1   26.3   29.3   31.2     35   37.7   40.1   41.6   43.3   44.7   46.5   46.6   47.8   47.1   48.1   48.4   49.9     45   47.1   47.7   48.7
 -1   37.4   29.9   29.2   30.3   32.4   33.1   33.6   33.9   34.8     35   34.6   35.4   35.9   36.2   37.3     35     -1     -1     36   37.5
 82      1      1      5      3   1214      1      1     21     21      0   Length @ Age Sample Size
  0      1     25     28     55     57    181     50    130     35     68     61     44     23     32     10     10      4      3      3      3
  0      1     10      9     34     29    106     29     65     27     27     22      8     11      8      1      2      0      0      1      1
 82      1      3      4      0    200      1      1     25     25      0
  0      0      0      0      0 0.0011 0.0025 0.0251 0.0499 0.0654 0.0898 0.0945 0.0751 0.0959 0.1275 0.1306 0.1097 0.0548 0.0462  0.024 0.0065 0.0014      0      0      0
 82      1      4      4      0     29      1      1     25     25      0
  0      0      0      0      0      0      0      0      0      0      0      0      0      0 0.10101 0.04974 0.09947 0.34252 0.20363 0.15155 0.05208      0      0      0      0
 83      1      1      2      3   2302      1      1     21     21      0
  0      0 0.00685 0.05874 0.02025 0.04486 0.07836 0.19574 0.06954 0.10352 0.0233 0.04735 0.03249 0.0283 0.01067 0.02086 0.00246 0.00362 0.00384 0.01051 0.0293
  0 0.00025 0.0054 0.03654 0.00901 0.01208 0.02772 0.04269 0.01174 0.02117 0.00555 0.01106 0.00276 0.00545 0.00195 0.00565 0.00331 0.00214      0 0.00225 0.00272
 83      1      1      4      3   2610      1      1     25     25      0
  0      0      0      0      0      0      0 0.00026 0.00119 0.00566 0.02005 0.02678 0.03094 0.03468 0.04674 0.11427 0.17766 0.12963 0.10316 0.07023 0.02876 0.00281 0.0031      0      0
  0      0      0      0      0      0 0.00019 0.00056 0.00178 0.01436 0.03767 0.04326 0.0563 0.03254 0.00944 0.0019 0.00184 0.00177 0.00182 0.0001 0.00055      0      0      0      0
 83      1      1      5      3   2241      1      1     21     21      0   Mean Length @ Age
 -1     -1   30.9   32.4     35   37.4   40.4   41.6   42.9   43.3   44.3   46.3   47.3   46.6   47.7   47.6   45.1   48.6   47.4   47.8   49.8
 -1   26.1   29.2   29.8   31.9   32.4   33.2   33.8     34   34.7   34.5   35.1   35.6   35.9   34.5   36.5   37.4   38.2     -1     36   36.5
 83      1      1      5      3   2241      1      1     21     21      0   Length @ Age Sample Size
  0      0     23    195     63    114    165    358    115    241     38    112     67     61     32     48      5      7      6      7     20
  0      2     15     89     32     36     50    108     27     62     16     50     12     24      5     22      6      2      0      4      2
 83      1      2      2      3     68      1      1     21     21      0
  0      0      0      0 0.03801 0.04856 0.12017 0.23373 0.06967 0.15155 0.06215 0.06632 0.01971 0.10633      0 0.03413      0      0      0      0      0
  0      0      0      0      0 0.01442      0 0.02748      0 0.00777      0      0      0      0      0      0      0      0      0      0      0
 83      1      3      4      0    200      1      1     25     25      0
  0      0      0      0      0 0.0046  0.018 0.0244  0.071  0.087 0.1694 0.1512 0.0677 0.0402 0.0595 0.0718 0.0872 0.0535 0.0565 0.0346  0.002 0.0013      0      0      0
 83      1      5      4      3    100      1      1     25     25      0
  0      0      0 0.0002 0.0027 0.0024 0.0028 0.0035 0.0189   0.05 0.0649 0.1084 0.1033 0.0204  0.014 0.0146 0.0238 0.0185 0.0151 0.0143 0.0085 0.0004 0.0005      0      0
  0      0      0 0.0005  0.002 0.0013 0.0018 0.0048 0.0499 0.0705 0.1615 0.1363  0.038 0.0312 0.0144 0.0004      0      0      0      0      0      0      0      0      0
 83      1      4      4      0     20      1      1     25     25      0
  0      0      0      0      0      0      0      0      0      0      0 0.02222      0      0 0.02222 0.17738 0.08886 0.11073 0.28777 0.29081      0      0      0      0      0
 84      1      1      2      3   3576      1      1     21     21      0
  0 0.0001 0.01457 0.07665 0.14233 0.0713 0.04074 0.04917 0.10605 0.03603 0.03339 0.02846 0.03145 0.01747 0.01986 0.0136 0.01247 0.00449 0.00145 0.00844 0.01338
  0 0.00069 0.00728 0.03979 0.02796 0.0339 0.01393 0.02087 0.03675 0.01657 0.02355 0.01321 0.01061 0.00825 0.00712 0.00626 0.00453 0.0015 0.00088 0.0005 0.00445
 84      1      1      4      3   4762      1      1     25     25      0
  0      0      0      0      0      0 0.0001 0.00041 0.00227 0.00306 0.01173 0.04101 0.07376 0.11377 0.08376 0.09363 0.09952 0.09118 0.06528 0.04635 0.01207 0.00336 0.00128      0 0.00004
  0      0      0      0      0      0      0 0.00029 0.0029 0.0114 0.03277 0.06253 0.07649 0.05336 0.01074 0.00097 0.00172 0.00096 0.00183 0.0006 0.00081      0 0.00004      0      0
 84      1      1      5      3   3522      1      1     21     21      0   Mean Length @ Age
 -1   27.7   32.4   34.5   35.8   36.9     39   40.5   41.6     42   43.3   43.2     45   45.7   45.9   46.3   47.1   46.8     48   47.7     48
 -1   28.6   29.6   30.9   31.5   32.2     33   33.7   33.9   34.2   34.7   35.1   35.6   34.6   35.8   36.8   36.8   36.4     36   35.1     36
 84      1      1      5      3   3522      1      1     21     21      0   Length @ Age Sample Size
  0      1     58    260    455    247    191    235    381    147    133     96     90     57     56     37     34      9      5      6      2
  0      2     19     98     98     93     75     91    175     84     81     49     41     33     26     18     18     13      4      3      1
 84      1      2      2      3     42      1      1     21     21      0
  0      0      0      0      0      0 0.09639 0.09639 0.27041 0.22864 0.16415 0.03138      0 0.04047 0.04078      0 0.01585      0      0 0.01554      0
  0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0
 84      1      3      4      0    200      1      1     25     25      0
  0      0      0      0      0 0.0034 0.0065 0.0198  0.031 0.0556 0.1026 0.1849 0.2044 0.1449  0.067 0.0827 0.0555 0.0236 0.0127  0.001 0.0019 0.0012      0      0  0.001
 84      1      4      4      0     20      1      1     25     25      0
  0      0      0      0      0      0      0      0      0      0      0      0      0      0 0.05311 0.10621 0.15932 0.21242 0.19172 0.19172      0 0.08551      0      0      0
 85      1      1      2      3   3270      1      1     21     21      0
  0 0.00006 0.00506 0.01736 0.05539 0.17602 0.08302 0.05188 0.0331 0.0483 0.0491 0.03036 0.02559 0.01289 0.01471 0.00891 0.00568 0.0072 0.00263 0.00335 0.00752
  0 0.00024 0.00025 0.00512 0.01186 0.04601 0.04272 0.03422 0.03018 0.05126 0.02967 0.02947 0.02017 0.01369 0.01128 0.01029 0.00583 0.00426 0.00315 0.00278 0.00943
 85      1      1      4      3   7163      1      1     25     25      0
  0      0      0      0      0      0 0.00258 0.0008 0.00196 0.0077 0.01789 0.03818 0.0591 0.10802 0.12444 0.07957 0.06773 0.06109 0.04306 0.02077 0.00417  0.001 0.00019      0      0
  0      0      0      0      0      0 0.00012 0.00018 0.00288 0.02568 0.07131 0.11172 0.0926 0.04398 0.00821 0.00313 0.00052 0.00048 0.00019 0.00058 0.00019      0      0      0      0
 85      1      1      5      3   3210      1      1     21     21      0   Mean Length @ Age
 -1     27   27.9   30.2   33.2   36.4   38.2   39.5     39   41.8   42.7   43.6   44.7   45.3   46.1   47.1   47.3   47.4   47.8   48.8   48.9
 -1   23.5   26.1   28.6     30   30.6   31.5     32   32.5   33.3   33.8   34.4   34.9   35.5   35.2     36   35.7   36.1   36.2   35.8   36.9
 85      1      1      5      3   3210      1      1     21     21      0   Length @ Age Sample Size
  0      1     13     54    189    599    292    180    116    156    134     93     69     45     46     34     19     26     10     14      4
  0      1      3     17     43    151    130     90     85    139     89     99     70     46     42     36     28     14     15     11      7
 85      1      2      2      3    266      1      1     21     21      0
  0      0      0      0 0.00125 0.04707 0.03274 0.05105   0.04 0.1183 0.1347 0.18394 0.09694 0.06287 0.00588 0.01659 0.04871 0.0149 0.01274 0.00007 0.00593
  0      0      0 0.00103      0 0.00227 0.00143 0.00425 0.00482 0.00663 0.02632 0.02274 0.01632 0.00421      0 0.00465 0.00355      0 0.01991 0.00149 0.00668
 85      1      2      4      3    514      1      1     25     25      0
  0      0      0      0      0      0      0      0      0      0      0 0.00069 0.00386 0.02543 0.05827 0.08947 0.20166 0.26533 0.18397 0.04306 0.00387      0      0      0      0
  0      0      0      0      0      0      0      0      0 0.0005 0.00227 0.02485 0.05615 0.02433 0.01567      0 0.00063      0      0      0      0      0      0      0      0
 85      1      2      5      3    265      1      1     21     21      0   Mean Length @ Age
 -1     -1     -1     -1   34.8   36.2   38.3   39.8   38.4   42.3   43.5   43.9   45.7     46     47   46.5   48.2   48.2   47.4   47.4   46.9
 -1     -1     -1   27.5     -1   32.2   30.8   32.5   32.8   33.2   33.8   34.7   35.3     35     -1   36.5   36.3     -1   36.8   35.3     -1
 85      1      2      5      3    265      1      1     21     21      0   Length @ Age Sample Size
  0      0      0      0      1     24     16     20     15     33     36     30     18     10      1      3      8      2      2      1      1
  0      0      0      1      0      1      2      2      5      6      5      5      7      2      0      3      1      0      3      1      0
 85      1      3      4      0    200      1      1     25     25      0
  0      0 0.0013 0.0004 0.0003 0.0014 0.0044 0.0099 0.0164 0.0309 0.0766 0.1151 0.1183 0.1192 0.1505 0.1173 0.1083 0.0745 0.0306 0.0139 0.0097 0.0007 0.0003      0      0
 85      1      4      4      0    283      1      1     25     25      0
  0      0      0      0      0      0      0      0      0      0      0 0.01431 0.01788 0.0422 0.10285 0.15002 0.10327 0.33346 0.15421 0.07517 0.00663      0      0      0      0
 86      1      1      2      3   2013      1      1     21     21      0
```

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0 0.00749 0.00981 0.00907 0.05007 0.12122 0.14267 0.034 0.05231 0.03234 0.05839 0.01609 0.02923 0.0099 0.01294 0.01605 0.00952 0.00651 0.00751 0.00333 0.01198
0 0.00639 0.00432 0.00324 0.01663 0.04712 0.06569 0.02515 0.04421 0.0213 0.04506 0.01297 0.02911 0.00789 0.01025 0.00506 0.00248 0.00126 0.00129 0.00158 0.00856
86 1 1 4 3 4080 1 1 25 25 0
0 0 0 0 0 0.0001 0.00018 0.00014 0.00462 0.01116 0.01987 0.03471 0.07024 0.11225 0.12248 0.08851 0.08015 0.05517 0.03395 0.01742 0.00456 0.00031 0 0 0
0 0 0 0 0 0.00003 0.00083 0.00213 0.00889 0.0302 0.09143 0.0988 0.06844 0.03137 0.00614 0.00312 0.0014 0 0.00032 0.00108 0 0 0 0 0
86 1 1 5 3 1961 1 1 21 21 0 Mean Length @ Age
-1 27.7 28.8 31.7 33.4 35.9 38 39.2 40 41.5 42.5 43.3 44.2 45.3 45.4 47 45.2 47.9 49 47.8 50
-1 27.8 27.5 31.5 30.5 30.7 31.4 32 32.5 33.1 33.3 34.4 34.6 35.7 36.1 35.4 35.9 34.4 36.4 35.5 35.7
86 1 1 5 3 1961 1 1 21 21 0 Length @ Age Sample Size
0 19 21 16 99 245 294 74 117 68 115 29 51 15 29 24 19 11 12 5 5
0 11 5 8 40 89 117 46 88 48 87 32 55 14 21 9 6 4 6 4 3
86 1 2 2 3 414 1 1 21 21 0
0 0.00067 0.00197 0.00045 0.00087 0.00773 0.0627 0.05743 0.09681 0.10063 0.15901 0.10871 0.0795 0.02979 0.09445 0.06975 0.01445 0.03579 0.00092 0.00641 0.02134
0 0 0 0.00034 0.00034 0.00331 0.00199 0.00128 0.00875 0.00405 0.00926 0.00225 0.00705 0.00452 0.00077 0.00092 0 0.00305 0.00104 0.00064 0.00104
86 1 2 4 3 824 1 1 25 25 0
0 0 0 0 0 0 0 0 0 0.00062 0.00174 0.00041 0.00132 0.01094 0.0461 0.18516 0.18818 0.22833 0.20676 0.05517 0.0075 0.00003 0 0 0
0 0 0 0 0 0 0 0 0 0 0.00033 0.01055 0.02739 0.01279 0.00756 0.00161 0.00291 0.00171 0.00147 0.00143 0 0 0 0 0
86 1 2 5 3 406 1 1 21 21 0 Mean Length @ Age
-1 28.9 29.9 34.5 39.9 40.2 40.5 41.7 41.7 42.8 43.9 44.4 44.5 46.8 46.2 47.2 46.4 47.2 49.4 48.7 48.5
-1 -1 -1 33.1 36.4 38.1 35.8 37.8 36.9 32.8 34.3 34.5 35.7 35.6 35.1 48.5 -1 37.7 37.3 35.6 -1
86 1 2 5 3 406 1 1 21 21 0 Length @ Age Sample Size
0 1 1 2 1 14 33 31 41 31 61 25 36 16 24 14 5 10 1 5 2
0 0 0 1 1 2 3 2 9 4 7 4 8 4 1 1 0 3 1 1 0
86 1 3 4 0 200 1 1 25 25 0
0 0 0 0 0.0015 0.0055 0.0207 0.0759 0.1181 0.0586 0.0395 0.065 0.0915 0.0838 0.1037 0.1471 0.0982 0.044 0.0327 0.0111 0.0025 0 0.0006 0 0
86 1 4 4 0 213 1 1 25 25 0
0 0 0 0 0 0 0 0 0 0.00004 0.00406 0 0.02192 0.00978 0.0301 0.13214 0.11193 0.32959 0.2251 0.10464 0.03059 0.00011 0 0 0
86 1 5 4 3 100 1 1 25 25 0
0 0 0 0.00021 0 0.01262 0.09523 0.09677 0.08372 0.00744 0.00139 0.00345 0.00587 0.03211 0.04822 0.05857 0.04761 0.03261 0.00963 0.00528 0.00425 0 0 0 0
0 0 0 0 0 0.01754 0.06092 0.11131 0.06127 0.00857 0.0258 0.09214 0.05567 0.01574 0.00485 0.0012 0 0 0 0 0 0 0 0 0
86 1 4 5 3 171 1 1 21 21 0 Mean Length @ Age
-1 -1 34 30.1 -1 40 40.2 42.3 42.7 43.4 44.7 44.2 45.2 47.4 47 46.8 48.3 47.4 49.5 51.4 -1
-1 -1 -1 -1 -1 -1 34.2 -1 -1 38.2 34.1 35.7 35.1 34.3 46 33.6 35 -1 -1 -1 -1
86 1 4 5 3 171 1 1 21 21 0 Length @ Age Sample Size
0 0 1 1 0 6 14 6 17 15 27 13 21 3 13 5 4 2 5 3 0
0 0 0 0 0 0 1 0 0 2 1 2 4 2 1 1 1 0 0 0 0
87 1 1 2 3 2267 1 1 21 21 0
0.00382 0.00338 0.31334 0.01077 0.00592 0.03341 0.04882 0.1037 0.02729 0.00504 0.00922 0.02422 0.01007 0.015 0.00167 0.00038 0.00485 0.00167 0.00179 0.00123 0.00129
0.00153 0.00123 0.1115 0.01272 0.00443 0.01813 0.0363 0.06644 0.01968 0.00747 0.01315 0.025 0.00942 0.01608 0.01011 0.00401 0.0046 0.00337 0.0013 0.00247 0.0042
87 1 1 4 3 4160 1 1 25 25 0
0 0 0 0 0 0.00028 0.00033 0.0011 0.00987 0.04357 0.14042 0.11991 0.03739 0.02582 0.04622 0.07008 0.06417 0.03188 0.02109 0.0096 0.00294 0.00008 0.00004 0.00001 0
0 0 0 0 0 0 0.00008 0.00113 0.01981 0.08388 0.06862 0.08795 0.08032 0.02662 0.00406 0.0022 0.00052 0.00001 0.00001 0 0 0 0 0 0
87 1 1 5 3 2242 1 1 21 21 0 Mean Length @ Age
-1 25 30.6 32 35.6 38.5 39.1 41 42.3 43.3 44.1 44.5 45.2 45.9 43.8 46.6 47.6 49.1 46.8 47.3 49.8
-1 27.9 28.4 29.2 29.8 32.4 32.2 32.9 33.5 33.7 33.8 34.8 35.3 34.6 35.4 36.2 36 36.4 35.8 36.3 35.9
87 1 1 5 3 2242 1 1 21 21 0 Length @ Age Sample Size
0 1 664 17 13 108 92 252 64 13 30 55 19 36 7 7 15 7 6 6 2
0 2 245 30 13 45 59 139 44 17 31 57 31 41 20 9 19 9 2 9 6
87 1 2 2 3 159 1 1 21 21 0
0 0 0.00453 0.00427 0.02493 0.00835 0.03982 0.24017 0.04222 0.01902 0.11491 0.17287 0.03303 0.10922 0.01045 0.00767 0.0092 0.00973 0 0.00892 0.01411
0.00008 0 0.00392 0.00771 0.00267 0.00259 0.00348 0.04916 0.01073 0.00273 0.00269 0.01894 0.00587 0.01594 0 0.00001 0.00008 0 0 0.00001 0
87 1 2 4 3 387 1 1 25 25 0
0 0 0 0 0 0 0 0 0 0.00292 0.00309 0.00138 0.00345 0.00892 0.01701 0.14156 0.22209 0.19469 0.17075 0.06162 0.02974 0.00225 0 0 0
0 0 0 0 0 0 0 0 0 0.00791 0.01838 0.03199 0.03236 0.02383 0.01553 0.00203 0.00273 0.00237 0.00205 0.00086 0.00047 0 0 0 0
87 1 2 5 3 159 1 1 21 21 0 Mean Length @ Age
-1 -1 29.8 -1 37.3 -1 40.4 42 42.5 44 44.5 44.6 44.8 46.6 45.2 47.5 47 48 -1 47.5 49.6
-1 -1 28.8 30.3 -1 -1 32.6 33.9 33.8 -1 -1 33.4 36 36.6 -1 -1 -1 -1 -1 -1 -1
87 1 2 5 3 159 1 1 21 21 0 Length @ Age Sample Size
0 0 2 0 2 0 4 43 7 3 18 29 6 19 1 2 1 1 0 1 1
0 0 1 2 0 0 2 6 1 0 0 3 2 2 0 0 0 0 0 0 0
87 1 3 4 0 200 1 1 25 25 0
0 0.0018 0 0 0 0.0123 0.0233 0.0555 0.1038 0.1222 0.1213 0.1046 0.0923 0.031 0.0386 0.0314 0.069 0.0801 0.0451 0.0192 0.021 0.0164 0.0109 0 0
87 1 4 4 0 27 1 1 25 25 0
0 0 0 0 0 0 0 0 0.00071 0.00088 0.00354 0.00386 0.00057 0.04204 0.26203 0.26144 0.15198 0.11368 0.04156 0.11544 0.00224 0.00003 0 0 0
88 1 1 2 3 2167 1 1 21 21 0
0 0.00064 0.01847 0.38116 0.00754 0.00451 0.03297 0.02749 0.06903 0.01709 0.00532 0.00719 0.02037 0.00293 0.00795 0.00007 0.0034 0.00219 0.00001 0.00046 0.00323
0 0.00164 0.00466 0.20004 0.00338 0.00311 0.01493 0.02694 0.05616 0.01467 0.00413 0.01049 0.02055 0.00311 0.00702 0.00354 0.00453 0.00446 0.00102 0.00062 0.00301
88 1 1 4 3 4407 1 1 25 25 0
0 0 0 0 0 0 0 0.00054 0.00468 0.012 0.05019 0.12303 0.13614 0.08801 0.03435 0.038 0.0575 0.05268 0.01946 0.01536 0.00497 0.00043 0.0002 0 0
0 0 0 0 0 0 0.00014 0.00112 0.01221 0.05978 0.08731 0.08358 0.07097 0.03882 0.00441 0.00251 0.0016 0 0 0 0 0 0 0 0
88 1 1 5 3 2266 1 1 21 21 0 Mean Length @ Age
-1 27 30.3 33.6 34.8 38.2 39.6 39.7 42.1 43.4 42.3 45.1 45.1 44.7 46.7 50.7 48.8 48.5 47.9 48.8 49
-1 26.6 27.9 30.2 31 32.2 33 32.8 33.8 33.8 33.3 34 35.1 34.5 35.7 36.9 36 36.3 36.2 36.2 35.5
88 1 1 5 3 2266 1 1 21 21 0 Length @ Age Sample Size
0 2 36 835 24 12 74 74 184 29 7 12 43 8 19 2 5 9 1 3 8
0 4 25 392 10 10 41 47 131 35 16 28 57 7 21 9 17 17 4 2 6
88 1 2 2 3 214 1 1 21 21 0
0 0 0.00098 0.26494 0.00325 0.01684 0.01922 0.05436 0.1747 0.03988 0.01947 0.04094 0.1106 0.00703 0.03166 0 0.00432 0 0.00841 0 0.02063
0 0.00333 0 0.10204 0.00333 0.00459 0 0.0069 0.01575 0.00473 0 0.00317 0.02936 0.00289 0.0022 0 0 0.00449 0 0 0
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88 1 2 4 3 539 1 1 25 25 0
0 0 0 0 0 0 0 0 0.00059 0.0006 0.00333 0.06044 0.12156 0.02451 0.01052 0.01279 0.25171 0.22731 0.11434 0.03061 0.00469 0 0 0 0
0 0 0 0 0 0 0 0.00052 0.00018 0.00623 0.09662 0.01152 0.00994 0.01131 0.00021 0.00027 0.00001 0.00017 0.00001 0 0 0 0 0 0
88 1 2 5 3 217 1 1 21 21 0 Mean Length @ Age
-1 -1 30.9 34.3 34.5 38.2 39.1 41 43 44.4 45.1 44.9 46.1 43.5 45.2 -1 48.5 -1 47.7 -1 47.6
-1 24.8 -1 30.3 30.5 30.6 -1 33.1 33.8 34.1 -1 36 35.5 34.9 34 30.2 -1 37 -1 -1 -1
88 1 2 5 3 217 1 1 21 21 0 Length @ Age Sample Size
0 0 1 58 1 5 5 9 35 6 4 5 14 2 10 0 1 0 2 0 1
0 1 0 23 1 3 0 5 8 2 0 1 9 1 2 1 0 1 0 0 0
88 1 3 4 0 200 1 1 25 25 0
0 0 0 0 0 0 0.0051 0.0182 0.048 0.1277 0.2399 0.3057 0.1633 0.0412 0.0211 0.0139 0.0027 0.0114 0 0.002 0 0 0 0 0
88 1 4 4 0 122 1 1 25 25 0
0 0 0 0 0 0 0 0.01501 0.01504 0.14361 0.08352 0.09355 0.2114 0.07385 0.10573 0.05282 0.05269 0.08609 0.06596 0.00071 0.00002 0 0 0 0
89 1 1 2 3 2524 1 1 21 21 0
0 0.00062 0.03725 0.03831 0.38838 0.00479 0.0026 0.02125 0.02452 0.05147 0.01051 0.00206 0.00314 0.01469 0.00037 0.00521 0 0.00006 0.0009 0.00002 0.00155
0 0.00126 0.02172 0.02876 0.18684 0.00442 0.00132 0.0182 0.0221 0.04388 0.01026 0.00491 0.00436 0.02 0.00462 0.00832 0.00575 0.00087 0.00271 0.00016 0.00184
89 1 1 4 3 4581 1 1 25 25 0
0 0 0 0 0 0.00015 0 0.00056 0.0015 0.01637 0.03211 0.05261 0.09467 0.15884 0.12331 0.04025 0.03187 0.0309 0.01233 0.00691 0.00075 0 0 0 0
0 0 0 0 0 0.00051 0.00016 0.00073 0.00887 0.04468 0.12109 0.12049 0.06925 0.02753 0.0027 0.00042 0.00031 0.00002 0.00011 0 0 0 0 0 0
89 1 1 5 3 2484 1 1 21 21 0 Mean Length @ Age
-1 27.3 29.7 31.9 36 36.9 38.6 40.3 40.7 42.8 43.8 44 46.1 45.2 45.7 45.6 -1 47.7 49.2 51.2 48.7
-1 24.1 27.9 29.5 31.3 32.6 32.6 33.1 32.4 33.9 34 33.3 35.2 35.1 35.7 34.8 35.3 36 37.2 38 38.5
89 1 1 5 3 2484 1 1 21 21 0 Length @ Age Sample Size
0 4 98 98 991 13 9 50 69 141 24 4 11 35 4 14 0 1 3 1 1
0 2 45 52 458 17 4 36 48 90 24 12 16 49 9 22 11 6 10 1 1
89 1 2 2 3 311 1 1 21 21 0
0 0 0.00085 0.02649 0.40751 0 0.01186 0.00787 0.05014 0.30214 0.00336 0.04403 0.00881 0.03384 0.00582 0.02756 0.00066 0 0.00198 0 0
0 0 0 0.00093 0.03918 0.0005 0 0.00076 0.00221 0.00837 0 0.00053 0.00549 0 0.00826 0 0.00043 0.00043 0 0 0
89 1 2 4 3 644 1 1 25 25 0
0 0 0 0 0 0 0 0 0 0.00736 0.02497 0.03816 0.10753 0.13223 0.129 0.0856 0.12849 0.08595 0.13862 0.00531 0.01494 0.02316 0 0 0.00056
0 0 0 0 0 0 0 0 0 0.01277 0.01846 0.02763 0.01052 0.00533 0.0023 0.00113 0 0 0 0 0 0 0 0 0
89 1 2 5 3 309 1 1 21 21 0 Mean Length @ Age
-1 -1 31.7 30.3 36 -1 38.5 40.6 41 43.1 44 47.3 44.1 46.4 45.7 48.8 40.9 46.9 48 -1 -1
-1 -1 -1 28.9 32.2 30.6 -1 41.2 34.2 34 -1 31.4 35.5 -1 36.7 -1 37.2 37.5 -1 -1 -1
89 1 2 5 3 309 1 1 21 21 0 Length @ Age Sample Size
0 0 3 5 119 0 8 9 30 57 5 1 6 14 3 4 2 1 1 0 0
0 0 0 2 21 1 0 1 2 5 0 1 3 0 1 0 2 2 0 0 0
89 1 3 4 0 200 1 1 25 25 0
0 0 0 0 0.0028 0.0045 0.0064 0.0204 0.034 0.1068 0.1578 0.1775 0.2159 0.1679 0.0549 0.0262 0.0135 0.0092 0.0014 0 0.0007 0 0 0 0
89 1 5 4 3 100 1 1 25 25 0
0.00022 0.00017 0.00264 0.04525 0.16453 0.018 0.00746 0.01475 0.01446 0.01452 0.03718 0.01998 0.01216 0.02005 0.05558 0.01586 0.00775 0.01254 0.00989 0.00426 0.00164 0.00066 0.00018 0.00009 0
0.0003 0.00017 0.00402 0.04922 0.16993 0.01612 0.0091 0.02135 0.01356 0.05496 0.04785 0.05882 0.04724 0.01975 0.0065 0.00093 0.00007 0.00004 0.00005 0 0.00004 0.00013 0 0 0
89 1 4 4 0 284 1 1 25 25 0
0 0 0 0 0 0 0 0 0 0.02067 0.08823 0.08856 0.42672 0.21168 0.03578 0.05856 0.02323 0.01019 0.01429 0.0189 0.0021 0.0011 0 0 0
90 1 1 2 3 1706 1 1 21 21 0
0 0.00396 0.02848 0.05169 0.03964 0.22851 0.04522 0.01564 0.02147 0.01884 0.02775 0.00442 0.0216 0.00285 0.0112 0.0018 0.00769 0.00177 0.00468 0.0026 0.01282
0.00014 0.00346 0.03005 0.04406 0.02454 0.14243 0.02983 0.01958 0.01464 0.00931 0.02585 0.00796 0.02363 0.00431 0.01886 0.00741 0.01915 0.00354 0.00746 0.00336 0.00777
90 1 1 4 3 5053 1 1 25 25 0
0 0 0 0 0 0.00003 0 0.00064 0.00215 0.01506 0.02946 0.05457 0.06142 0.0723 0.1335 0.09932 0.04364 0.02897 0.02085 0.0107 0.00296 0.00032 0 0 0
0 0 0 0 0 0 0.00093 0.00111 0.00791 0.03304 0.08947 0.15263 0.08732 0.03916 0.0088 0.00248 0 0.00096 0 0.00008 0.00025 0 0 0 0
90 1 1 5 3 1677 1 1 21 21 0 Mean Length @ Age
-1 26.7 31.2 32.5 35.4 37.9 38.1 39.7 40.8 41.6 42.9 39.1 43.7 46.2 46.5 46.4 46.6 33.3 44.9 48.1 47.3
-1 26.6 28.7 30.2 31.2 32.1 32.9 33.6 33.4 34 34 34.8 34.1 36.8 35 35 35.9 36.2 36.9 36.5 36.8
90 1 1 5 3 1677 1 1 21 21 0 Length @ Age Sample Size
0 19 35 81 76 450 86 29 32 33 51 8 28 7 14 6 9 1 5 3 4
0 15 33 51 43 254 47 18 26 23 47 16 29 8 30 8 24 7 7 8 6
90 1 2 2 3 443 1 1 21 21 0
0 0.01205 0.01936 0.02685 0.03649 0.41969 0.05326 0.005 0.01901 0.03533 0.04208 0.01625 0.01913 0.01136 0.0298 0.00124 0.0162 0.0006 0 0 0.00124
0 0 0.00344 0.01721 0.00354 0.09771 0.02555 0.01845 0.0011 0.00714 0.01158 0.01238 0.00468 0.00532 0.00886 0.00756 0.00565 0.00024 0.00051 0.00134 0.00279
90 1 2 4 3 953 1 1 25 25 0
0 0 0 0 0 0.00256 0 0 0.00622 0.00987 0.01094 0.02186 0.02406 0.06044 0.22428 0.20562 0.04328 0.0712 0.04857 0.02379 0.00222 0.0005 0 0 0
0 0 0 0 0 0 0 0 0 0.00479 0.06291 0.08903 0.04353 0.02235 0.01205 0.00677 0.00012 0.00303 0 0 0 0 0 0 0
90 1 2 5 3 429 1 1 21 21 0 Mean Length @ Age
-1 27.2 30.8 33.3 36.7 39.1 39.7 41.1 43.3 43.8 43.5 43.7 44.8 45.4 46.7 45.4 48 51.8 -1 -1 47.8
-1 -1 29.8 30.9 31.5 32.7 32.5 33.8 32.7 34 33.6 34.6 38 33.7 34.9 32.3 35.9 34.5 35.6 39.7 -1
90 1 2 5 3 429 1 1 21 21 0 Length @ Age Sample Size
0 2 9 13 16 149 23 5 8 17 30 5 15 4 15 1 6 1 0 0 1
0 0 2 7 3 39 12 7 1 3 7 5 5 3 5 2 5 1 1 1 0
90 1 4 2 3 15 1 1 21 21 0
0 0 0 0.1 0 0.6 0.3 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
90 1 4 4 0 80 1 1 25 25 0
0 0 0 0 0 0 0 0 0 0 0.02382 0.01563 0.09862 0.18831 0.50726 0.14933 0.00223 0.00568 0.00912 0 0 0 0 0 0
91 1 1 2 3 1600 1 1 21 21 0
0 0.00773 0.05927 0.07774 0.09341 0.07117 0.18076 0.02482 0.00756 0.01385 0.02093 0.0158 0.00446 0.00951 0 0.01051 0 0.00134 0 0 0.0086
0 0.00456 0.05704 0.05362 0.04556 0.02767 0.07911 0.03252 0.00767 0.01452 0.01363 0.01635 0.00364 0.01186 0.0017 0.01019 0.00003 0.00398 0.00027 0 0.00863
91 1 1 4 3 7850 1 1 25 25 0
0 0 0 0 0 0.00005 0.00063 0.00401 0.01246 0.02529 0.04389 0.06939 0.06279 0.07074 0.07573 0.0797 0.04642 0.02814 0.01482 0.00981 0.00371 0.00124 0 0.00045 0
0 0 0 0 0 0.00054 0.00006 0.00419 0.01454 0.05774 0.09989 0.13876 0.08004 0.04132 0.0101 0.00222 0.00021 0.00067 0 0.00045 0 0 0 0 0
```

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91 1 1 5 3 1580 1 1 21 21 0 Mean Length @ Age
-1 27.1 29.8 32.3 35.4 37.3 39.4 40 41.7 43.2 43.4 44.1 45 45.3 -1 46.3 -1 44.5 -1 -1 50.7
-1 26.3 28.3 29.8 31.6 31.9 32.8 32.4 33.4 34.1 33.9 33.9 34.7 35.3 34.9 35.6 36.1 36.9 36.1 -1 36.4
91 1 1 5 3 1580 1 1 21 21 0 Length @ Age Sample Size
0 18 105 123 161 106 265 39 17 27 22 30 5 17 0 12 0 4 0 0 1
0 10 79 69 86 60 145 45 14 18 17 24 9 19 2 14 1 10 1 0 5
91 1 2 2 3 96 1 1 21 21 0
0 0 0.00323 0.00323 0.08852 0.09965 0.42022 0.08767 0 0.04309 0.00252 0.01067 0 0.00388 0 0.02133 0 0 0 0 0
0 0 0.0487 0.00459 0.05142 0.00272 0.05564 0.00136 0 0 0 0.04089 0 0 0 0 0 0.01067 0 0 0
91 1 2 4 3 486 1 1 25 25 0
0 0 0 0 0 0 0 0 0.00068 0.01011 0.02877 0.06029 0.0554 0.08733 0.12188 0.18837 0.09319 0.02126 0.02819 0.01764 0 0 0 0 0
0 0 0 0 0 0 0 0 0.00211 0.03416 0.05379 0.07978 0.04654 0.03714 0.01916 0.00294 0.01115 0 0 0.00013 0 0 0 0 0
91 1 4 2 3 424 1 1 21 21 0
0 0.00755 0.02812 0.03238 0.09783 0.0896 0.26242 0.06648 0.03278 0.02049 0.01364 0.02161 0 0.00624 0.00177 0.004 0 0.00297 0 0 0
0 0.00122 0.02368 0.02636 0.05384 0.0393 0.07995 0.01817 0 0.00579 0.00867 0.01804 0 0.00998 0 0.00862 0 0.01218 0 0.00633 0
91 1 4 4 0 1788 1 1 25 25 0
0 0 0 0 0 0.00079 0 0.00817 0.01511 0.03158 0.09456 0.16855 0.15155 0.16215 0.09928 0.13925 0.06727 0.0368 0.02008 0.00373 0.00112 0 0 0 0
91 1 4 5 3 417 1 1 21 21 0 Mean Length @ Age
-1 29.2 30.7 32.5 35.7 38.1 40.4 40.6 40.1 43.1 43.7 43.6 -1 42.9 49.4 45 -1 43.3 -1 -1 -1
-1 25.5 29.2 29.9 31.7 32.2 32.7 33.9 -1 32.7 34.2 34.6 -1 35.7 -1 34.7 -1 35.8 -1 33.5 -1
91 1 4 5 3 417 1 1 21 21 0 Length @ Age Sample Size
0 3 18 24 46 41 97 23 8 7 4 7 0 4 1 1 0 1 0 0 0
0 2 7 9 29 13 34 9 0 4 3 8 0 5 0 4 0 4 0 1 0
92 1 1 2 3 1680 1 1 21 21 0
0 0.00149 0.065 0.10407 0.10242 0.09255 0.06563 0.11444 0.02999 0.00685 0.01053 0.01128 0.01427 0.01019 0.00584 0.00231 0.00472 0.00233 0.00136 0.00112 0.00285
0 0.00026 0.0183 0.03558 0.03689 0.05579 0.032 0.075 0.03349 0.00798 0.00455 0.00329 0.0112 0.00659 0.0071 0.00292 0.00338 0.00091 0.0028 0.00026 0.01247
92 1 1 4 3 3120 1 1 25 25 0
0 0 0 0 0 0 0.0001 0.00335 0.02254 0.05105 0.08108 0.07468 0.07092 0.06663 0.07806 0.0715 0.06173 0.03749 0.02112 0.0144 0.0026 0 0 0 0
0 0 0 0 0 0.0001 0.0002 0.00205 0.01748 0.03821 0.0824 0.10481 0.06383 0.02042 0.00659 0.00203 0.00135 0.00181 0.00056 0.0009 0 0 0 0 0
92 1 1 5 3 2055 1 1 21 21 0 Mean Length @ Age
-1 30.2 28.5 30.8 33 35.8 37.3 40 41.1 41.9 43.4 44 43.8 44.5 45.7 46 46.7 46.7 45.7 44.1 48.1
-1 26.1 27.9 28.5 30.2 31.6 31.5 32.6 32.7 32.8 33.3 34 34 34.6 35.3 35.8 34.8 34.9 33.5 36.5 32.2
92 1 1 5 3 2055 1 1 21 21 0 Length @ Age Sample Size
0 4 90 157 179 204 167 308 81 20 27 26 28 24 15 5 12 5 3 2 4
0 1 35 67 65 101 67 154 72 22 14 15 20 14 15 7 12 3 6 2 2
92 1 2 2 3 406 1 1 21 21 0
0 0 0 0.00953 0.04627 0.07553 0.10768 0.31097 0.06142 0.01211 0.03219 0.0324 0.02043 0.02282 0.0152 0.01063 0.01892 0.01437 0.00903 0 0.0019
0 0 0.00361 0.02065 0.01247 0.04233 0.02973 0.04803 0.0068 0.00052 0 0.00815 0.00562 0.00464 0.00321 0 0.00722 0.00066 0.00494 0 0
92 1 2 4 3 898 1 1 25 25 0
0 0 0 0 0 0 0 0 0 0.00597 0.01659 0.02344 0.05107 0.06364 0.10182 0.15961 0.16381 0.07002 0.06404 0.02663 0.00435 0 0 0 0
0 0 0 0 0 0 0 0 0.00529 0.01609 0.04149 0.0794 0.02987 0.01905 0.0161 0.02001 0.01263 0.00452 0.00303 0.00028 0.00126 0 0 0 0
92 1 2 5 3 401 1 1 21 21 0 Mean Length @ Age
-1 -1 -1 31.5 34.8 36.4 37.7 40.9 41.8 41.8 44.2 44.2 45.6 45.1 46.4 45 46.9 48.4 46.5 -1 -1
-1 -1 27.9 28.1 30.7 31.2 31.1 33.6 32.7 33.3 -1 33.3 32.7 37.2 36 -1 39.6 40.1 37.7 -1 -1
92 1 2 5 3 401 1 1 21 21 0 Length @ Age Sample Size
0 0 0 6 23 26 37 111 23 7 12 15 13 10 8 5 10 5 5 0 0
0 0 2 6 8 13 11 17 7 1 0 3 3 6 1 0 4 1 2 0 0
92 1 4 2 3 745 1 1 21 21 0
0 0 0.00215 0.02403 0.09452 0.1189 0.10107 0.19199 0.05093 0.01729 0.02367 0.04118 0.02322 0.02677 0.013 0.00151 0.01073 0.00081 0.01317 0.00058 0.01081
0 0.00014 0.00046 0.01029 0.05065 0.02764 0.02178 0.04211 0.01641 0.00541 0.00503 0.00705 0.00215 0.01504 0.01369 0.0008 0.00837 0.00301 0.00126 0 0.00236
92 1 4 4 0 2883 1 1 25 25 0
0 0 0 0 0 0 0 0.00212 0.00523 0.0225 0.0907 0.11811 0.1301 0.10806 0.12884 0.10707 0.13572 0.08318 0.04295 0.01855 0.00636 0.00051 0 0 0
92 1 5 4 3 100 1 1 25 25 0
0 0 0.00933 0.08722 0.02507 0.00654 0.01376 0.01312 0.00928 0.0489 0.14499 0.05306 0.02575 0.00882 0.00264 0.00122 0.0016 0.00229 0.00013 0.00005 0.0004 0 0 0 0
0 0.00002 0.01219 0.09446 0.02838 0.0053 0.01516 0.01442 0.0392 0.15959 0.11529 0.03508 0.01809 0.00827 0.00022 0.00004 0 0 0 0.00004 0.00007 0 0 0 0
92 1 4 5 3 740 1 1 21 21 0 Mean Length @ Age
-1 -1 30.5 31.5 34.2 36.2 38.1 40.9 41.5 41.5 43.3 43.7 43.6 45.1 44.4 44.2 44.9 48 47.3 43 -1
-1 26.7 27.6 28.9 30.6 30.9 32.2 32.3 33.1 32 34.2 34 32.3 33 35.4 34.5 35.5 34.2 35.5 -1 -1
92 1 4 5 3 740 1 1 21 21 0 Length @ Age Sample Size
0 0 5 19 60 76 71 159 55 13 19 32 20 24 9 1 7 1 7 1 0
0 1 1 6 22 22 19 36 13 6 3 7 2 7 5 2 5 3 1 0 0
93 1 1 2 3 1132 1 1 21 21 0
0.00046 0.00336 0.03614 0.12518 0.1281 0.09765 0.06533 0.05645 0.09131 0.01973 0.00673 0.01751 0.00995 0.0119 0.00466 0.00463 0.00061 0.00203 0.0019 0.00574 0.0027
0 0.00246 0.02417 0.06699 0.04258 0.03781 0.01595 0.012 0.0398 0.02033 0.00804 0.0058 0.00582 0.0035 0.00296 0.00617 0.00173 0.0028 0.0006 0.0025 0.00593
93 1 1 4 3 2952 1 1 25 25 0
0 0 0 0 0 0.00016 0.00141 0.01002 0.01948 0.07598 0.13657 0.09132 0.08581 0.08709 0.06245 0.05189 0.03967 0.02109 0.00664 0.0041 0.00067 0 0 0 0
0 0 0 0 0 0.0001 0.00189 0.01226 0.05492 0.09498 0.07942 0.04296 0.01405 0.00462 0.00009 0 0 0 0 0 0.00037 0 0 0 0
93 1 1 5 3 1954 1 1 21 21 0 Mean Length @ Age
-1 24.8 27.4 29.8 31.9 34 35.5 36.8 38.9 39.4 41.1 42.2 42.9 43.2 43.7 40.6 44.3 45.7 46 45.7 47.6
-1 25 26 27.4 28.8 29.7 30.1 30.7 31.4 31.2 31.4 31.8 31.6 32.8 33.1 32.6 33.1 34.5 33.9 34.6 35.5
93 1 1 5 3 1954 1 1 21 21 0 Length @ Age Sample Size
0 14 63 220 213 188 132 95 204 38 11 27 17 19 12 10 2 8 3 9 1
0 10 63 122 78 81 45 38 86 40 16 14 20 11 11 11 4 11 2 4 1
93 1 2 2 3 188 1 1 21 21 0
0 0 0 0.00744 0.02252 0.03953 0.10747 0.09227 0.32627 0.042 0.02995 0.05794 0.07228 0.05138 0.0225 0.02639 0.00505 0.00998 0 0 0
0 0 0.00111 0.00224 0.01716 0.01498 0.00388 0.0026 0.02512 0 0 0.0051 0 0 0.00117 0.00036 0 0.01328 0 0 0
93 1 2 4 3 967 1 1 25 25 0
0 0 0 0 0 0 0 0 0.00222 0.0276 0.04343 0.05295 0.06159 0.14644 0.19893 0.18652 0.10083 0.05559 0.00812 0 0 0 0 0 0
0 0 0 0 0 0 0 0.0016 0.00989 0.02693 0.04748 0.01948 0.00827 0.00195 0 0.00019 0 0 0 0 0 0 0 0 0
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93 1 2 5 3 187 1 1 21 21 0 Mean Length @ Age
-1 -1 -1 29.6 31.6 34.3 36.4 38.1 39.2 38.8 40 41.2 43.5 43.1 42.1 44.3 35.2 42.4 -1 -1 -1
-1 -1 25.6 27.6 27.8 28.8 28.9 30.1 31.5 -1 -1 34.4 -1 -1 30.1 32.7 -1 36.3 -1 -1 -1
93 1 2 5 3 187 1 1 21 21 0 Length @ Age Sample Size
0 0 0 4 6 13 17 22 46 11 5 8 8 8 3 4 1 2 0 0 0
0 0 1 2 5 2 4 4 7 0 0 1 0 0 1 1 0 1 0 0 0
93 1 3 4 0 200 1 1 25 25 0
0 0 0 0 0 0 0 0.0656 0.2974 0.1313 0.0328 0.0328 0 0.1498 0.0749 0.2154 0 0 0 0 0 0 0 0 0
93 1 4 2 3 1037 1 1 21 21 0
0 0 0.03597 0.15868 0.11747 0.12879 0.10602 0.07496 0.14738 0.02644 0.00946 0.00967 0.01868 0.0114 0.00472 0.00373 0.00358 0.00349 0.0028 0.00378 0.00588
0 0 0.00679 0.02456 0.00307 0.00685 0.02027 0.01349 0.01619 0.00169 0.00215 0.00679 0.00446 0.00041 0.00591 0.01049 0 0.00041 0.00357 0 0
93 1 4 4 0 3307 1 1 25 25 0
0 0 0 0 0 0.00017 0.00328 0.02449 0.05948 0.1123 0.18241 0.17431 0.1507 0.10863 0.07316 0.04592 0.02749 0.02035 0.00865 0.00537 0.00242 0.00058 0.00029 0 0
93 1 4 5 3 431 1 1 21 21 0 Mean Length @ Age
-1 -1 28.6 29.8 30.7 32.9 35.2 37.1 37.8 39.2 41.3 41.3 41 41.9 41.1 39.9 44.9 45.7 44.3 45.8 43.2
-1 -1 24 27.5 27.9 28.3 29.8 29.1 30.4 29.3 31.9 31.3 32.1 30.9 32.9 33.1 -1 31.4 33.5 -1 -1
93 1 4 5 3 431 1 1 21 21 0 Length @ Age Sample Size
0 0 5 32 36 41 57 43 79 17 3 7 12 11 5 5 3 4 3 3 2
0 0 2 7 6 8 11 4 4 3 1 2 3 1 1 5 0 1 4 0 0
94 1 1 2 3 742 1 1 21 21 0
0 0.00048 0.04192 0.04909 0.09349 0.08434 0.09426 0.05538 0.01067 0.06738 0.01415 0.00111 0.00934 0.00462 0.00614 0.00272 0.00069 0.00021 0.00569 0.00605 0.00079
0 0.00522 0.02419 0.03328 0.05169 0.05276 0.04432 0.03774 0.05853 0.05329 0.0288 0.00621 0.00647 0.00941 0.00911 0.00865 0.0041 0.00276 0.00025 0.0014 0.01331
94 1 1 4 3 3827 1 1 25 25 0
0 0 0 0 0 0 0 0.00112 0.00709 0.01808 0.02775 0.04873 0.06831 0.11267 0.06628 0.064 0.04997 0.04329 0.02047 0.00996 0.00091 0.00073 0.00037 0 0
0 0 0 0 0 0 0.00036 0.0042 0.0489 0.10519 0.12516 0.09627 0.05895 0.01507 0.00463 0.00037 0.00118 0.00002 0 0 0 0 0 0 0
94 1 1 5 3 745 1 1 21 21 0 Mean Length @ Age
-1 29.9 29 33.4 35.2 36.7 37.7 39.5 40 43.2 43.3 41.4 46.5 45.8 40.5 46.3 49.2 36.1 48 36 28.8
-1 27.1 27.8 29.8 30.1 30.7 31.8 32.6 32.7 33.7 33.9 34 33.8 34.6 35.3 34.4 35.5 35.3 35.1 38.5 35.9
94 1 1 5 3 745 1 1 21 21 0 Length @ Age Sample Size
0 2 22 29 98 77 69 43 20 42 16 3 5 6 5 4 2 1 6 1 1
0 5 17 19 35 37 29 22 23 36 21 5 7 8 6 7 6 4 1 2 3
94 1 2 2 3 253 1 1 21 21 0
0 0 0.00295 0 0.02384 .09083 0.07533 0.11408 0.06737 0.13003 0.01364 0.01353 0.01557 0.00765 0.00239 0.00088 0.00988 0.0012 0 0 0.00725
0 0 0.00395 0.0011 0.02054 0.07918 0.04645 0.08202 0.04622 0.09535 0.01021 0.00725 0.00725 0 0.00143 0.00758 0.00725 0 0 0 0.0078
94 1 2 5 3 191 1 1 21 21 0 Mean Length @ Age
-1 -1 -1 -1 35.6 38 40.8 41.2 42.8 43.2 43.5 44.6 46 46.7 49.2 44 47.3 42.7 -1 -1 -1
-1 -1 30 31.5 30.5 29.5 33.3 33.6 34.3 33.8 -1 -1 -1 -1 35.1 36 -1 -1 -1 -1 35.3
94 1 2 5 3 191 1 1 21 21 0 Length @ Age Sample Size
0 0 0 0 3 13 19 25 21 39 5 5 8 8 2 1 3 1 0 0 0
0 0 3 2 1 3 3 5 2 12 0 0 0 0 2 4 0 0 0 0 1
94 1 3 4 0 200 1 1 25 25 0
0 0 0 0 0 0.0186 0.0568 0.0777 0.1093 0.117 0.1334 0.1097 0.0703 0.1166 0.1906 0 0 0 0 0 0 0 0 0
94 1 4 2 3 251 1 1 21 21 0
0 0 0.0003 0.03727 0.05931 0.09645 0.06173 0.09833 0.04248 0.02752 0.01996 0.00012 0.02026 0.01998 0.00151 0.01825 0 0 0.00047 0 0.01827
0 0 0 0.0365 0.05491 0.09092 0.05523 0.09076 0.03724 0.0205 0.01843 0 0.01841 0.01809 0.00032 0.01809 0 0 0 0 0.01837
94 1 4 4 0 3602 1 1 25 25 0
0 0 0 0 0 0 0.00343 0.01765 0.0571 0.11936 0.1344 0.12927 0.13902 0.11337 0.08166 0.07158 0.05787 0.03982 0.01859 0.00886 0.0054 0.00239 0.00024 0 0
94 1 4 5 3 120 1 1 21 21 0 Mean Length @ Age
-1 -1 32.6 34.2 36.1 38.8 39 40.8 41.8 42.7 42.6 44.8 45.6 44.1 43.3 42 -1 -1 46.3 -1 -1
-1 -1 -1 -1 -1 32.4 -1 -1 33 33.3 34.2 -1 -1 -1 -1 -1 -1 -1 -1 -1 38.4
94 1 4 5 3 120 1 1 21 21 0 Length @ Age Sample Size
0 0 1 2 12 14 10 9 11 26 5 1 5 5 5 1 0 0 1 0 0
0 0 0 0 0 1 0 0 3 6 1 0 0 0 0 0 0 0 0 0 1
95 1 1 2 3 1306 1 1 21 21 0
0 0.00337 0.02315 0.10821 0.07 0.13191 0.06353 0.05012 0.04496 0.01481 0.0571 0.02224 0.00451 0.01011 0.03782 0.00614 0.00716 0.00035 0 0.00252 0.00913
0 0.00354 0.00863 0.04771 0.02858 0.04096 0.04709 0.02629 0.01896 0.01048 0.02533 0.02317 0.00956 0.00756 0.00685 0.01559 0.00312 0.00265 0.00005 0.00265 0.00408
95 1 1 4 3 3717 1 1 25 25 0
0 0 0 0 0 0 0.0001 0.00483 0.00531 0.02108 0.04614 0.05879 0.05578 0.07593 0.10785 0.09337 0.06823 0.04183 0.03071 0.00864 0.00333 0.00131 0 0 0
0 0 0 0 0 0 0.00105 0.00854 0.02264 0.06703 0.09244 0.11136 0.04797 0.01847 0.00306 0.00112 0.00082 0.00088 0.00138 0 0 0 0 0 0
95 1 1 5 3 1290 1 1 21 21 0 Mean Length @ Age
-1 29.4 31.8 32.1 35.2 37.7 38.6 39.9 41.1 42 43.8 44.3 45.2 45.3 47 46.3 48.5 45.7 -1 47.8 48.6
-1 28.2 28.6 29 30.4 31.1 31.8 32.1 33.2 33 33.7 33.8 34.5 35.3 34.2 34.7 35 36.2 37.2 35.7 36
95 1 1 5 3 1290 1 1 21 21 0 Length @ Age Sample Size
0 8 31 87 97 148 118 73 49 38 86 29 14 8 9 6 6 1 0 5 3
0 7 18 44 39 69 58 45 32 24 54 24 7 8 11 13 8 3 2 4 4
95 1 2 2 3 60 1 1 21 21 0
0 0 0 0 0.02343 0.02343 0.04686 0.10486 0.02343 0.14961 0.32082 0.04966 0.02623 0.06619 0.04211 0.04621 0.02687 0.02687 0 0 0
0 0 0 0 0 0 0 0 0 0 0.02343 0 0 0 0 0 0 0 0 0 0
95 1 3 4 0 200 1 1 25 25 0
0 0 0 0 0 0 0.0365 0 0.1094 0.5006 0.1775 0.0619 0.0253 0.0365 0.0445 0 0.008 0 0 0 0 0 0 0 0
95 1 4 2 3 249 1 1 21 21 0
0 0 0.00476 0.01943 0.03432 0.15499 0.18651 0.10328 0.09504 0.02914 0.0384 0.02164 0 0.00663 0 0.00303 0 0 0.00108 0.00271 0
0 0 0 0 0.03843 0.05195 0.05975 0.04285 0.0201 0.01175 0.02407 0.00874 0 0.01032 0.00392 0 0.00392 0 0.00108 0.00657 0.01561
95 1 4 4 0 842 1 1 25 25 0
0 0 0 0 0 0.00045 0.00228 0.00672 0.00911 0.0555 0.09948 0.11686 0.09996 0.12696 0.21299 0.10376 0.06316 0.05427 0.0227 0.01582 0.00919 0 0.00081 0 0
95 1 5 4 3 100 1 1 25 25 0
0 0 0.00518 0.06342 0.00747 0.01814 0.0256 0.0404 0.0178 0.00748 0.03156 0.03538 0.01987 0.02225 0.03188 0.0453 0.02479 0.02622 0.02506 0.0118 0.00457 0.00069 0.00008 0 0
0 0 0.02147 0.05574 0.00583 0.01321 0.03011 0.03542 0.02394 0.05639 0.07993 0.10336 0.07178 0.0313 0.00588 0.00035 0.00017 0 0.00017 0 0 0 0 0 0
95 1 4 5 3 176 1 1 21 21 0 Mean Length @ Age
```

```
-1      -1      -1    32.7    35.9      37    37.9    39.9    41.6    42.3    42.5    43.2      -1    47.2      -1    44.1      -1      -1      -1      -1      -1
-1      -1      -1      -1    33.5    33.2    37.1    35.2    37.5    33.1    35.6    34.6      -1    40.1    34.6      -1      36      -1      -1    49.5    35.5
95       1       4       5       3     176       1       1      21      21       0         Length @ Age Sample Size
 0       0       0       5       5      31      38      18       8       2       7       2       0       1       0       1       0       0       0       0       0
 0       0       0       0       8      11      11       8       4       3       5       2       0       2       1       0       1       0       0       1       1
96       1       1       2       3     803       1       1      21      21       0
 0 0.00334 0.07881 0.02036 0.08551 0.09748 0.04357 0.05234 0.05575 0.02312 0.00996 0.04393 0.00359       0 0.00354 0.00783 0.00166 0.00043       0 0.00805  0.0012
 0 0.00975  0.0542 0.01483 0.04851 0.04882 0.05245 0.01923 0.04232 0.02038 0.04003 0.03788 0.02216 0.00436 0.00239 0.00024  0.0036 0.00176 0.01877 0.01111 0.00673
96       1       1       4       3    3257       1       1      25      25       0
 0       0       0       0       0       0 0.00057 0.00252 0.01957 0.04494 0.04522 0.03067 0.03793 0.06125 0.05704 0.06022 0.05397 0.02268 0.01735 0.00606 0.00129 0.00032       0       0       0
 0       0       0       0       0       0 0.00822 0.05165  0.1091 0.10039 0.08732 0.09903 0.06513 0.01188 0.00222 0.00102 0.00054 0.00086       0 0.00104       0       0       0       0       0
96       1       1       5       3     792       1       1      21      21       0         Mean Length @ Age
-1    28.8    28.9    33.4    34.8    36.3    39.6    40.2    41.6    43.1    41.8    44.3    43.4      -1    46.4    46.6    45.8    44.9      -1    47.1      -1
-1    25.5    27.5    29.4    30.3      30    31.5    32.9    32.7    33.1    33.7    33.7    34.3      35      35    36.3      35    35.3    35.7    34.4    38.8
96       1       1       5       3     792       1       1      21      21       0         Length @ Age Sample Size
 0       2      55      14      62      50      61      61      34      29      13      41       8       0       6       5       5       3       0       2       0
 0       7      34      12      30      41      35      26      37      25      20      23      12       6       6       1       9       4       5       3       5
96       1       2       2       3      37       1       1      21      21       0
 0       0       0       0 0.03324       0 0.03324 0.13298 0.11764  0.0844 0.06649 0.24043       0 0.03324       0 0.03324 0.06906 0.05373 0.05115       0 0.01791
 0       0       0       0       0       0       0       0       0 0.03324       0       0       0       0       0       0       0       0       0       0       0
96       1       3       4       0     200       1       1      25      25       0
 0       0       0       0       0  0.0015  0.0556  0.0418  0.0765  0.2325  0.1068  0.0672  0.0717  0.0645   0.059  0.0577  0.1387   0.022  0.0042       0       0       0       0       0       0
96       1       4       2       3     189       1       1      21      21       0
 0       0 0.01229 0.06256 0.25687 0.20724 0.05814 0.09443 0.01997 0.07132 0.01374 0.03258 0.00205 0.00068       0 0.00628       0       0 0.00061 0.00068       0
 0       0 0.00179 0.01265 0.02381 0.01322 0.03084 0.02067 0.00115 0.02032  0.0055 0.02434       0       0       0 0.00628       0       0       0       0       0
96       1       4       4       0    1138       1       1      25      25       0
 0       0       0       0       0 0.00322 0.00228   0.018 0.03894 0.05412 0.08673  0.1521 0.14726 0.14065 0.12905 0.11575 0.06529 0.03007 0.01258 0.00228 0.00167       0       0       0       0
```