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Slope rockfish stock assessment for the west coast of Canada in 1997 and recommended yield options for 1998

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Abstract

For assessment purposes, slope rockfish include Pacific ocean perch, redstripe rockfish, yellowmouth rockfish, rougheye rockfish, shortraker rockfish, and shortspine and longspine thornyheads. The best information pertains to the Goose Island Gully stock of Pacific Ocean perch. An age-structured analysis for this stock uses catch-age data available from 1963-96 and a series of trawl surveys, updated with recent surveys in 1994 and 1995. Based on this analysis, the foreign fishery of the late 1960s and early 1970s reduced the stock to about a third of the 1965 exploitable biomass by 1977. Between 1977-84, biomass remained relatively constant. Exploitable biomass then increased to more than half of the 1965 level by 1994, as a result of above-average recruitment and low fishing mortality rates. Point estimates of beginning of year biomass decreased slightly between 1994-97. Biomass is likely to decrease again for 1998, given the absence of incoming above average year-classes, but is anticipated to remain near the expected long-term average biomass.

Because of limited data, we are less certain about the status and potential yields of other stocks of Pacific ocean perch. Based on recent surveys, we have recommended decreases in the yields in Areas 3C and 5E-S and an increase in the Area 5E-N yield. We have not recommended changes to the yields in Areas 3D and 5C/D.

Yields for redstripe rockfish, yellowmouth rockfish, and shortspine thornyheads are derived from 25%, 38%, and 12%, respectively, of the Pacific ocean perch yield. These percentages are expanded from Goose Island Gully bottom trawl survey information, after considering potential midwater abundance and recent ratios in the catch. Yields for rougheye rockfish are based on the species longevity of up to 147 years of age. Yields for shortraker rockfish are determined from the ratio of shortraker to rougheye rockfish in monitored landings. We have no scientific basis for recommending yields for longspine thornyheads.

Résumé

Aux fins de la présente évaluation, les sébastes de la zone de la pente continentale comprennent le sébaste à longue mâchoire, le sébaste à raie rouge, le sébaste à bouche jaune, le sébaste à oeil épineux, le sébaste à longue mâchoire et les sébastolobes à longues épines et à courtes épines. Les meilleurs renseignements ont trait au stock de sébaste à longue mâchoire du stock du goulet de Goose Island. Une analyse par structure d'âge de ce stock a été faite à partir des données des captures selon l'âge de 1963 à 1996 et d'une série de relevés au chalut mise à jour avec les données de relevés récents réalisés en 1994 et 1995. D'après cette analyse, la pêche étrangère de la fin des années 1960 et du début des années 1970 avait réduit, en 1977, le stock au tiers environ de la biomasse exploitable de 1965. La biomasse est demeurée relativement constante entre 1977 et 1984. En 1994, la biomasse exploitable avait augmenté au plus du double de sa valeur de 1965 suite à un recrutement supérieur à la moyenne et à de faibles taux de mortalité par pêche. La biomasse ponctuelle estimée en début d'année a diminué légèrement entre 1994 et 1997. La biomasse devrait diminuer de nouveau en 1998 étant donné l'absence de l'arrivée de classes annuelles supérieures à la moyenne, mais sa valeur devrait se rapprocher de la moyenne prévue à long terme.

Étant donné le peu de données dont nous disposons, le degré d'incertitude est plus important en ce qui a trait à l'état et au rendement des autres stocks de sébaste à longue mâchoire. Nous avons recommandé, en nous fondant sur les derniers relevés, une diminution des rendements dans les zones 3C et 5E-S et une augmentation dans la zone 5E-N. Nous n'avons pas recommandé de modifications des rendements dans les zones 3D et 5C/D.

Les rendements du sébaste à raie rouge, du sébaste à bouche jaune et des sébastolobes à longues épines et à courtes épines ont été obtenus à partir de rendements respectifs de 25% , 38% et 12% de celui du sébaste à longue mâchoire. Ces pourcentages sont extrapolés à partir des résultats des chalutages de fond du goulet de Goose Island après avoir pris en compte l'abondance en zone pélagique et les rapports de capture récents. Les rendements du sébaste à oeil épineux sont fondés sur la longévité de cette espèce qui peut atteindre un âge de 147 ans. Les rendements du sébaste boréal sont fondés sur le rapport entre les quantités de sébaste boréal et de sébaste à oeil épineux au sein des débarquements contrôlés. Nous ne disposons d'aucun fondement scientifique pour recommander des rendements pour les sébastolobes à longues épines ou à courtes épines.

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1. General Introduction

For assessment purposes, slope rockfishes include Pacific ocean perch, redstripe rockfish, yellowmouth rockfish, rougheye rockfish, shortraker rockfish and shortspine/longspine thornyheads (collectively termed "thornyheads"). A major review of the stock status of slope rockfish in British Columbia was completed in 1996 (Richards and Olsen 1996). With a few exceptions, this document represents a routine update of the 1996 assessment. However, some sections have been substantially revised to reflect work conducted during 1996/97 and new sources of data.

Major additions to this document from the 1996 assessment include:

1. an overview of multispecies information from the 1996 observer data
2. results from a 1996 survey off the west coast of Vancouver Island
3. results (preliminary) from a 1996 survey in the north of 54° experimental area
4. results (preliminary) from a 1997 survey off the west coast of the Queen Charlotte Islands
5. simulation studies to evaluate alternative harvest strategies for Goose Island Gully Pacific ocean perch
6. yield recommendations by major area for most species

Items (1)–(4) represent new sources of data which directly influence our interpretation of slope rockfish stock status. Industry participated in the collection of these data. Item (5) reflects recent research on applying the precautionary approach. Item (6) responds to a request from managers to provide area-specific rather than coastwide yield recommendations.

Yield options (Table 1.1) are presented for each area and species as a range from low to high risk. Our ability to quantify risk varies for species and areas. The best information is for Pacific ocean perch from southern Queen Charlotte Sound (Goose Island Gully). Yield options for this stock are derived from a statistical catch-age model and a biomass forecast. For the 1996 assessment, low risk was derived from a fixed harvest rate applied to the lower 25th percentile of the biomass estimate. Similarly, high risk was derived from a fixed harvest rate applied to the mean estimate. For 1997, we associate risk with the probability that long term stock biomass falls below a reference point.

Because of limited data, we are much less certain about the status and potential yields of other stocks of Pacific ocean perch and other slope rockfish species. Yield ranges for these stocks are not based on formal statistical models. Instead, we have used a combination of catch histories, survey information and biological characteristics. A regular survey schedule has now been initiated, with the intent that all slope rockfish stocks will be surveyed over a five-year period. Surveys have now been completed in southern Queen Charlotte Sound (1994–95), the lower west coast of Vancouver Island (1996) and the west coast of the Queen Charlotte Islands (1997). Yield options for Area 3C and 5E stocks reflect the results of recent biomass surveys in those areas.

All slope rockfish assessments suffer from the lack of reliable time series on fishery catch. The port monitoring program initiated in 1994 and the at-sea observer program initiated in 1996 have

led to major improvements in data quality. However, we have no information on historical levels of dumping, discarding, or misreporting. Without a mechanism for reconstructing the actual historical catch, we have assumed that the reported landed catch represents the actual catch at-sea, except where explicitly stated, and we treat the term "catch" as synonymous with the term "landings".

A major change to the trawl fishery in 1997 was the introduction of individual transferable quotas. In addition, the schedule of management was changed from a calendar year basis to a April through March fishing year. We assume that the change in fishing year has no effect on yield recommendations, given the longevity of all slope rockfish species. Thus, we maintain a calendar year basis for the purpose of stock assessment.

1.1 History of the Fishery

A trawl fishery for slope rockfish has existed in BC since the 1940s. However, historical Canadian trawl catches were relatively minor. Between 1965-76, rockfish along the BC coast were targeted primarily by Soviet and Japanese vessels. Exact removals by foreign fisheries are unknown due to a lack of species composition and locality information, especially for Soviet vessels. Ketchen (1980) estimated the Soviet rockfish catch in BC to be between 29,000-63,000 tonnes in 1966, the year of the largest fishery.

No quotas were in effect for slope rockfish prior to 1977. For most subsequent years, rockfish management has involved a combination of species/area quotas, area/time closures, and trip limits on the major species (Table 1.2). Quotas were first introduced in 1979 for Pacific ocean perch (Table 1.3) and yellowmouth rockfish (Table 1.4), in 1982 for rougheye rockfish (Table 1.5), in 1993 for redstripe rockfish (Table 1.6), and in 1996 for shortraker rockfish and shortspine thornyheads.

In 1983, an open-fishing experiment was initiated in the Langara Spit area (north of 54°). Open fishing continued until 1991, when a trawl closure was established in the main region of the Pacific ocean perch fishery. The experimental design involved an open fishery, followed by a fishery closure, where open and closed periods were planned to extend for equivalent time periods, initially five years each (Leaman and Stanley 1993). This experiment is now complete and the area re-opened to fishing in 1997. Preliminary results from surveys done in this area in July of 1996 and September of 1997 are presented here.

2. Multispecies overview

The observer database, initiated in 1996, has significantly extended the quantity and quality of data available for stock assessment analysis. In particular, this database contains detailed geographic information and species composition of the catch, including discarded catch. This section provides an overview of some of this new information.

Groundfish catch data from 1954 to 1995 are accessible on the PBS VAX system through a FORTRAN program called GFSEL. The data come primarily from logbooks, with the remainder

coming from sales slip records. In 1996, data collection switched to a new observer program for all Option A vessels and some Option B vessels. Option B and C vessels will still submit logbook records, documenting roughly 5% of the catch. All the trawl data will eventually reside in an ORACLE database housed on the DFO mainframe in Vancouver. The new system will perform error checks, convert geo-reference data to management areas, and compare official dockside-monitored weights with observer species composition per tow to prorate the validated weights accordingly.

At present, the ORACLE database is not operational; however, the 1996 Option A trawl data are available in an ACCESS relational database with two principal tables (Table 2.1). The fishing effort table represents 21,312 tows, of which 95% are bottom trawls and the remaining 5% are midwater trawls. The hail code and set number together identify a unique tow and provide a link between fishing effort and catch data. Geo-reference data (initial and final latitude-longitude coordinates) are available for most tows. Currently, the catch table includes 231,709 catch records by species, for an average of 10.9 species per tow. A total of 326 species were captured in 1996, 58 of which are fish species sold commercially.

Figure 2.1 shows 1996 tow locations by depth strata on a map of the B.C. coast, where each point has been plotted at the midpoint of a tow. Because points tend to overwrite each other on a map of this scale, the coordinates have been jittered in an attempt to represent tow frequencies at various coastal regions. Boundary lines for major statistical areas (3C, 3D, 5A/B, 5C/D, 5E-S, 5E-N) are also shown. The shallowest depth interval (0–100 m) has been chosen to include most catch of flatfish species, which are not part of this assessment. Thereafter, the depth intervals increase by 50, 100, 200, 400, and 800 m. Typically, shelf rockfish are found down to 150 m, and slope rockfish are harvested in the four depth intervals below 150 m.

Figure 2.2 extends the spatial analysis of Fig. 2.1 by including a temporal component of the fishery. Here tows by depth are grouped by month and latitude intervals of ½°; for example, the label '48' denotes the latitude interval from 48° to 48°30′. Because almost no fishing occurred in January, this month has been omitted. Circles in this figure represent the number of tows in each latitude-month-depth stratum, where circular area is proportional to the tow count. Most effort was expended in the 150–450 m depth range, with shallow fisheries (0–150 m) primarily in the north, and deep water fisheries (below 450 m) primarily in the south, off the west coast of Vancouver Island. The figure also shows some seasonal patterns in the effort. We examined another figure similar to Fig. 2.2, depicting the number of hours towed, rather than the number of tows. Patterns of effort by hour are very similar to those of effort by tow, except that the very deep tows (below 850 m) represent disproportionately larger amounts of time. Thus, fishers tend to extend tow durations for nets dropped to depths near 1 km.

The effort patterns in Figs. 2.1–2.2 produced a catch of 326 species in 1996, as mentioned earlier. Figure 2.3 represents the catch of the principal six species of this report, where the seventh species (shortraker rockfish) has been excluded for lack of space. In this figure, circles indicate the catch biomass within a stratum defined by species, month, and latitude, where circular area is proportional to biomass. Circle shading portrays catch depth, using the shadings introduced in Fig. 2.2. Because a species-month-latitude stratum can include catches at various depths, the shading indicates mean depth d weighted by catch:

$$d = \frac{\sum_i c_i d_i}{\sum_i c_i},$$

where c_i and d_i denote the catch and depth of the ith tow in the stratum. The six species in Fig. 2.3 occur almost entirely in the four deepest strata of Fig. 2.2. Ideally, all circles in Fig. 2.3 should be comparable to each other; however, this would leave nothing but circles reduced to invisible dots for the minor species. To avoid this problem, maximum circle sizes correspond to the biomass scale of 64, 128, 256, 512, or 1024 tonnes, where factors of 2 allow easy comparison among panels. For each species, the maximum circle size has been chosen to best reveal the catch distribution among strata.

From Figure 2.3, Pacific ocean perch catch was greatest between latitudes 51½° and 52° N (Area 5A/B) at depths of 250-400 m in April and November. During the summer months harvesting switched to shallower depths (150-250 m). Noticeable overlap by season and depth occurred between the yellowmouth rockfish and Pacific ocean perch fisheries, although yellowmouth rockfish tended to be caught earlier in the year and further south. Redstripe rockfish were consistently caught at 150-250 m with harvest peaks in spring and autumn. Longspine thornyhead catch exhibited separation by depth from most other slope rockfish. They were typically caught at depths greater than 850 m along the west coast of Vancouver Island. Rougheye rockfish catch occurred at depths of 250–450 m along the northwest coast of the Queen Charlotte Islands, predominantly in the spring and fall. Harvesting of rougheye rockfish was also high in Moresby Gully during October and November. Shortspine thornyheads were harvested along the west coast of Vancouver Island at depths greater than 450 m, where they appear to co-occur with longspine thornyheads. Further north, shortspine thornyheads were caught at 250-450 m in Moresby Gully and off the northwest coast of the Queen Charlotte Islands in spring and autumn. Harvesting of all slope rockfish tended to decline in summer, probably due to Option A vessels switching their fishing effort to the joint venture hake fishery.

Figure 2.3 represents the catch of individual species in isolation from each other. As mentioned earlier, each tow captures an average of 10.9 species; consequently species associations play an important role in this fishery. Figure 2.4 illustrates these associations in Area 3C for each pair of slope rockfish species, based on the following codes:

1. PP – Pacific ocean perch
2. YM – yellowmouth rockfish
3. RS – redstripe rockfish
4. LT – longspine thornyheads
5. RE – rougheye rockfish
6. ST – shortspine thornyheads
7. SR – shortraker rockfish

Given two species j and k from this list, a panel in the figure represents a scatter plot of points

$$(x_i, y_i) = (\log_{10}(1 + c_{ij}),\ \log_{10}(1 + c_{ik}))$$

for each tow i in Area 3C, where c_{is} denotes the catch (kg) of species s ($s = j,k$). The logarithmic scale with offset 1 implies, for example, that the units 0, 1, 2, and 3 in Fig. 2.4 represent catches of 0 kg, 9 kg, 99 kg, and 999 kg, respectively. Points in the figure have been jittered to reveal their density along the x and y axes.

Typically, each panel shows three clusters of points: the cluster along each axis and a third cluster in which both x and y are positive. These correspond to the three possibilities of catching (1) species j but not k, (2) species k but not j, or (3) both species j and k together. Let n_j, n_k, and n_{jk} denote the number of tows in each of these clusters, respectively. Then the sample probability of not catching k in the species j fishery is

$$d(j,k) = 1 - p(k \mid j) = 1 - \frac{n_{jk}}{n_j + n_{jk}} = \frac{n_j}{n_j + n_{jk}},$$

where $p(k \mid j)$ denotes the probability of catching k, given that j has been caught. Within the species j fishery, the quantity $d(j,k)$ can be regarded as a distance metric from species j to k, where the metric is scaled from 0 to 1. For example, k is close to j if j cannot be caught without also catching k. In this case, $n_j = 0$ and $d(j,k) = 0$. Similarly, k is far from j if k is never caught in the fishery for j. In this case, $n_{jk} = 0$ and $d(j,k) = 1$. The distance $d(j,k)$ is not symmetric; in general $p(k \mid j) \neq p(j \mid k)$ and $d(j,k) \neq d(k,j)$.

Figure 2.5 uses star plots to represent distances $d(j,k)$ for each species pair in the six regions 3C, 3D, 5A/B, 5C/D, 5E-S, and 5E-N. Given species j labeled at the plot center, rays labeled by alternative species k have lengths proportional to $d(j,k)$. A dashed circle indicates the radius $d = 0.5$. The 42 stars in Fig. 2.5 portray distances for 252 species pairs (6 areas × 7 species × 6 alternative species). Relatively few of these correspond to rays inside the dashed circles, where

$$d(j,k) < 0.5,$$

that is, species k occurs with greater than 50% probability in the fishery for species j.

Stars corresponding to a fixed species j often look similar in different management areas. For example, Pacific ocean perch stars with center label PP show very similar patterns in areas 3C, 3D, 5A/B, and 5C/D. Generally, shortspine thornyheads (ST) are the most likely alternative species in a tow that catches Pacific ocean perch (PP). This association is particularly strong in Area 5C/D, where the ST fishery also shows a strong association with PP. Area 5C/D can also illustrate the lack of symmetry in $d(j,k)$. For example, PP is strongly associated with the RE (rougheye rockfish) fishery, but RE is only weakly associated with the PP fishery.

Figures 2.1–2.5 portray only some of the information available from the 1996 observer database. We have confined our exploratory graphics here to the seven slope rockfish species, although we

have examined similar plots for other species. We anticipate future analyses in which data from different fishing years can be compared and contrasted. In the long term, multispecies stock assessment models can routinely incorporate the annual observer data.

3 Fishery Data Sources

3.1 Trawl Data

We extracted catch per unit effort (CPUE) and related quantities from logbook data in the database as follows. First, the database was screened for all records with a slope rockfish catch. Next, catch and effort were summed across the selected records for a given trip. Thus, each data point in the analysis represents one trip, or the portion of a trip with a slope rockfish catch. Trips were then excluded if the slope rockfish catch (for Tables 3.1 to 3.7) or the individual species catch (for Figs. 3.1 to 3.6) accounted for less than 20% of the all-species catch for that trip (or trip portion). Although a qualification method based on individual tows rather than trips might be preferable, tow by tow data were not available in the database prior to 1991.

Tables 3.1 to 3.7 report catch statistics both coastwide and by major area for Pacific ocean perch, redstripe rockfish, yellowmouth rockfish, rougheye rockfish, shortraker rockfish, and thornyheads. Each table includes information on total trawl catch, species proportions, CPUE, and effort. Catch refers to the Canadian trawl landed catch as listed in the Groundfish data base, excluding discards. Catch is determined from logbooks and landing data, but effort data are available from logbooks only. Species proportions are relative to the total all-species catch from qualified records. Following Richards and Schnute (1992), CPUE is calculated as the median CPUE value (ratio of catch to effort) across qualified records. Estimated effort is then the ratio of the total slope rockfish catch (from logbooks and fish slips) to qualified CPUE. Nominal effort is the total effort that corresponds to the total slope rockfish catch (from logbooks only). The number of qualified trips gives another measure of effort and the sample size used to calculate CPUE.

Slope rockfish effort has been expanding since the mid 1980s. In 1996, estimated effort and nominal effort increased to the highest values ever recorded (Table 3.7). The CPUE data are considered to have little value in interpreting recent stock abundance trends because of restrictive trip limits, unknown levels of dumping, discarding and misreporting, and frequent changes to the management plan.

3.2 Hook and Line Data

Since 1994, 96% of the hook and line rockfish catch biomass reported on fish slips has been entered into an INGRES database by species. The remaining 4% of the rockfish catch biomass was entered into the ADABAS data base. We incorporate these data here for the relevant species (Table 3.8). Categories for hook and line gear include handline, salmon troll, salmon freezer troll, and longline. We combined these gear types into longline and handline/troll to simplify our presentation.

4. Pacific Ocean Perch

4.1 Summary of Fishery Data

The major fishery for Pacific ocean perch occurs in Queen Charlotte Sound in three gullies: Goose Island, Mitchell's and Moresby Gullies (Areas 5A/B and 5C/D, Fig. 3.1). Goose Island Gully and to a lesser extent Mitchell's Gully were the main sites of the historical fishery, while Moresby Gully began to be targeted in about 1980. Large reported landings also occurred from the Langara Spit area off the north-west coast of Graham Island (area 5E-N) during 1983-90 (Table 3.6) as a result of an open-fishing experiment (Leaman and Stanley 1993).

Table 4.1 apportions catch and effort information for Queen Charlotte Sound from Tables 3.3 (Area 5A/B) and 3.4 (Area 5C/D) by gully, and includes foreign catches and two alternative CPUE series. The method for calculating CPUE follows that described in Section 3.1. Rockfish CPUE was determined from the ratio of the all-species rockfish catch to effort. Pacific ocean perch CPUE was determined from the ratio of the Pacific ocean perch catch to effort. In both cases, the CPUE value represents the sample median across qualified trips for the year.

In 1996, the largest catch of Pacific ocean perch was from Moresby Gully, where both catch and nominal effort more than doubled from 1995 (Tables 3.4 and 4.1; Fig. 3.1). In Area 3C (Table 3.1), Goose Island Gully and Mitchell's Gully, the Pacific ocean perch catch decreased by more than half between 1995-96, although nominal effort increased. This change in the catch distribution implies that the 1996 Area 5C/D catch exceeded the high risk yield recommendation, while the Area 5A/B catch was substantially smaller than the low risk yield recommendation (Table 1.3). Because of the change in the database, we are continuing to investigate whether these shifts are real or simply reflect more accurate locality information gathered from the at-sea observer program.

4.2 Area 3C

For assessment purposes, the definition of Area 3C stock is extended to include statistical areas 25 and 125 within Area 3D.

Area 3C was targeted by the foreign fishery, with large removals of Pacific ocean perch in the mid 1960s. Several analyses in the late 1970s indicated that stock biomass was substantially reduced from the mid 1960 levels (see review in Leaman and Stanley 1993). In an attempt to gain more information on biomass levels and potential yield, an overfishing experiment was conducted between 1980-84. The Pacific ocean perch quota was raised from 300 to 500 tonnes for the duration of this 5 year period. Upon completion of the experiment, Pacific ocean perch relative biomass was estimated at approximately 1,900 tonnes, a reduction of 51% from the estimate of 1979 (Leaman and Stanley 1993). In addition, the survey CPUE for all rockfishes fell by 68% between 1979 and 1985 (Leaman and Stanley 1993). More recently, Ianelli et al. (1995) projected a continued low Pacific ocean perch abundance in the neighbouring US Vancouver-Columbia Region.

In September 1996, the F/V CALEDONIAN was chartered to perform a three-week trawl survey off the southwest coast of Vancouver Island (Olsen et al. 1997). The relative biomass estimate of Pacific ocean perch in Area 3C using naïve bootstrap methods was 1,950 – 2,220 tonnes (25th percentile and mean). This is similar to the estimate obtained in the 1985 survey (1,860 tonnes ± 17%) but less than the estimate from the 1979 survey (4,220 tonnes). However, the sampling design and depth strata differed for these two surveys. To compare the 1979, 1985, and 1996 surveys, data from the 1996 survey were reanalyzed by applying the same depth strata used in 1979 and 1985. Point estimates of relative biomass of Pacific ocean perch decreased from 11,500 tonnes in 1979 to 3,760 tonnes in 1985, and decreased again to 2,220 tonnes in 1996.

Based on age structure data collected during the 1996 survey, the 1984 year-class now forms the dominant mode in the population age-structure (Fig. 4.1). This year-class would not have been detected in the 1985 survey. The 1976 year-class, although still present in the 1996 samples, appears less dominant than in comparable samples from Goose Island Gully and Moresby Gully (Richards and Olsen 1996) and from Langara Spit (Leaman et al. In prep.). The absence of strong year-classes after 1984 is consistent with other Pacific ocean perch age stocks in BC.

To obtain an approximate estimate of total mortality between 1985 and 1996, we compared the 1985 survey biomass estimate for the proportion of fish aged 16 yr and older (proportion = 0.64) with the 1996 survey biomass estimate for the proportion of fish aged 27 yr and older (proportion = 0.15). The difference in the logarithm of the biomass estimates approximates the total mortality, ignoring any increases in biomass due to growth and any other problems in comparing survey estimates. Annual mortality estimates range from 0.12 to 0.18, larger than expected from a policy of $F=M$ (about 0.10). The mean annual reported catch over this period was 495 tonnes.

In the previous assessment, we had recommended a yield range of 250-500 tonnes, pending completion and review of the survey data. We now believe this range to be overly optimistic. Without any incoming strong year-classes, the 1984 year-class must continue to support the fishery and biomass is expected to decline. Between 1985-96, the reported average annual catch of 495 tonnes led to total mortality rates in the range of 0.12-0.18. In addition, we note that the 1995 survey biomass estimate for Area 5A/B is 14 times greater than the 1996 Area 3C estimate.

Table 1.1 lists proposed yield recommendations. We considered two options for Area 3C Pacific ocean perch yields, based on the survey data. Option 1 applies a 5% harvest rate to the 25th percentile and mean survey biomass estimates. This option assumes that the survey estimate provides at least a minimum estimate of the true biomass. Option 2 adjusts the Area 3C yield relative to the Area 5A/B yield using the ratio of the Area 3C survey estimates to the Goose Island Gully survey estimates. These two methods lead to essentially identical yield recommendations, and we use the range in yields from these methods for our recommended 1998 yield range of 80 – 110 tonnes.

4.3 Area 3D

For assessment purposes, the definition of Area 3D excludes statistical areas 25 and 125 which are considered part of the Area 3C stock. Reported catch from Area 3D declined steadily between 1989-95 but increased between 1995-96 (Table 3.2). Nominal effort varied without trend between 1989-95, but more than doubled between 1995-96.

Limited information is available to assess the status of Pacific ocean perch in Area 3D. The large foreign fishery in the mid 1960s did not find significant quantities of fish in Area 3D, suggesting that the mid-1960 exploitable biomass was lower than in Area 3C or Goose Island Gully (Leaman 1988). In the 1996 assessment, we had recommended a reduction in yield to 100-300 tonnes from the previous range of 200-600 tonnes. We have no additional information to revise our previous yield recommendations.

4.4 Area 5A/B

For assessment purposes, the definition of Area 5A/B is the portion of southern Queen Charlotte Sound encompassing Goose Island and Mitchell's Gullies. However, statistical analyses include data from Goose Island Gully only.

A catch-age analysis using the Pacific ocean perch data from Goose Island Gully formed the basis for the major stock assessment in 1996. For this assessment, we update the analysis with 1996 age composition and catch data. In addition, we provide forecasts of stock status under a range of constant catch harvest policies consistent with the precautionary approach. This work extends the examination of harvest policies initiated in 1996.

Figure 4.2 illustrates the time series of age proportion data. Between 1963-76, ages were obtained by surface readings of otoliths. Surface readings are known to underestimate the true age for rockfish. Since 1997, ages have been obtained by the break and burn method (MacLellan 1997). Age structure data for a given year are generated averaging over samples, independent of the number of age determinations for that sample. For 1996, 15 samples were examined for a total sample size of 608 age structures. The major modes in the 1996 age distribution correspond to the 1976, 1980, and 1984 year-classes. The age data contain no evidence of incoming strong year-classes. In the historic data, strong year-classes can be identified by age 9.

The catch-age analysis based on 1963–95 data is completely described in Richards et al. (1997a) as well as in the 1996 assessment. Richards et al. (1997a) provide exploratory analysis of the available data, residual analysis, and an appendix with the exact catch-age model specification. In addition, an updated analysis using 1996 data is presented in Richards et al. (1997b), Richards and Schnute (1998), and Richards et al. (in prep.). The most critical model assumptions are: (1) the model is correctly specified; (2) the series of biomass surveys are comparable and index the exploitable abundance; and (3) the landed and recorded catch reflects the actual catch at-sea. The amount of Pacific ocean perch which may have been dumped, discarded, or misreported is not known and has not been considered.

Given these assumptions, the analysis indicates that the foreign fishery reduced the Goose Island Gully stock of Pacific ocean perch to about a third of the 1965 exploitable biomass by 1977 (Fig. 4.3). The addition of 1996 year data to the analysis led to minor changes in the historical trajectory. Between 1977-84, exploitable biomass remained relatively constant. Exploitable biomass then increased to more than half of the 1965 level by 1994, as a result of above-average recruitment and low fishing mortality rates. Point estimates of beginning of year biomass decreased slightly between 1994-97. Biomass is likely to decrease again for 1998, given the absence of incoming above average year-classes. However, biomass is anticipated to remain near the expected long-term average biomass.

Biomass reconstructions and projections

At its 1996 meeting, the Groundfish PSARC Subcommittee agreed that a biomass-based reference point was appropriate for this stock. Under the precautionary approach, limit biomass reference points (B_{lim}) establish a minimum biomass; harvest strategies should be designed to maintain the biomass above B_{lim} with high probability. Research was conducted in 1997 to explore a range of harvest strategies consistent with this approach while respecting the large uncertainties inherent in the biomass estimates. We chose estimated stock biomass in 1977 (at the time of extended jurisdiction) as our measure of B_{lim}. Several analyses in the early 1980s (Ketchen 1981; Archibald et al. 1983) indicated large declines in biomass by the late 1970s. The fishing industry also agreed that the stock was depleted at this time. We have no evidence for a stock-recruitment relationship that might provide an alternative value for B_{lim}. Indeed, the largest estimates of recruitment are associated with relatively small biomass estimates (Richards et al. 1997).

To investigate harvest strategies, we used the parameter vector and covariance matrix from the catch-age analysis to generate 300 plausible scenarios for the historical biomass trajectory and, consequently, 300 plausible scenarios for the current state. Specifically, we generated multivariate random draws from the parameter distributions. If sample parameter values obtained by this process fell exterior to pre-determined parameter bounds used during estimation, we set the value at the bound. For example, we constrained the natural mortality rate M to the range (0.02,0.08). We also rejected a few cases where the implied historical stock biomass became 0. For each random vector, we then applied the model equations to recreate the perceived population state dynamics. Next, we re-sampled recruitments from the estimated 1963–96 series. Because the historical recruitments are components of the parameter vector, each scenario provided a different series of recruitments for the forward projection. For each set of 300 scenarios (past estimates and future recruitments), we then applied a constant catch policy and projected forward 50 years. We examined constant catch policies ranging from 0 to 4,000 tonnes. If the projected biomass in any scenario became smaller than the catch, the biomass was set to 0 and maintained at 0.

Sample trajectories in Fig. 4.4 illustrate uncertainties in the historical reconstruction and the propagation of that uncertainty into the forward projections, given a future annual catch of 2,000 tonnes. Fig. 4.5 portrays the biomass in projected year 50 with B_{lim}, the estimated 1977 biomass, under a range of catch policies. Estimates of B_{lim} differ for each historical trajectory, ranging from approximately 10,000 to 60,000 tonnes. The final projected biomass is obviously correlated

with B_{lim}; low estimates of final biomass tend to be associated with low estimates of B_{lim}. Thus, our interpretation of B_{lim} depends on the model parameter estimates and the corresponding uncertainty in the 1977 biomass estimate. Points below the 45° line in Fig. 4.5 represent projections where the biomass is less than B_{lim}. This condition never occurs under a no fishing policy. However, even under a low catch policy of 1,000 tonnes, the condition is met for 3% of the simulations. Under a catch policy of 3,000 tonnes, 75% of the simulations lead to year-50 biomass estimates smaller than B_{lim}.

Table 4.2 relates risk (the proportion of the simulations where the year-50 biomass was less than B_{lim}) to the catch policy. This proportion increases progressively with larger annual catches. For example, in 25% of the simulations, final biomass is less than B_{lim} under a catch policy of 2,000 tonnes. Thus, in order to maintain a risk of less than 5% under a fixed catch policy, the catch must be smaller than 1,500 tonnes. Obviously, this analysis points to a compromise between the definition of B_{lim} and acceptable risk.

The current analysis suggests a more conservative yield range than that recommended last year. In 1996, the recommended low to high risk range in exploitable biomass for Goose Island Gully was 30,000-40,000 tonnes corresponding to the 25th percentile (with estimated M) and median (with fixed M) of the distribution for the estimated 1997 exploitable biomass. We then increased yields by 20% from the Goose Island Gully estimates to reflect the Mitchell's Gully contribution as determined from the 1991–95 catch. For the low to high risk exploitable biomass and F=0.05, low to high risk yields were 1,760-2,340 tonnes. From the current analysis (Table 4.2), again increasing yields by 20% for Mitchell's Gully, we recommend a yield range of 1,200-2,400 tonnes. The upper end of the range corresponds to a probability of 25% that long-term biomass will fall below B_{lim}. We emphasize that the change in recommended yield reflects a re-evaluation of risk rather than a change in stock status. Exploitable biomass is predicted to continue to decrease in the absence of incoming strong year-classes.

4.5 Area 5C/D

For assessment purposes, the definition of Area 5C/D is the portion of northern Queen Charlotte Sound and Hecate Strait encompassing Moresby Gully.

We have no new evidence to change our previously recommended low-high risk yield range from 1,500-3,400 tonnes. This range was consistent with some of the model scenarios from a catch-age analysis and the previous management plan based on a 1981 survey biomass estimate (Leaman 1988). Depending on workload priorities, future analyses could examine detailed observer records from the 1994-95 derby fisheries and the 1996 observer program for possible information on stock status.

4.6 Area 5E-S

A survey was conducted in Area 5E-S in September 1997. Preliminary analyses of data collected during this survey suggest a Pacific ocean perch relative biomass estimate of 4,200 – 6,050 tonnes (25th percentile and mean bootstrap estimates), approximately half the estimated biomass from Area 5E-N.

The previous area-specific recommended yield of 300 – 500 tonnes (Table 1.3) was based on declines in CPUE in the late 1980s and on mortality rates estimated from length-frequency analysis (Leaman 1989). Yields based on the survey data are more pessimistic (Table 1.1). To determine yield ranges from the survey data, we followed the same rationale as described for Area 3C. Option 1 applies a 5% harvest rate to the 25th and mean survey biomass estimates. This option assumes that the survey estimate provides at least a minimum estimate of the true biomass. Option 2 adjusts the Area 5E-S yield relative to the Area 5A/B yield using the ratio of the Area 5E-S survey estimates to the Goose Island Gully survey estimates. We use the range in yields from these methods for our recommended 1998 yield range of 170-300 tonnes.

4.7 Area 5E-N

Surveys of the Area 5E-N Langara Spit region were conducted in 1993 (Leaman et al. 1996) and July 1996 (Leaman et al. In prep) to conclude the overfishing experiment (Leaman and Stanley 1993). An additional survey, conducted co-operatively with industry, was completed in September 1997. Preliminary results from these surveys are presented here. The 1993 and 1996 surveys used the W.E. RICKER, while the 1997 survey used a chartered commercial vessel. Thus, interpretation of the surveys must acknowledge vessel effects as well as differences in survey design. However, for the purposes of comparison, the 1997 survey data were post-stratified to correspond to the 1996 survey design.

Relative Pacific ocean perch biomass estimates from the 1993, 1996, and 1997 surveys are given in Table 4.3. Biomass estimates increased between 1993 and 1996 for combined strata and for individual strata except stratum E. Between 1996 and 1997, biomass estimates increased for combined strata and for stratum A and C, but decreased for other strata.

The 1996 and 1997 surveys suggest a rebuilding of the Pacific ocean perch stock in the Langara Spit experimental area since the 1993 survey. However, Leaman et al. (In prep.) state that this increase appears to be associated with growth of fish from cohorts that had already recruited to the exploitable biomass in 1993. Recruitment of recent cohorts appears lower than during the early to mid-1980s in most strata, with the Inside Edge the only area indicating a relatively strong 1990 year-class (Leaman et al. In prep.). Thus, the absence of significant recruitment of cohorts from the late 1980s into the survey area suggests that increases in biomass over the next few years will be limited primarily to contributions from existing cohorts. This conclusion is consistent with an examination of age structure data from stocks of Pacific ocean perch in other areas.

In 1996, we had recommended a provisional yield option of 150 – 170 tonnes based on previous assessments (Table 1.3), pending completion of the survey, data analysis, and review. We also noted that Pacific ocean perch assessments for the Gulf of Alaska now indicate some recovery from the foreign fishery of the mid 1960s (Heifetz et al. 1995). We now consider two options for Area 5E-N Pacific ocean perch yields, based on the survey data. Option 1 applies a 5% harvest rate to the 25th percentile and mean survey biomass estimates. This option assumes that the survey estimate provides at least a minimum estimate of the true biomass. Option 2 adjusts the Area 5E-N yield relative to the Area 5A/B yield using the ratio of the Area 5E-N survey

estimates to the Goose Island Gully survey estimates. We use the range in yields from these methods for our recommended 1998 yield range of 280-520 tonnes.

5. Redstripe Rockfish

5.1 Summary of Fishery Data

The coastwide trawl catch of redstripe rockfish declined by over 30% between 1995-96; the 1995-96 catches are the lowest on record since 1984 (Table 3.7, Fig. 3.2). The decline occurred in Area 3C (52% reduction), Area 3D (74% reduction), and Area 5A/B (32% reduction). Most of the 1996 catch was taken from Areas 5A/B and 5C/D (Tables 3.1 to 3.6). Prior to the 1994 introduction of port monitoring, redstripe rockfish catch may have been inflated by landings of Pacific ocean perch. For example, the 1992 redstripe rockfish reported catch from Area 5A/B is double the reported Pacific ocean perch catch, while the 1996 reported redstripe rockfish catch is roughly one quarter of the Pacific ocean perch catch. Low quotas for redstripe rockfish and for rockfish commonly associated with them (canary rockfish, silvergrey rockfish) may have also contributed to the decrease in catch. The discard rate for redstripe rockfish is considerably higher than for other slope rockfish (Table 5.1), probably because of their smaller size and a marketable size of 30 cm. The hook and line catch of redstripe rockfish was negligible in 1996 (Table 3.8).

5.2 Stock Status and Recommendations

A survey conducted in Area 3C in 1996 yielded a redstripe rockfish relative biomass estimate of 572 – 955 tonnes (25^{th} percentile and mean bootstrapped estimates), approximately 30% - 40% of the comparable estimates for Pacific ocean perch in this area. This represents an increase from the 1985 survey estimate of 121 tonnes (±162%). This increase may be due in part to the shallower depths that were fished during the 1996 survey. Neither the 1985 nor the 1996 survey targeted redstripe rockfish depths, which range from around 100 to 250 m. A comparison of 1995 mid-water and bottom trawl catches from Areas 5A/B and 3D indicates that between 40% – 76% of the redstripe rockfish catch was harvested by mid-water trawl. If we assume that 76% of the redstripe rockfish biomass exists mid-water, then the biomass estimate from the Area 3C survey expands by a factor of four to approximately 2,300 – 3,800 tonnes. We recommend a yield option for redstripe rockfish in Area 3C of 120 – 190 tonnes based on this expansion and a 5% harvest rate.

We have no new information for redstripe rockfish in Areas 3D, 5A/B, and 5C/D other than 1996 commercial data. To calculate yield options for these areas we set the 1998 coastwide recommended yield to 25% of the suggested coastwide yield for Pacific ocean perch, as we did in last years assessment. Next, we apportion the 1998 coastwide yield by the ratios of the 1996 catch in areas 3D, 5A/B, and 5C/D to the 1996 coastwide catch. This method of assigning yields is termed option 3 in Table 1.1. The recommended yields for redstripe rockfish in Areas 3D, 5A/B, and 5C/D are therefore, 70 - 150 tonnes, 370 - 790 tonnes, and 190 - 400 tonnes, respectively.

A survey of Area 5E conducted in 1997 yielded a relative biomass estimate of redstripe rockfish of 678 – 1,020 tonnes (25th percentile and mean bootstrapped estimates) in Area 5E-S. Redstripe rockfish were captured only in the shallowest stratum, 180 – 275 m. The mid-water biomass of redstripe rockfish may be significant and would not have been detected by the survey. Following our assumption that the mid-water biomass of redstripe rockfish represents 76% of the total biomass, we expand the potential yield from the survey (option 1 in Table 1.1) by a factor of four, resulting in a recommended yield of 140 – 200 tonnes.

Commercial catches in Area 5E-N have been negligible since 1990 because of the experimental closure. The 1997 survey estimate of redstripe rockfish in Area 5E-N was 1,100 – 4,100 tonnes (25th percentile and mean). However, this estimate is based on only seven tows and is associated with a large uncertainty (95% C.I. = 22 – 12,000 tonnes). The survey captured almost all redstripe rockfish from the shallowest stratum (180 – 275 m). The 1996 survey yielded a relative biomass estimate of only 51 tonnes (95% C.I. = 11 – 100 tonnes), but none of the survey tows were shallower than 220 m. Given the large uncertainty in the 1997 survey estimate, the low 1996 survey estimate, and the absence of recent catch information, we have little evidence to recommend yield for this area. We suggest a provisional yield option of 20 – 80 tonnes, based on a conservative harvest rate of 2% of the 1997 biomass estimate.

6. Yellowmouth Rockfish

6.1 Summary of Fishery Data

The coastwide trawl catch of yellowmouth rockfish increased 22% between 1995-96 (Table 3.7, Fig. 3.3) resulting from increases in Area 3C (up 72%), Area 5C/D (up 315%), and Area 5E-S (up 76%). Only Area 5A/B saw a significant decrease (down 26%). Over 67% of the 1996 yellowmouth rockfish catch was taken from Area 5A/B and 5C/D, with relatively smaller catches spread across other areas (Tables 3.1 to 3.6). Area 5A/B catches of yellowmouth rockfish have been relatively consistent since 1989. In Area 5E-S, the yellowmouth rockfish catch had been declining somewhat in parallel to the Pacific ocean perch catch, from a peak of over 1,200 tonnes in 1977 to less than 100 tonnes in 1994-95. However, the 1996 5E-S catch represents a return to levels seen in the early 1990s. The 1995-96 hook and line catch of yellowmouth rockfish was approximately 10 tonnes (Table 3.8).

6.2 Stock Status and Recommendations

The 1996 Area 3C survey yielded a yellowmouth rockfish relative biomass estimate of 161 – 286 tonnes (25th percentile and mean bootstrapped estimates), about 8% - 13% of the estimate for Pacific ocean perch and up from the estimate of 127 tonnes (±188%) from the 1995 survey. The 1995 Area 5A/B survey yielded a yellowmouth rockfish biomass estimate of 6,100 – 10,200 tonnes (25th percentile and mean bootstrapped estimates). A 1997 Area 5E survey yielded biomass estimates of 1,370 – 2,400 tonnes for Area 5E-S (33-40% of Pacific ocean perch estimates) and 79 – 136 tonnes for Area 5E-N (10% of Pacific ocean perch estimates; 25th percentile and mean bootstrapped estimates).

Although these surveys targeted Pacific ocean perch, yellowmouth rockfish are distributed over similar depths (Section 2). Thus, a significant biomass of yellowmouth rockfish does not likely exist outside of the survey boundaries. Indeed, most of the 1996 commercial catch of yellowmouth rockfish in these areas was taken in the depths covered by the surveys. Nevertheless, yellowmouth rockfish biomass can also be harvested by mid-water gear. Since none of the surveys employed mid-water trawls, we have no information on the potential mid-water biomass. An analysis of the 1995 commercial catch indicates that as much as 10% of yellowmouth rockfish catch is taken by mid-water gear in Area 5A/B. Thus, following last years' assessment, we assume that the coastwide biomass of yellowmouth rockfish is approximately 38% of Pacific ocean perch, based on an expansion of the 1995 survey biomass estimates.

We recommend area specific yield options from option 3 in Table 1.1. which is based on 38% of the Pacific ocean perch coastwide yield. Thus, we recommend yield options of 130 – 260 tonnes for Area 3C, 190 – 390 tonnes for Area 3D, 460 – 980 tonnes for Area 5A/B, 390 – 830 tonnes for Area 5C/D, and 100 – 210 tonnes for Area 5E-S. Option 3 suggests a yield of 0 tonnes for Area 5E-N because no catch was taken during to the experimental closure. For this area, we base our yield recommendation on 38% of the 1997 Area 5E-N Pacific ocean perch yield. This results in a yield option of 110 – 200 tonnes.

7. Rougheye Rockfish

7.1 Fishery Data

Rougheye rockfish are targeted by both trawl and hook and line fleets (Tables 3.7 and 3.8, Fig. 3.4). In 1996, the hook and line catch amounted to 27% of the total coastwide catch of 1,148 tonnes. Coastwide trawl catches have been relatively constant for the past few years (Table 3.7). The majority of the 1996 trawl catch (45%) was harvested from Area 5E-S (Table 3.5) although the catch in this area decreased by 19% from 1995. The historical hook and line catch of rougheye has been much greater in Area 5E than other areas (Table 3.8). However, between 1995-96, the Area 5E hook and line catch area decreased by over 87% while the Area 3D catch increased by 390%, resulting in nearly equal catches in these two areas (Table 3.8). Hook and line catches in Area 3D were larger than trawl catches in 1996 (Table 3.2, 3.8).

7.2 Summary of Stock Status and Recommendations

Rougheye rockfish are the longest lived (up to 147 yr) of any of the BC rockfish species for which we have age data. Consequently, we expect a lower productivity for rougheye rockfish than for other species and exploitation rates for rougheye rockfish should be lower than, for example, those for Pacific ocean perch.

Our only basis for yield recommendations is the longevity and low productivity of rougheye rockfish in comparison with Pacific ocean perch. In particular, we apply last year's coastwide yield range of 500 - 900 tonnes and apportion this to areas, as defined by option 3 in Table 1.1. This results in recommended yield options of 70 – 130 tonnes for Area 3C, 40 – 70 tonnes for

Area 3D, 60 – 100 tonnes for Area 5A/B, 90 – 160 tonnes for Area 5C/D, and 210 – 380 tonnes for Area 5E-S. Because Area 5E-N was closed to fishing in 1996, we recommend a yield option for this area based on a 3% harvest rate and biomass estimates from the 1997 survey, or 50 – 100 tonnes. Summing these yield options over areas, we arrive at a coastwide yield option of 520 - 950 tonnes, up slightly from last year. We note that recent surveys of Area 5E-N primarily targeted Pacific ocean perch and biomass estimates may be conservative if rougheye rockfish have a broader distribution in hard-bottom habitats not covered by the surveys.

8. Shortraker Rockfish

8.1 Fishery Data

Shortraker rockfish are targeted by both trawl and hook and line fleets (Tables 3.7 and 3.8, Fig. 3.4). In 1996, the hook and line catch amounted to 30% of the total coastwide catch of 201 tonnes. The majority of the catch is harvested from Areas 3D, 5C/D and 5E, where the 1996 all-gear catch was 156 tonnes.

8.2 Summary of Stock Status and Recommendations

In the previous assessment, we recommended that the shortraker rockfish yield option be set at 20% of the recommended rougheye rockfish yield. Since 1984, the shortraker rockfish coastwide trawl catch has varied from 2% to 41% of the corresponding rougheye rockfish catch (Table 3.7). Biomass estimates from recent surveys of Areas 3C and 5E suggest that the shortraker rockfish biomass is approximately 2% and 20% respectively, of the rougheye rockfish biomass. Therefore, we again recommend a coastwide yield option based on 20% of the coastwide rougheye rockfish yield. The yield options per area derived from option 3 of Table 1.1 are 20 – 40 tonnes for Area 3C, 20 – 40 tonnes for Area 3D, 10 – 20 tonnes for Area 5A/B, 30 – 50 tonnes for Area 5C/D, 20 – 30 tonnes for Area 5E-S, and 10 – 20 tonnes for Area 5E-N. Summing over areas leads to a coastwide yield option of 110 - 200 tonnes.

9. Thornyheads

9.1 Fishery Data

The coastwide trawl catch of thornyhead has increased six fold since 1992 (Table 3.7, Fig. 3.6) with annual increases of between 300 and 360 tonnes. These increases reflect a growing foreign market for this species. Between 1995-96, the trawl catch increased by over 30% with increases in Areas 3C (up 117%) and 3D (up 366%). Other areas showed large decreases, most notably Areas 5A/B (down 65%), 5C/D (down 39%), and 5E-N (down 68%). Shortspine thornyhead account for 91% of the trawl catch in 1996. Thornyhead are also harvested by hook and line gear; the 1996 hook and line catch of shortspine thornyhead was approximately 6 tonnes.

9.2 Summary of Stock Status and Recommendations

A 1996 survey of Area 3C yielded a biomass estimate for shortspine thornyhead of 100 – 111 tonnes (25^{th} percentile and mean bootstrapped estimates). However, the survey did not target thornyhead depths and this estimate may be conservative. The 1995 survey estimate of 583 – 646 tonnes (25^{th} percentile and mean bootstrapped estimates) from Area 5A/B suffers from the same limitation. For these areas and for Area 3D and Area 5C/D, we have no new information on which to base a change in the recommended yield range. We recommend yield options for these areas based on option 3 in Table 1.1 which is derived from a starting coastwide yield set to 12% of the 1998 coastwide Pacific ocean perch yield. This is twice the maximum biomass ratio estimated from the Goose Island Gully surveys, but less than the 1995 shortspine thornyhead trawl catch ratio of 20% of the Pacific ocean perch catch. This leads to yield options per area of 310 – 540 tonnes for Area 3C, 80 – 140 tonnes for Area 3D, 20 – 30 tonnes for Area 5A/B, and 50 – 90 tonnes for Area 5C/D. We base our recommended yields for Areas 5E-S and 5E-N on the 1997 survey and a 5% harvest rate. Unlike the surveys of Area 3C and 5A/B, the survey of Area 5E covered greater depths and the shortspine biomass estimates produced are probably much less conservative. Therefore, we recommend yield options of 10 – 20 tonnes for Area 5E-S and 20 – 30 tonnes for Area 5E-N.

We have no additional data on longspine thornyheads and their stock status is uncertain. We note that shortspine and longspine thornyhead biomass indices have been steadily declining in neighbouring U.S. regions to the south (Rogers et al. 1997).

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Table 1.1. Bootstrapped biomass estimates (25th percentile, mean, and 95% confidence intervals) from recent surveys and yield options for slope rockfish species by area. Yield option 1 is based on a harvest rate of 5% of the 25th percentile and mean biomass estimates, except for rougheye where it's based on a more conservative 3%. Option 2 is based on the ratio of the 25th percentile and mean biomass estimates to the 25th percentile (30,000 tonnes) and mean (40,000 tonnes) biomass estimates for Pacific ocean perch from a catch-age analysis of Area 5A/B, multiplied by the 1998 recommended yield option for Pacific ocean perch in Area 5A/B (1,200 - 2,400 tonnes). Option 3 yields are based on the ratios of the 1996 area-specific catches to the 1996 coastwide catch, multiplied by the coastwide yield. The calculation for the option 3 coastwide yield follows the rational given for the calculation of last years' coastwide yield. Thus, where applicable, it is modified to reflect the change in the yield on which it is based. In particular, the redstripe rockfish and yellowmouth rockfish coastwide yields for option 3 are based on 25% and 38%, respectively, of the Pacific ocean perch recommended coastwide yield while the shortraker rockfish option 3 coastwide yield is based on 20% of the rougheye rockfish recommended coastwide yield. The 1997 recommended yield, 1998 recommended yield, and, and rationale for the 1998 yield are given. Biomass estimates for Area 3C are from a survey conducted in 1996, estimates for Area 5A/B are from a 2-vessel survey conducted in 1995, and Area 5E-S/N estimates are from a survey conducted in 1997. Yield options could be combined across areas provided that effort is widely distributed.

Pacific ocean perch	Biomass Estimate			Yield Options				1998 Yield Option	Rationale
	25th	mean	95% CI	option 1	option 2	option 3	1997 option		
3C	1950	2220	1580 - 2780	98 - 111	78 - 100		250 - 500	80 - 110	1996 survey.
3D							100 - 300	100 - 300	No change; catch history.
5A/B	26500	30400	2100 - 41500	1325 - 1520			1760 - 2340	1200 - 2400	Catch-age analysis and forecast.
5C/D							1500 - 3400	1500 - 3400	No change; 1981 biomass survey.
5E-S	4200	6050	1900 - 10600	210 - 303	168 - 272		300 - 500	170 - 300	1997 survey.
5E-N	7010	10300	3300 - 18900	351 - 515	280 - 464		150 - 170	280 - 520	1997 survey.
CST							4060 - 7210	3330 - 7030	
redstripe									
3C	572	955	1580 - 2780	29 - 48	23 - 43	87 - 183		120 - 190	Mid-water biomass expansion of option 1.
3D						73 - 154		70 - 150	Option 3.
5A/B	538	649	315 - 998	27 - 32	22 - 29	373 - 787		370 - 790	Option 3.
5C/D						193 - 408		190 - 400	Option 3.
5E-S	678	1020	285 - 2050	34 - 51	27 - 46	106 - 225		140 - 200	Mid-water biomass expansion of option 1.
5E-N	1100	4100	22 - 12000	55 - 205	44 - 185	1 - 1		20 - 80	2% harvest rate of biomass estimate.
CST						833 - 1758	1020 - 1800	910 - 1810	
rougheye									
3C	51	64	36 - 97	2 - 2	2 - 3	74 - 134		70 - 130	Option 3.
3D						38 - 68		40 - 70	Option 3.
5A/B	101	125	67 - 193	3 - 4	4 - 6	59 - 107		60 - 110	Option 3.
5C/D						88 - 159		90 - 160	Option 3.
5E-S	3650	4420	2500 - 6450	110 - 133	146 - 199	211 - 379		210 - 380	Option 3.
5E-N	1800	2300	1130 - 3600	54 - 69	72 - 104	30 - 53		50 - 100	1997 Survey.
CST						500 - 900	500 - 900	520 - 950	

The option 3 coastwide yield is calculated from 25% of the coastwide POP yield.

The option 3 coastwide yield is the same as last years' coastwide yield which is partly based on the longevity of this species.

Table 1.1. continued.

shortraker	biomass estimate			yield options				1998 yield option	rationale
	25th	mean	95% CI	option 1	option 2	option 3	1997 option		
3C	25	33	12 - 59	1 - 2	1 - 1	22 - 40		20 - 40	Option 3.
3D						19 - 35		20 - 40	Option 3.
5A/B	17	29	0 - 75	1 - 1	1 - 1	11 - 21		10 - 20	Option 3.
5C/D						28 - 50		30 - 50	Option 3.
5E-S	188	250	122 - 417	9 - 13	8 - 11	16 - 28		20 - 30	Option 3.
5E-N	54	75	27 - 141	3 - 4	2 - 3	8 - 15		10 - 20	Option 3.
CST						104 - 190	100 - 180	110 - 200	
yellowmouth									
3C	161	286	41 - 612	8 - 14	6 - 13	125 - 263		130 - 260	Option 3.
3D						185 - 391		190 - 390	Option 3.
5A/B	6100	10200	1770 - 21900	305 - 510	244 - 459	464 - 979		460 - 980	Option 3.
5C/D						391 - 826		390 - 830	Option 3.
5E-S	1370	2400	530 - 4540	69 - 120	55 - 108	100 - 212		100 - 210	Option 3.
5E-N	79	136	5 - 297	4 - 7	3 - 6	106 - 198		110 - 200	38% of Area 5E-N POP yield.
CST						1265 - 2671	1540 - 2740	1380 - 2870	
shortspine thornyhead									
3C	100	111	84 - 137	5 - 6	4 - 5	311 - 535		310 - 540	Option 3.
3D						80 - 138		80 - 140	Option 3.
5A/B	583	646	470 - 831	29 - 32	23 - 29	19 - 32		20 - 30	Option 3.
5C/D						51 - 88		50 - 90	Option 3.
5E-S	370	446	264 - 629	19 - 22	15 - 20	11 - 19		10 - 20	1997 Survey.
5E-N	490	521	400 - 678	25 - 26	20 - 23	18 - 31		20 - 30	1997 Survey.
CST						400 - 844	490 - 870	490 - 850	

The option 3 coastwide yield is calculated from 20% of the 1997 recommended coastwide rougheye rockfish yield.

The option 3 coastwide yield is calculated from 38% of the 1997 recommended coastwide Pacific ocean perch yield.

The option 3 coastwide yield is calculated from 12% of the 1997 recommended coastwide Pacific ocean perch yield. The coastwide and area-specific 1996 catches are combined longspine and shortspine thornyhead.

Table 1.2. Outline of historic fishery management practices and participating countries in the slope rockfish fishery off the BC coast between 1965-96.

Year	Management Practice	Participants
1965-76	None.	Soviet, Japanese, US, Canadian
1977-85	Species/area quotas, area/time closures, trip limits.	US until 1980, Canadian
1986	Coastwide quotas and trip limits.	Canadian
1987-88	Species/area quotas, area/time closures, trip limits.	Canadian
1989-93	Coastwide quotas and trip limits.	Canadian
1994-95	Aggregate rockfish management.	Canadian
1995-96	Aggregate rockfish management.	Canadian
1996-97	Species/area quotas, area/time closures, trip limits.	Canadian

Table 1.3. History of recommended yield options (low to high risk), assigned quotas, and commercial trawl catch for Pacific ocean perch stocks. Area 5E-S was managed on the basis of the slope rockfish aggregate (Pacific ocean perch, yellowmouth rockfish, and rougheye rockfish) between 1983-1988. An open fishing experiment was conducted in Area 5E-N between 1983-90; the area was closed from 1991-97 and yields were given for reference only. In 1986, coastwide aggregate quotas were assigned to the slope aggregate. In 1989-93 and 1997, species quotas were assigned on a coastwide basis and area-specific quotas reflect the contribution in the coastwide quota. Coastwide aggregate quotas were again assigned in 1994-96. Quotas listed for years in which aggregates were assigned include other species in addition to Pacific ocean perch.

	Area 3C			Area 3D			Area 5A/B			Area 5C/D			Area 5E-S			Area 5E-N			Area 3C-5E		
Year	Yield	Quota	Catch	Yield	Quota	Catch	Yield	Quota	Catch	Yield	Quota	Catch	Yield	Quota	Catch	Yield	Quota	Catch	Yield	Quota	Catch
1979	50	50	125	10		-	2000	2000	1257			370	600	600	839			227	2670		2818
1980	600	600	430			-	2000	2200	1387			2545	600	600	877		200	85	3200		5324
1981	500	500	547			-	1500	1500	1621	1600	1800	2217	600	600	599	200	200	109	4400		5094
1982	500	500	508		250	-	1000	1000	913	1600	2000	3626	600	600	614	200	200	342	3900		6003
1983	500	500	752	250	250	86	1100-2000	1000	1485	2000-2800	2000	2220	agg	agg	835	open	open	292			5670
1984	150-500	500	551	250	250	193	1100-2000	800	937	1900-2800	2000	2055	agg	agg	841	open	open	2186			6763
1985	0-500	300	243	250-500	350	313	850-1300	850	823	1700-2500	2000	1967	400-1000	agg	829	0-200	open	1921			6096
1986	0-350	100	242	175-350	350	1046	595-910	500	644	1190-1750	2000	629	280-700	agg	642	0-140	open	2725	2550-3800	5000	5928
1987	0-200	100	542	250-500	350	450	400-650	500	1646	1700-2500	2000	1911	400-1000	agg	661	open	open	1130			6340
1988	100-200	100	307	200-600	350	492	700-1000	700	1198	1900-3000	3000	3105	400-700	agg	766	150-170	open	1089			6957
1989	100-200	150	278	200-600	400	994	700-1000	850	1179	1900-3000	3000	1498	300-500	400	571	150-170	open	1525		4650	6045
1990	100-200	150	278	200-600	400	919	700-1000	850	1391	1900-3000	2450	1410	300-500	400	605	150-170	open	1154		4100	5757
1991	100-200	0	22	200-600	400	807	700-1000	850	865	1900-3000	2150	2019	300-500	400	635	150-170	0	-		3800	4349
1992	100-200	0	390	200-600	400	681	700-1000	850	949	1900-3000	2400	1699	300-500	400	374	150-170	0	-		4050	4093
1993	100-200	150	970	200-600	400	667	700-1000	850	895	1900-3000	2400	1556	300-500	400	477	150-170	0	19		4200	4584
1994	*		1365	*		233	350-1800		2428	1500-3400		1270	*		287	*	0	28	3400-5700	4917	5613
1995	*		789	*		102	350-1800		2600	1500-3400		1539	*		802	*	0	48	3400-5700	4234	5880
1996	*		378	*		139	350-1800		1177	1500-3400		3647	*		624	*	0	21	3400-5700	6884	5985
1997	250-500	431		100-300	230		1760-2340	2358		1500-3400	2818		300-500	644 (5E)		150-170	0		4060-7210	6481	
1998	80-110			100-300			1200-2400			1500-3400			170-300			280-520			3330-7030		

Table 1.4. History of recommended yield options (low to high risk), assigned quotas, and commercial trawl catch for yellowmouth rockfish stocks. Area 5E-S was managed on the basis of the slope rockfish aggregate (Pacific ocean perch, yellowmouth rockfish, and rougheye rockfish) between 1983-1988. An open fishing experiment was conducted in Area 5E-N between 1983-90; the area was closed from 1991-97 and yields were given for reference only. In 1986, coastwide aggregate quotas were assigned to the slope aggregate. In 1989-93 and 1997, species quotas were assigned on a coastwide basis and area-specific quotas reflect the contribution in the coastwide quota. Coastwide aggregate quotas were again assigned in 1994-96. Quotas listed for years in which aggregates were assigned include other species in addition to yellowmouth rockfish. The quota for 1996 is included in the Pacific ocean perch quota (Table 1.3).

	Area 3C			Area 3D			Area 3D/5AB			Area 5CD			Area 5E-S			Area 5E-N			Area 3C-5E		
Year	Yield	Quota	Catch	Yield	Quota	Catch	Yield	Quota	Catch	Yield	Quota	Catch	Yield	Quota	Catch	Yield	Quota	Catch	Yield	Quota	Catch
1979	*		2	*		-	100	50	-	50		20	750	750	389			17	950		438
1980	*		-	*		-	100	250	-	50		20	800	800	500			-	1200		548
1981	*		-	*		-	250		-	50		110	600	800	922	200		2	1200		1039
1982	*		7	*		-	250	250	-			442	600	100	414	100	600	68	950		1159
1983	*		52	*		20	200-500	250	628			204	agg	agg	588	open	open	52			1524
1984	*		12	*		114	200-500	250	458	300	300	338	agg	agg	441	open	open	73			1322
1985	*		4	*		412	200-500	350	716	200-300	250	232	400-1000	agg	496		open	180			1628
1986	*		3	*		980	140-350		1208	140-210	250	100	280-700	agg	564		open	615	400-800		2491
1987	*		11	*		699	200-500	350	1170	200-300	250	116	400-1000	agg	451		open	109			1857
1988	*		14	*		161	250-750	375	574	160-500	250	323	400-700	agg	289	350-500	open	107			1307
1989	*		56	*		299	250-750	500	983	160-500	350	176	400-700	600	228	350-500	open	158		1450	1602
1990	*		67	*		253	250-750	500	974	160-500	330	141	400-700	550	299	350-500	open	178		1380	1659
1991	*		52	*		201	250-750	500	862	160-500	330	169	400-700	550	121	350-500	0	-		1380	1204
1992	*		87	*		245	250-750	500	937	160-500	330	316	400-700	550	123	350-500	0	1		1380	1464
1993	*		73	*		276	250-750	500	741	160-500	330	156	400-700	550	144	350-500	0	4		1380	1119
1994	*		124	*		330	*		989	*		62	*		44	*	0	-	1100-1850	1593	1219
1995	*		92	*		231	*		1027	*		119	*		72	*		-	1100-1850	1465	1310
1996	*		158	*		234	*		819	*		494	*		127	*		-	1100-1850		1598
1997	*	100		*			710-1000	1866		*	360		*	104 (5E)		*			1540-2740	2430	
1998	130-260			190-390			460-980 (5A/B)			390-830			100-210			110-200			1380-2870		

Table 1.5. History of recommended yield options (low to high risk), assigned quotas, and commercial trawl catch for rougheye rockfish stocks. Area 5E-S was managed on the basis of the slope rockfish aggregate (Pacific ocean perch, yellowmouth rockfish, and rougheye rockfish) between 1983-1988. An open fishing experiment was conducted in Area 5E-N between 1983-90; the area was closed from 1991-97 and yields were given for reference only. In 1986, coastwide aggregate quotas were assigned to the slope aggregate. In 1989-93 and 1997, species quotas were assigned on a coastwide basis and area-specific quotas reflect the contribution in the coastwide quota. Coastwide aggregate quotas were again assigned in 1994-96.

	Area 3C			Area 3D			Area 5A/B			Area 5C/D			Area 5E-S			Area 5E-N			Area 3C-5E		
Year	Yield	Quota	Catch	Yield	Quota	Catch	Yield	Quota	Catch	Yield	Quota	Catch	Yield	Quota	Catch	Yield	Quota	Catch	Yield	Quota	Catch
1979	*		3	*		-	*		5	*		4	150		192			14	150		218
1980	*		27	*		-	*		-	*		1	150		51			3	150		82
1981	*		7	*		-	*		1	*		-	250		10	200		98	450		116
1982	*		5	*		-	*		-	*		38	250	250	274	250		69	500		386
1983	*		2	*		-	*		5	*		6	agg	agg	74	open	open	127			214
1984	*		-	*		-	*		11	*		7	agg	agg	101	open	open	227			346
1985	*		1	*		-	*		-	*		3	100-500	agg	158	0-250	open	454			616
1986	*		1	*		12	*		14	*		3	70-350	agg	269	0-175	open	461	100-500		758
1987	*		3	*		2	*		3	*		6	100-500	agg	296	open	open	180	100-400		490
1988	*		49	*		22	*		106	*		95	200-300	200	353	50-100	open	467			1092
1989	*		140	*		17	*		57	*		28	200-300	250	251	50-100	open	511			1003
1990	*		106	*		19	*		89	*		17	200-300		470	50-100	open	494			1195
1991	*		171	*		52	*		103	*		31	200-300		607	50-100	0	1			964
1992	*		302	*		99	*		144	*		29	200-300		1061	50-100	0	7			1641
1993	*		403	*		98	*		167	*		27	200-300		1126	50-100	0	54			1874
1994	*		156	*		13	*		118	*		20	*		946	*	0	80	500-900	796	1333
1995	*		241	*		17	*		159	*		77	*		567	*		41	500-900	735	1101
1996	*		169	*		38	*		106	*		200	*		458	*		45	500-900	**1311	1016
1997	*			*			*			*			*			*			500-900	380	
1998	70-130			40-70			60-110			90-160			210-380			50-100			520-950		

** includes rougheye rockfish and shortraker rockfish quotas.

Table 1.6. History of recommended yield options (low to high risk), assigned quotas, and commercial trawl catch for redstripe rockfish stocks. No quotas were assigned prior to the coastwide quota in 1993.

	Area 3C			Area 3D		Area 3D/5AB			Area 5C/D			Area 5E-S			Area 5E-N			Area 3C-5E		
Year	Yield	Quota	Catch	Yield	Catch	Yield	Quota	Catch	Yield	Quota	Catch	Yield	Quota	Catch	Yield	Quota	Catch	Yield	Quota	Catch
1988	200-1000		393	*	285	350-900		678	350-570		199	100-200		517	500-700		114	*		1824
1989	200-1000		288	*	311	350-900		599	350-570		234	50-100		154	500-700		151	*		1616
1990	200-1000		343	*	218	350-900		561	350-570		321	50-100		199	500-700		69	*		1970
1991	200-1000		251	*	238	350-900		489	350-570		120	50-100		245	500-700		4	*		1600
1992	200-1000		271	*	237	350-900		508	350-570		266	50-100		388	500-700		1	*		3051
1993	200-1000		349	*	198	350-900		547	350-570		95	50-100		330	500-700		12	*	2200	1912
1994	*		435	*	96	*		531	*		153	*		226	*		1	950-2570	1840	1397
1995	*		193	*	300	*		493	*		93	*		99	*		6	950-2570	1755	1282
1996	*		93	*	78	*		171	*		207	*		114	*		1	950-2570	2024	893
1997	*	100		*		470-660	1198			49			226 (5E)					1020-1800	1623	
1998	120-190			70-150		370-790 (5A/B)			190-400			140-200			20-80			910-1810		

Table 2.1. Fields from the fishing effort and catch data tables in the 1996 ACCESS observer database, showing the number and percentage of records with non-null entries.

FISHING EFFORT				
Field Name	**Description**	**Type**	**# Records**	**% Records**
hail_in_no	Trip ID	Long integer	21,312	100
set_no	Set ID	Integer	21,312	100
gear_type	1=trawl	Byte	21,312	100
gear_subtype	1=bottom, 3=midwater	Byte	21,312	100
start_latitude	degrees & minutes	Long integer	21,267	99.8
start_longitude	degrees & minutes	Long integer	21,267	99.8
end_latitude	degrees & minutes	Long integer	21,242	99.7
end_longitude	degrees & minutes	Long integer	21,241	99.7
major_stat_area	Areas 1 to 9	Integer	21,260	99.8
minor_stat_area	Subareas of above	Integer	21,212	99.5
locality	Specific locations	Integer	19,478	91.4
dfo_mgmt_area	Areas 1 to 142	Integer	21,240	99.7
dfo_mgmt_subarea	Subareas of above	Integer	17,788	83.5
start_date	day/month/year	Date/Time	21,312	100
start_time	hour:min	Date/Time	21,312	100
end_time	hour:min	Date/Time	21,312	100
duration	Tow effort (min)	Integer	21,312	100
start_bottom_depth	(fathoms)	Integer	21,197	99.5
end_bottom_depth	(fathoms)	Integer	21,130	99.1
CATCH				
Field Name	**Description**	**Type**	**# Records**	**% Records**
hail_in_no	Trip ID	Long integer	231,709	100
set_no	Set ID	Integer	231,709	100
species_code	Species Hart code	Text	230,773	99.6
est_weight	Observer est. weight (lb)	Long integer	230,734	99.6
est_count	Observer est. counts (pieces)	Integer	8,205	3.5
catch_utilization_code	1=retain, 22-28=discard	Integer	230,757	99.6

Table 3.1. Area 3C (including statistical areas 25 and 125) Canadian trawl catch (tonnes) of Pacific ocean perch, redstripe, yellowmouth, rougheye, and shortraker rockfish, and longspine and shortspine thornyheads, the proportions of Pacific ocean perch, redstripe, yellowmouth, rougheye, and shortraker rockfish, and longspine and shortspine thornyheads constituting the 20% qualified catch, 20% qualified median CPUE, estimated effort, nominal effort, and the number of vessel trips used to calculate CPUE.

	Catch (tonnes)						Proportion of qualified catch						CPUE	E. Eff	N. Eff	No.
Year	POP	Reds	YelM	Reye	Sraker	Thorny	POP	Reds	YelM	Reye	Sraker	Thorny	(tonnes/h)	(h)	(h)	trips
67	7	-	-	-	-	-	0.85	-	-	-	-	-	0.255	27	17	3
68	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-
69	2	-	-	-	-	-	0.26	-	-	-	-	-	0.101	20	41	1
70	304	-	-	-	-	-	0.66	-	-	-	-	-	0.739	411	580	12
71	218	-	-	9	-	-	0.52	-	-	0.02	-	-	0.245	928	717	16
72	117	-	-	-	-	-	0.87	-	-	-	-	-	0.502	233	21	2
73	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75	5	-	-	-	-	-	0.52	-	0.17	-	-	-	0.274	18	167	2
76	1	-	-	-	-	-	1.00	-	-	-	-	-	0.869	1	5	1
77	16	-	-	-	-	-	0.32	-	-	-	-	-	0.188	85	467	3
78	53	1	-	-	-	-	0.49	-	-	-	-	-	0.499	108	78	3
79	125	2	2	3	5	1	0.41	0.02	0.01	0.01	0.02	0.02	1.241	111	213	4
80	430	-	-	27	16	-	0.61	-	-	0.03	0.01	-	0.681	694	765	13
81	547	13	-	7	3	-	0.58	0.01	-	0.01	-	0.01	0.634	899	1095	22
82	508	3	7	5	3	-	0.63	-	0.01	0.01	-	-	0.565	931	916	17
83	752	30	52	2	-	2	0.50	0.03	0.05	-	-	-	0.874	959	916	21
84	551	35	12	-	-	-	0.75	0.01	0.01	-	-	-	0.555	1078	1043	21
85	243	61	4	1	1	2	0.37	0.08	0.01	-	-	-	0.340	918	1409	28
86	242	515	3	1	-	1	0.16	0.31	-	-	-	-	0.711	1071	1895	44
87	542	377	11	3	1	3	0.32	0.21	0.01	-	-	-	0.727	1289	1921	66
88	307	393	14	49	7	14	0.14	0.25	0.01	0.02	-	0.01	0.381	2057	3022	74
89	278	288	56	140	19	27	0.13	0.15	0.03	0.05	0.01	0.01	0.304	2661	4622	100
90	278	343	67	106	23	73	0.14	0.20	0.04	0.04	-	0.01	0.294	3029	4359	115
91	22	251	52	171	18	75	0.02	0.20	0.04	0.11	0.01	0.01	0.257	2296	2670	113
92	390	271	87	302	92	114	0.17	0.11	0.04	0.12	0.04	0.01	0.399	3148	3943	235
93	970	349	73	403	27	215	0.24	0.09	0.02	0.10	-	0.01	0.347	5865	7138	402
94	1365	435	124	156	70	177	0.37	0.11	0.03	0.04	0.01	0.01	0.337	6903	7580	357
95	789	193	92	241	78	446	0.28	0.07	0.03	0.08	0.02	0.03	0.280	6576	6763	339
96	378	93	158	169	41	970	0.14	0.02	0.06	0.07	0.02	0.41	0.111	16223	14573	281

Table 3.2. Area 3D Canadian trawl catch (tonnes) of Pacific ocean perch, redstripe, yellowmouth, rougheye, and shortraker rockfish, and longspine and shortspine thornyheads, the proportions of Pacific ocean perch, redstripe, yellowmouth, rougheye, and shortraker rockfish, and longspine and shortspine thornyheads constituting the qualified catch, 20% qualified median CPUE, estimated effort, nominal effort, and the number of vessel trips used to calculate CPUE.

	Catch (tonnes)						Proportion of qualified catch						CPUE	E. Eff	N. Eff	No.
Year	POP	Reds	YelM	Reye	Sraker	Thorny	POP	Reds	YelM	Reye	Sraker	Thorny	(tonnes/h)	(h)	(h)	trips
74	3	-	-	-	-	-	-	-	-	-	-	-	-	-	59	-
75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
77	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
78	3	6	-	-	-	-	-	0.23	-	-	-	-	0.193	47	36	1
79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-
81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-
82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28	-
83	86	4	20	-	-	-	0.34	-	0.04	-	-	-	1.127	98	115	2
84	193	9	114	-	-	-	0.50	0.02	0.39	-	-	-	1.671	189	122	5
85	313	43	412	-	-	4	0.36	0.04	0.42	-	-	0.01	0.943	818	529	19
86	1046	678	980	12	-	10	0.25	0.22	0.29	-	-	-	1.287	2117	1388	93
87	450	696	699	2	2	3	0.17	0.26	0.26	-	-	-	1.649	1123	904	73
88	492	285	161	22	1	4	0.37	0.21	0.12	0.02	-	-	1.061	910	1094	82
89	994	311	299	17	3	8	0.42	0.13	0.13	0.01	-	-	1.129	1445	1467	114
90	919	218	253	19	5	13	0.42	0.11	0.13	0.01	-	-	1.002	1424	1665	129
91	807	238	201	52	-	10	0.47	0.15	0.12	0.03	-	-	0.946	1383	1326	155
92	681	237	245	99	54	11	0.37	0.13	0.14	0.06	0.02	0.01	0.788	1684	1567	217
93	667	198	276	98	16	17	0.33	0.11	0.15	0.05	0.01	-	0.626	2030	1972	313
94	233	96	330	13	12	18	0.23	0.08	0.33	0.01	0.01	0.01	0.577	1217	1263	145
95	102	300	231	17	11	56	0.10	0.30	0.23	0.02	-	0.01	0.499	1437	1363	169
96	139	78	234	38	7	251	0.15	0.08	0.25	0.04	0.01	0.26	0.248	3002	3018	138

Table 3.3. Area 5A/B (Goose Island and Mitchell's Gullies) Canadian trawl catch (tonnes) of Pacific ocean perch, redstripe, yellowmouth, rougheye, and shortraker rockfish, and longspine and shortspine thornyheads, the proportions of Pacific ocean perch, redstripe, yellowmouth, rougheye, and shortraker rockfish, and longspine and shortspine thornyheads constituting the qualified catch, 20% qualified median CPUE, estimated effort, nominal effort, and the number of vessel trips used to calculate CPUE.

	Catch (tonnes)						Proportion of qualified catch						CPUE	E. Eff	N. Eff	No.
Year	POP	Reds	YelM	Reye	Sraker	Thorny	POP	Reds	YelM	Reye	Sraker	Thorny	(tonnes/h)	(h)	(h)	trips
67	399	-	-	-	-	-	0.79	-	-	-	-	-	0.758	526	449	33
68	881	-	-	-	-	-	0.87	-	-	-	-	-	0.655	1345	1048	42
69	1539	-	-	-	-	-	0.80	-	-	-	-	-	0.639	2408	2319	59
70	1767	-	-	-	-	-	0.83	-	-	-	-	-	0.604	2925	2814	53
71	1116	-	5	-	-	-	0.77	-	-	-	-	-	0.450	2488	2317	35
72	2196	-	-	8	-	-	0.73	-	-	-	-	-	0.739	2982	2944	44
73	1360	-	177	-	-	-	0.74	-	0.10	-	-	-	1.195	1286	1446	33
74	1513	-	79	-	-	-	0.79	-	0.04	-	-	-	0.866	1838	1688	43
75	1911	13	1	-	-	-	0.83	0.01	-	-	-	-	0.775	2483	2520	63
76	1518	12	12	14	-	-	0.69	0.01	0.01	0.01	-	-	0.696	2236	2428	63
77	1074	34	336	-	-	-	0.58	0.02	0.15	-	-	-	0.597	2420	2339	57
78	1203	18	17	1	-	-	0.53	0.01	0.01	-	-	-	0.704	1760	2525	59
79	1257	8	10	5	-	-	0.77	-	0.01	-	-	-	0.707	1811	2069	57
80	1387	-	28	-	-	-	0.74	-	0.02	-	-	-	0.876	1616	1556	64
81	1621	-	5	1	2	-	0.85	-	-	-	-	-	0.903	1804	1256	35
82	913	3	228	-	5	-	0.62	-	0.17	-	-	-	0.663	1734	1572	30
83	1485	37	608	5	-	2	0.53	0.01	0.29	-	-	-	2.033	1051	626	26
84	937	40	344	11	-	-	0.64	0.02	0.16	-	-	-	0.806	1652	795	30
85	823	117	304	-	-	4	0.34	0.11	0.07	-	-	0.01	0.733	1703	1491	42
86	644	395	228	14	5	2	0.27	0.25	0.11	0.01	-	-	0.889	1450	1692	73
87	1646	649	471	3	1	3	0.35	0.16	0.13	-	-	-	0.719	3855	3798	180
88	1198	316	413	106	4	4	0.33	0.09	0.13	0.03	-	-	0.616	3313	4457	197
89	1179	477	684	57	1	1	0.26	0.12	0.17	0.01	-	-	0.737	3257	4218	193
90	1391	821	721	89	1	5	0.25	0.13	0.12	0.01	-	-	0.735	4117	5998	232
91	865	742	661	103	3	2	0.22	0.20	0.19	0.03	-	-	0.724	3282	4018	275
92	949	1889	692	144	7	16	0.15	0.26	0.12	0.02	-	-	0.760	4864	4679	395
93	895	928	465	167	14	50	0.19	0.20	0.11	0.04	-	0.01	0.741	3399	3812	430
94	2428	485	659	118	63	282	0.41	0.07	0.11	0.02	0.01	0.04	0.752	5365	5469	397
95	2600	591	796	159	21	169	0.40	0.09	0.12	0.02	-	0.02	0.814	5329	6150	587
96	1177	400	586	106	4	59	0.32	0.10	0.15	0.03	0.00	0.01	0.370	6292	5621	288

Table 3.4. Area 5C/D (Moresby Gully) Canadian trawl catch (tonnes) of Pacific ocean perch, redstripe, yellowmouth, rougheye, and shortraker rockfish, and longspine and shortspine thornyheads, the proportions of Pacific ocean perch, redstripe, yellowmouth, rougheye, and shortraker rockfish, and longspine and shortspine thornyheads constituting the qualified catch, 20% qualified median CPUE, estimated effort, nominal effort, and the number of vessel trips used to calculate CPUE.

	Catch (tonnes)						Proportion of qualified catch						CPUE	E. Eff	N. Eff	No.
Year	POP	Reds	YelM	Reye	Sraker	Thorny	POP	Reds	YelM	Reye	Sraker	Thorny	(tonnes/h)	(h)	(h)	trips
68	-	-	-	-	-	-	-	-	-	-	-	-	-	-	44	-
69	1	-	-	-	-	-	-	-	-	-	-	-	-	-	24	-
70	27	-	-	-	-	-	-	-	-	-	-	-	-	-	594	-
71	10	-	-	-	-	-	0.90	-	-	-	-	-	0.055	181	346	3
72	13	-	-	-	-	-	-	-	-	-	-	-	-	-	567	-
73	38	-	-	-	-	-	0.79	-	-	-	-	-	0.763	50	673	2
74	36	-	-	-	-	-	0.67	-	-	-	-	-	1.051	34	596	4
75	117	-	-	-	-	-	0.79	-	-	-	-	-	0.804	146	1024	8
76	86	-	-	-	-	-	0.68	-	-	-	-	-	0.233	368	2185	8
77	74	1	4	-	-	-	0.31	0.01	0.10	-	0.01	-	0.198	399	1793	8
78	174	4	92	-	-	-	0.46	0.01	0.26	-	-	-	1.272	212	979	11
79	370	1	20	4	-	-	0.44	-	0.03	-	-	0.01	0.426	926	2086	36
80	2545	19	20	1	2	-	0.76	0.01	0.01	-	-	-	1.019	2539	2282	78
81	2217	5	110	-	2	4	0.73	-	0.02	-	-	-	1.062	2202	1807	45
82	3626	23	442	38	29	9	0.79	-	0.10	0.01	0.01	-	1.797	2318	1860	62
83	2220	20	204	6	11	5	0.83	0.01	0.04	-	0.01	-	1.865	1322	866	38
84	2055	71	338	7	2	6	0.72	0.02	0.07	-	-	-	1.472	1684	1636	39
85	1967	181	232	3	9	17	0.65	0.07	0.09	-	-	-	1.615	1491	1667	49
86	629	110	100	3	2	8	0.46	0.08	0.08	-	-	-	0.805	1058	1369	50
87	1911	307	116	6	2	7	0.66	0.11	0.03	-	-	-	1.342	1750	1845	104
88	3105	199	323	95	29	19	0.66	0.04	0.07	0.02	0.01	-	1.429	2637	2954	199
89	1498	234	176	28	4	7	0.49	0.07	0.06	0.01	-	-	1.124	1733	2209	123
90	1410	321	141	17	3	13	0.51	0.12	0.05	0.01	-	-	0.967	1970	2247	110
91	2019	120	169	31	12	13	0.68	0.04	0.06	0.01	-	-	1.264	1870	1890	158
92	1699	266	316	29	7	21	0.57	0.10	0.12	0.01	-	-	0.954	2451	1908	166
93	1556	95	156	27	6	61	0.60	0.04	0.07	0.01	-	0.01	0.729	2607	2368	217
94	1270	153	62	20	18	85	0.51	0.06	0.03	0.01	0.01	0.02	0.530	3032	2856	152
95	1539	93	119	77	60	262	0.52	0.03	0.04	0.03	0.02	0.05	0.463	4641	3792	221
96	3647	207	494	200	54	160	0.68	0.04	0.09	0.04	0.01	0.03	0.641	7431	7153	345

Table 3.5. Area 5E-S Canadian trawl catch (tonnes) of Pacific ocean perch, redstripe, yellowmouth, rougheye, and shortraker rockfish, and longspine and shortspine thornyheads, the proportions of Pacific ocean perch, redstripe, yellowmouth, rougheye, and shortraker rockfish, and longspine and shortspine thornyheads constituting the qualified catch, 20% qualified median CPUE, estimated effort, nominal effort, and the number of vessel trips used to calculate CPUE.

	Catch (tonnes)						Proportion of qualified catch						CPUE	E. Eff	N. Eff	No.
Year	POP	Reds	YelM	Reye	Sraker	Thorny	POP	Reds	YelM	Reye	Sraker	Thorny	(tonnes/h)	(h)	(h)	trips
76	79	-	-	-	-	-	0.99	-	-	-	-	-	1.339	59	59	2
77	1549	156	1257	76	10	-	0.46	0.05	0.39	0.02	-	-	2.411	1264	1061	66
78	2414	231	1105	139	25	1	0.56	0.05	0.26	0.03	0.01	-	3.201	1223	1140	64
79	839	73	389	192	11	1	0.50	0.04	0.23	0.11	0.01	-	1.936	778	644	38
80	877	111	500	51	1	-	0.37	0.09	0.38	0.04	-	-	1.465	1051	595	42
81	599	133	922	10	4	4	0.45	0.08	0.39	0.01	-	-	2.019	828	295	23
82	614	34	414	274	3	1	0.42	0.02	0.25	0.20	-	-	2.212	606	481	33
83	835	143	588	74	17	10	0.42	0.07	0.30	0.03	0.01	0.01	2.186	762	717	37
84	841	148	441	101	11	4	0.46	0.09	0.21	0.07	-	-	2.351	658	389	24
85	829	919	496	158	1	4	0.29	0.37	0.17	0.06	-	-	1.828	1316	913	50
86	642	728	564	269	4	14	0.19	0.26	0.22	0.07	-	-	2.107	1054	840	43
87	661	629	451	296	8	25	0.25	0.28	0.18	0.12	-	0.01	1.990	1040	1044	41
88	766	517	289	353	5	11	0.30	0.20	0.12	0.15	-	-	1.967	987	1257	54
89	571	154	228	251	6	6	0.36	0.10	0.15	0.17	-	-	1.294	940	799	35
90	605	199	299	470	21	25	0.29	0.09	0.15	0.23	0.01	0.01	1.354	1196	1120	44
91	635	245	121	607	15	17	0.31	0.12	0.06	0.29	0.01	0.01	1.523	1077	1119	74
92	374	388	123	1061	61	48	0.14	0.14	0.05	0.41	0.02	0.01	0.920	2234	2410	181
93	477	330	144	1126	218	93	0.14	0.11	0.05	0.36	0.04	0.02	0.859	2781	2541	225
94	287	226	44	946	292	99	0.13	0.09	0.02	0.40	0.09	0.03	0.864	2193	1972	129
95	802	99	72	567	72	61	0.39	0.05	0.03	0.27	0.03	0.02	1.012	1653	1708	114
96	624	114	127	458	30	35	0.40	0.07	0.08	0.29	0.02	0.02	0.933	1487	1369	111

Table 3.6. Area 5E-N Canadian trawl catch (tonnes) of Pacific ocean perch, redstripe, yellowmouth, rougheye, and shortraker rockfish, and longspine and shortspine thornyheads, the proportions of Pacific ocean perch, redstripe, yellowmouth, rougheye, and shortraker rockfish, and longspine and shortspine thornyheads constituting the qualified catch, 20% qualified median CPUE, estimated effort, nominal effort, and the number of vessel trips used to calculate CPUE.

	Catch (tonnes)						Proportion of qualified catch						CPUE	E. Eff	N. Eff	No.
Year	POP	Reds	YelM	Reye	Sraker	Thorny	POP	Reds	YelM	Reye	Sraker	Thorny	(tonnes/h)	(h)	(h)	trips
77	1	-	-	-	-	-	1.00	-	-	-	-	-	0.328	3	20	1
78	22	-	-	-	1	-	0.65	-	-	-	0.13	-	0.337	68	151	5
79	227	5	17	14	2	-	0.63	0.01	0.05	0.04	0.01	0.01	0.576	460	204	9
80	85	-	-	3	-	-	0.71	-	-	0.02	-	0.01	0.314	280	130	7
81	109	-	2	98	-	-	0.30	-	0.01	0.47	-	-	3.134	67	44	4
82	342	13	68	69	1	3	0.49	0.01	0.13	0.16	-	0.01	2.467	201	145	14
83	292	18	52	127	3	36	0.37	0.01	0.03	0.13	-	0.03	1.162	454	402	15
84	2186	111	73	227	8	41	0.63	0.04	0.02	0.07	-	0.01	1.639	1615	1227	42
85	1921	259	180	454	12	30	0.52	0.07	0.05	0.13	-	0.01	1.224	2334	1917	56
86	2725	717	615	461	6	51	0.52	0.12	0.12	0.08	-	0.01	1.387	3299	3036	65
87	1130	224	109	180	3	25	0.55	0.11	0.06	0.09	-	0.01	1.120	1492	1325	28
88	1089	114	107	467	13	73	0.44	0.05	0.04	0.20	0.01	0.03	1.077	1730	1802	34
89	1525	151	158	511	10	66	0.47	0.04	0.05	0.16	-	0.02	1.188	2038	2238	43
90	1154	69	178	494	52	81	0.46	0.03	0.07	0.20	0.02	0.03	0.706	2872	2551	30
91	-	4	-	1	30	39	0.01	0.36	-	0.03	0.03	0.31	0.247	300	67	6
92	-	1	1	7	21	9	0.01	0.06	0.06	0.24	0.07	0.10	0.211	184	29	9
93	19	12	4	54	63	77	0.09	0.07	0.02	0.27	0.04	0.05	0.361	634	376	29
94	28	1	-	80	94	151	0.06	-	-	0.20	0.09	0.17	0.346	1023	818	50
95	48	6	-	41	93	176	0.12	0.01	-	0.09	0.07	0.15	0.176	2070	899	40
96	21	1	-	45	5	56	0.13	0.00	0.00	0.29	0.03	0.36	0.114	1125	991	54

Table 3.7. Coastwide Canadian trawl catch (tonnes) of Pacific ocean perch, redstripe, yellowmouth, rougheye, and shortraker rockfish, and longspine and shortspine thornyheads, the proportions of Pacific ocean perch, redstripe, yellowmouth, rougheye, and shortraker rockfish, and longspine and shortspine thornyheads constituting the qualified catch, 20% qualified median CPUE, estimated effort, nominal effort, and the number of vessel trips used to calculate CPUE.

	Catch (tonnes)						Proportion of qualified catch						CPUE	E. Eff	N. Eff	No.
Year	POP	Reds	YelM	Reye	Sraker	Thorny	POP	Reds	YelM	Reye	Sraker	Thorny	(tonnes/h)	(h)	(h)	trips
67	406	-	-	-	-	-	0.79	-	-	-	-	-	0.757	536	465	36
68	882	-	-	-	-	-	0.87	-	-	-	-	-	0.655	1346	1185	42
69	1542	-	-	-	-	-	0.80	-	-	-	-	-	0.638	2416	2384	60
70	2098	-	-	-	-	-	0.80	-	-	-	-	-	0.606	3464	4004	64
71	1344	-	5	9	-	-	0.72	-	-	-	-	-	0.440	3085	3380	51
72	2327	-	-	8	-	-	0.73	-	-	-	-	-	0.739	3159	3532	46
73	1398	-	177	-	-	-	0.74	-	0.10	-	-	-	1.085	1451	2119	34
74	1552	-	79	-	-	-	0.79	-	0.04	-	-	-	0.879	1855	2343	44
75	2033	13	2	-	-	-	0.81	0.01	0.00	-	-	-	0.775	2642	3710	71
76	1684	12	12	14	-	-	0.69	0.01	0.01	0.01	-	-	0.695	2479	4677	67
77	2715	191	1596	77	10	-	0.50	0.04	0.30	0.02	-	-	0.959	4784	5679	127
78	3869	261	1213	140	27	1	0.53	0.04	0.17	0.02	-	-	1.166	4727	4909	131
79	2818	89	438	218	18	2	0.58	0.02	0.09	0.05	-	-	0.758	4725	5216	130
80	5324	131	548	82	19	1	0.66	0.02	0.08	0.01	-	-	1.063	5744	5332	176
81	5094	151	1039	116	11	9	0.67	0.02	0.08	0.02	-	-	0.979	6555	4514	113
82	6003	75	1159	386	41	14	0.65	0.01	0.13	0.05	0.01	-	1.268	6057	5002	120
83	5670	252	1524	214	30	55	0.55	0.03	0.17	0.02	-	0.01	1.614	4798	3641	110
84	6763	414	1322	346	22	52	0.63	0.04	0.09	0.04	-	0.01	1.240	7194	5211	124
85	6096	1579	1628	616	22	61	0.46	0.14	0.11	0.06	-	0.01	1.083	9235	7926	170
86	5928	3142	2491	758	17	85	0.35	0.19	0.15	0.04	-	-	1.215	10220	10220	308
87	6340	2882	1857	490	16	66	0.38	0.18	0.12	0.03	-	-	1.074	10852	10836	387
88	6957	1824	1307	1092	58	125	0.41	0.11	0.08	0.07	-	0.01	0.900	12624	14586	459
89	6045	1616	1602	1003	44	115	0.35	0.09	0.10	0.06	-	0.01	0.762	13687	15553	433
90	5757	1970	1659	1195	105	209	0.31	0.10	0.09	0.07	0.01	0.01	0.634	17175	17939	489
91	4349	1600	1204	964	78	156	0.35	0.13	0.10	0.08	-	-	0.776	10758	11089	557
92	4093	3051	1464	1641	242	219	0.24	0.17	0.09	0.11	0.01	0.01	0.719	14896	14537	921
93	4584	1912	1119	1874	345	512	0.25	0.11	0.07	0.11	0.01	0.01	0.571	18115	18206	1217
94	5613	1397	1219	1333	549	812	0.34	0.08	0.08	0.08	0.02	0.03	0.536	20395	19957	949
95	5880	1282	1310	1101	334	1171	0.35	0.08	0.08	0.07	0.01	0.03	0.527	21017	20715	1093
96	5985	893	1598	1016	141	1529	0.42	0.06	0.11	0.07	0.01	0.11	0.301	37028	32726	1217

Table 3.8. Hook and line catch (kg) of Pacific ocean perch, redstripe rockfish, roughey rockfish, shortraker rockfish, yellowmouth rockfish, and shortspine thornyhead from 1993 to 1996.

		Area								
Year	**Species**	**3C**	**3D**	**5A**	**5B**	**5C**	**5D**	**5E**	**Total**	**Fishery Types**
1993	POP	9	10		14	200		277	509	longline
	Redstripe	23	64	118	277	43		369	894	longline
	Rougheye	525	3,064	272	1,111	492	14	10,530	16,008	longline, handline
	Shortraker			23				10,144	10,167	longline
	Shortspine	181			9			5	195	longline
	Yellowmouth	1,440	510	386		45	18	583	2,982	longline, handline
1994	POP	18	816						835	longline
	Redstripe		955	544	15	29	42	243	1,829	longline, handline
	Rougheye	777	289	14,572	1,026			102,381	119,045	longline
	Shortraker			3,588	1,223			34,011	38,822	longline
	Shortspine	23	42	599	85	3		947	1,699	longline
	Yellowmouth			11,686				13	11,699	longline
1995	POP		74	102	138			617	930	longline
	Redstripe	3	4	47	11	37	18	190	310	longline, handline
	Rougheye	241	9,898	35,767	10,275	159	5	414,576	470,922	longline, handline
	Shortraker	140	9,467	12,168	3,104	4		62,934	87,817	longline
	Shortspine	37	1,323	2,672	238		171	11,745	16,186	longline, handline
	Yellowmouth		24	10,489	1,234			4,650	16,396	longline
1996	POP		110	499				362	971	longline
	Redstripe		38	23	18	4	54	94	231	longline, handline
	Rougheye	346	49,207	28,780	321	453	7	52,605	131,721	longline, handline
	Shortraker	907	30,563	17,973				10,632	60,075	longline, handline
	Shortspine	94	3,162	1,674			1	953	5,885	longline, handline
	Yellowmouth		675	6,999	45			1,848	9,567	longline

Table 4.1. Catch statistics for Pacific ocean perch in Goose Island, Mitchell's and Moresby Gullies, including the total (all-nation) trawl catch (tonnes), the Canadian trawl catch (tonnes), qualified total rockfish CPUE (tonnes/h), qualified Pacific ocean perch CPUE (tonnes/h), nominal effort (h), and the number of qualified trips. Foreign catches are not known for Moresby Gully.

	Goose Island Gully						Mitchell's Gully		Moresby Gully				
Year	T. Catch	C. Catch	RF CPUE	POP CPUE	N. Eff	Trips	T. Catch	C. Catch	C. Catch	RF CPUE	POP CPUE	N. Eff	Trips
59	1890	260	0.602	0.506	216	12	-	-	-	-	-	-	0
60	1679	397	0.871	0.871	346	18	-	-	-	-	-	-	0
61	1199	67	0.843	0.843	48	6	-	-	-	-	-	-	0
62	1838	545	1.277	1.207	498	11	-	-	-	-	-	-	0
63	3712	459	1.212	1.129	401	21	-	-	-	-	-	-	0
64	3450	389	0.859	0.697	609	23	56	56	-	-	-	-	0
65	7478	1419	1.288	1.218	1178	61	488	-	-	-	-	-	0
66	20752	2415	1.141	1.071	2002	73	1369	41	-	-	-	-	0
67	12119	313	0.779	0.762	371	30	5319	85	-	-	-	-	0
68	10213	814	0.746	0.655	980	42	2556	66	1	-	-	48	0
69	6872	1457	0.715	0.664	2180	59	2945	81	-	-	-	24	0
70	6489	1735	0.605	0.605	2736	53	1296	31	27	-	-	594	0
71	3455	1098	0.461	0.450	2300	35	813	17	9	0.055	0.055	346	3
72	5645	1966	0.831	0.739	2620	42	995	229	13	-	-	567	0
73	3755	487	0.661	0.504	895	18	2264	872	37	0.765	0.765	673	2
74	7269	482	0.702	0.675	770	23	1917	1030	36	1.053	1.053	596	4
75	4209	1151	0.742	0.689	1642	48	1151	759	116	0.911	0.804	1024	8
76	2442	1015	0.829	0.758	1749	47	576	502	85	0.251	0.233	2129	8
77	1693	884	0.608	0.573	1800	50	256	189	73	0.207	0.207	1770	7
78	865	839	0.785	0.585	1882	40	375	364	175	1.525	0.831	996	11
79	951	808	0.694	0.689	1344	42	480	448	369	0.433	0.427	2046	35
80	1226	1082	0.987	0.987	1226	50	304	304	2544	1.375	0.967	2259	77
81	940	940	0.659	0.597	1018	25	680	680	2216	1.213	0.963	1782	44
82	627	627	0.538	0.452	1173	23	285	285	3625	1.983	1.585	1846	61
83	1454	1454	2.165	2.014	559	18	31	31	2219	2.125	1.975	854	35
84	918	918	0.974	0.745	588	26	18	18	2055	1.842	1.360	1560	36
85	743	743	1.268	1.063	809	25	79	79	1967	1.793	1.396	1594	43
86	622	622	0.880	0.498	1089	46	20	20	628	1.354	0.873	1240	40
87	1548	1548	0.882	0.629	2688	132	97	97	1910	1.603	1.288	1676	93
88	989	989	0.779	0.518	3139	136	208	208	3104	1.761	1.281	2752	190
89	955	955	0.905	0.605	2448	107	224	224	1498	1.492	1.002	1842	110
90	1086	1086	1.017	0.589	3003	141	305	305	1410	1.397	0.949	1632	93
91	726	726	0.800	0.481	1788	135	139	139	2019	2.050	1.388	1494	128
92	786	786	1.067	0.594	1706	192	163	163	1699	1.317	0.959	1494	126
93	761	761	1.240	0.714	1427	217	134	134	1556	1.060	0.762	1976	187
94	1916	1916	0.899	0.644	3286	239	512	512	1270	0.820	0.519	2292	124
95	2292	2292	0.980	0.726	3397	395	308	308	1539	0.742	0.506	3037	182
96	983	983	0.531	0.282	3998	140	194	194	3647	0.822	0.606	6869	284

Table 4.2. The measure of risk (proportion of simulations with year-50 biomass less than B_{lim}) as a function of catch policy for Goose Island Gully biomass forecasts.

catch policy (tonnes)	risk
0	0.000
500	0.007
750	0.014
1000	0.027
1250	0.034
1500	0.062
1750	0.140
2000	0.253
2250	0.384
2500	0.521
2750	0.647
3000	0.747
4000	0.973

Table 4.3. Relative pacific ocean perch biomass estimates (tonnes) and 95% confidence intervals (in brackets) for Area 5E-N from surveys conducted in 1993, 1996, and 1997.

Year	Outside Upper (A)	Outside Lower (B)	Flats (C)	Rock Pile (D)	Deep Trench (E)	Inside Edge (F)	Total (All strata)
1993	125	1150	2820	55	1620	152	5930
	(35 - 362)	(560 - 2040)	(1450 - 6560)	(0 - 98)	(514 - 3620)	(76 - 279)	(3490 - 8850)
1996	341	2040	2980	538	1580	1180	8660
	(110 - 939)	(985 - 3580)	(1780 - 6560)	(52 - 1450)	(387 - 3990)	(183 - 2919)	(5610 - 12000)
1997	348	133	9030	159	391	33	10425
	(201 - 561)	(50 - 253)	(3280 - 21800)	(83 - 209)	(203 - 699)	(0 - 94)	(3321 - 20459)

Table 5.1. Observer reported catches and discards (tonnes) and the percent discarded of Pacific ocean perch, redstripe, yellowmouth, rougheye, and shortraker rockfish, and longspine and shortspine thornyheads.

	Pacific ocean perch			Redstripe			Yellowmouth		
Area	Total	Discard	%Discard	Total	Discard	%Discard	Total	Discard	%Discard
3C	395	17.4	4.4	130	36.8	28.3	160	2.5	1.6
3D	141	2.3	1.6	100	21.8	21.8	239	5.5	2.3
5A/B	1,231	54.3	4.4	484	84.8	17.5	601	15.4	2.6
5C/D	3,784	137.6	3.6	227	19.9	8.8	500	5.4	1.1
5E-S	628	3.8	0.6	121	7.2	6.0	127	0.3	0.2
5E-N	22	0.5	2.3	1	0.2	22.8	0	0.0	1.6
Coastwide	6,208	216.0	3.5	1,064	170.9	16.1	1,629	29.1	1.8

	Rougheye			Shortraker			Thornyheads		
Area	Total	Discard	%Discard	Total	Discard	%Discard	Total	Discard	%Discard
3C	169	0.3	0.2	42	0.7	1.7	1,048	78.2	7.5
3D	38	0.1	0.2	7	0.0	0.5	269	18.2	6.8
5A/B	107	0.6	0.5	4	0.0	0.2	60	1.8	3.0
5C/D	200	0.8	0.4	54	0.2	0.4	166	6.2	3.8
5E-S	461	2.8	0.6	30	0.0	0.0	38	3.3	8.6
5E-N	46	0.3	0.6	5	0.1	0.9	57	1.7	2.9
Coastwide	1,021	4.8	0.5	142	1.0	0.7	1,640	109.5	6.7

Table 5.2. Estimates of redstripe rockfish, yellowmouth rockfish, rougheye rockfish, and thornyhead relative biomass (tonnes) and coefficient of variation (%CV) from Goose Island Gully surveys conducted between 1965-95. For comparison, the ratio of the biomass with the corresponding estimate for Pacific ocean perch (%POP) is also shown.

Year	Vessel	Redstripe			Yellowmouth			Rougheye			Thornyheads		
		Rel Bio	%CV	%POP	Rel Bio	%CV	%POP	Rel Bio	%CV	%POP	Rel Bio	%CV	%POP
1965	G.B. Reed	-	-	-	-	-	-	70	88	0.5	341	20	2.3
1966	G.B. Reed	535	70	3.0	461	52	2.5	36	56	0.2	278	20	1.5
1967	G.B. Reed	335	51	2.1	375	59	2.3	87	63	0.5	327	16	2.0
1969	G.B. Reed	1807	92	15.8	1183	61	10.3	-	-	-	310	15	2.7
1970	G.B. Reed	47	56	0.4	902	84	7.0	150	45	1.2	333	15	2.6
1971	G.B. Reed	555	60	7.6	359	54	4.9	10	49	0.1	339	22	4.6
1973	G.B. Reed	637	50	6.2	195	48	1.9	427	97	4.1	471	20	4.6
1976	G.B. Reed	357	43	4.9	-	-	-	22	57	0.3	529	20	7.3
1984	G.B. Reed	329	39	4.4	105	81	1.4	11	71	0.1	515	12	6.9
1984	Eastward Ho	547	50	3.7	2044	64	14.0	117	57	0.8	342	22	2.3
1994	Ocean Selector	895	75	5.7	2454	58	15.5	22	84	0.1	967	13	6.1
1995	Ocean Selector	576	38	2.2	9265	56	34.8	106	25	0.4	548	12	2.1
1995	Frosti	744	30	3.0	7481	45	29.9	104	29	0.4	714	12	2.9

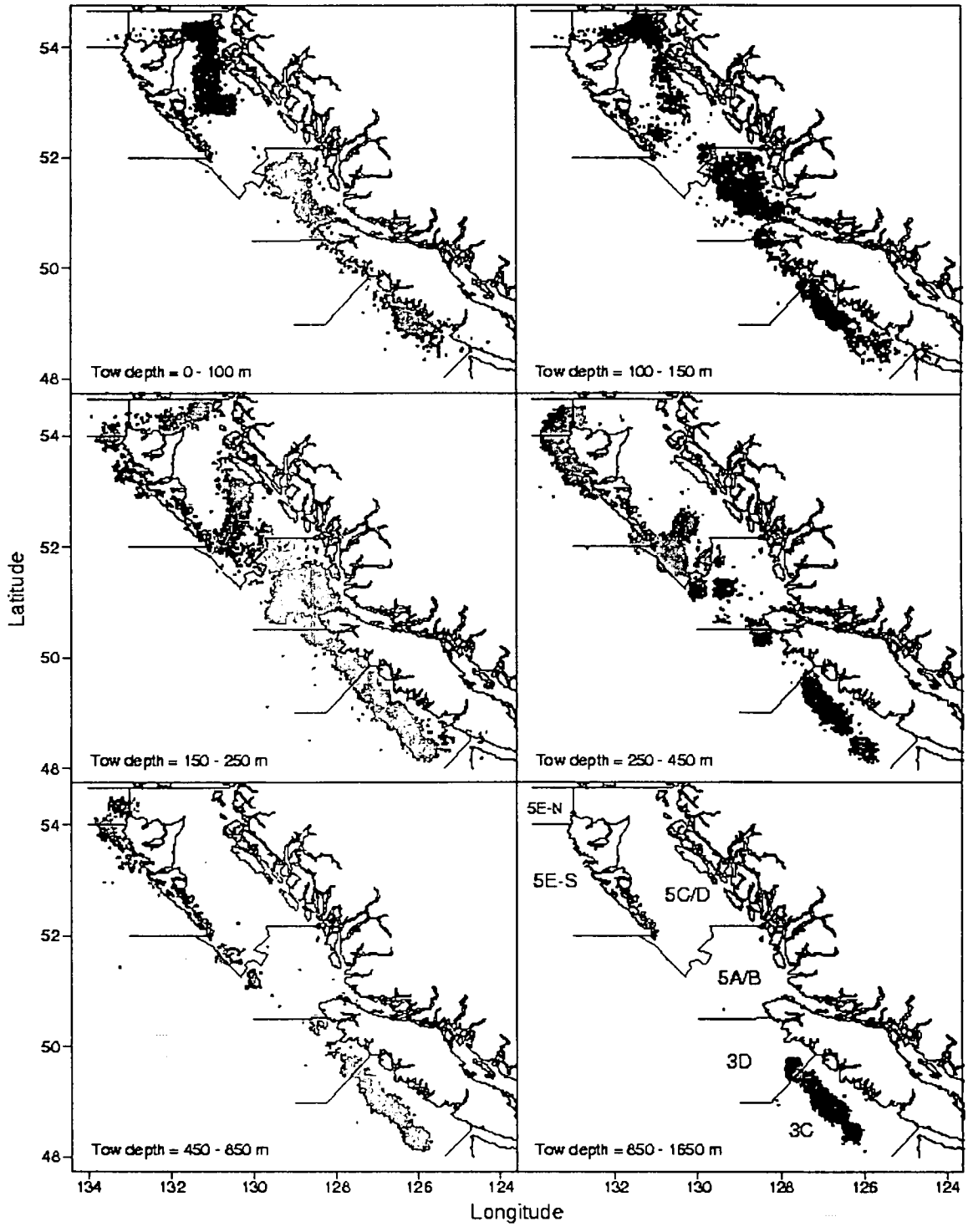


Figure 2.1. Jittered coastal locations of 1996 trawls, stratified by mean depth.

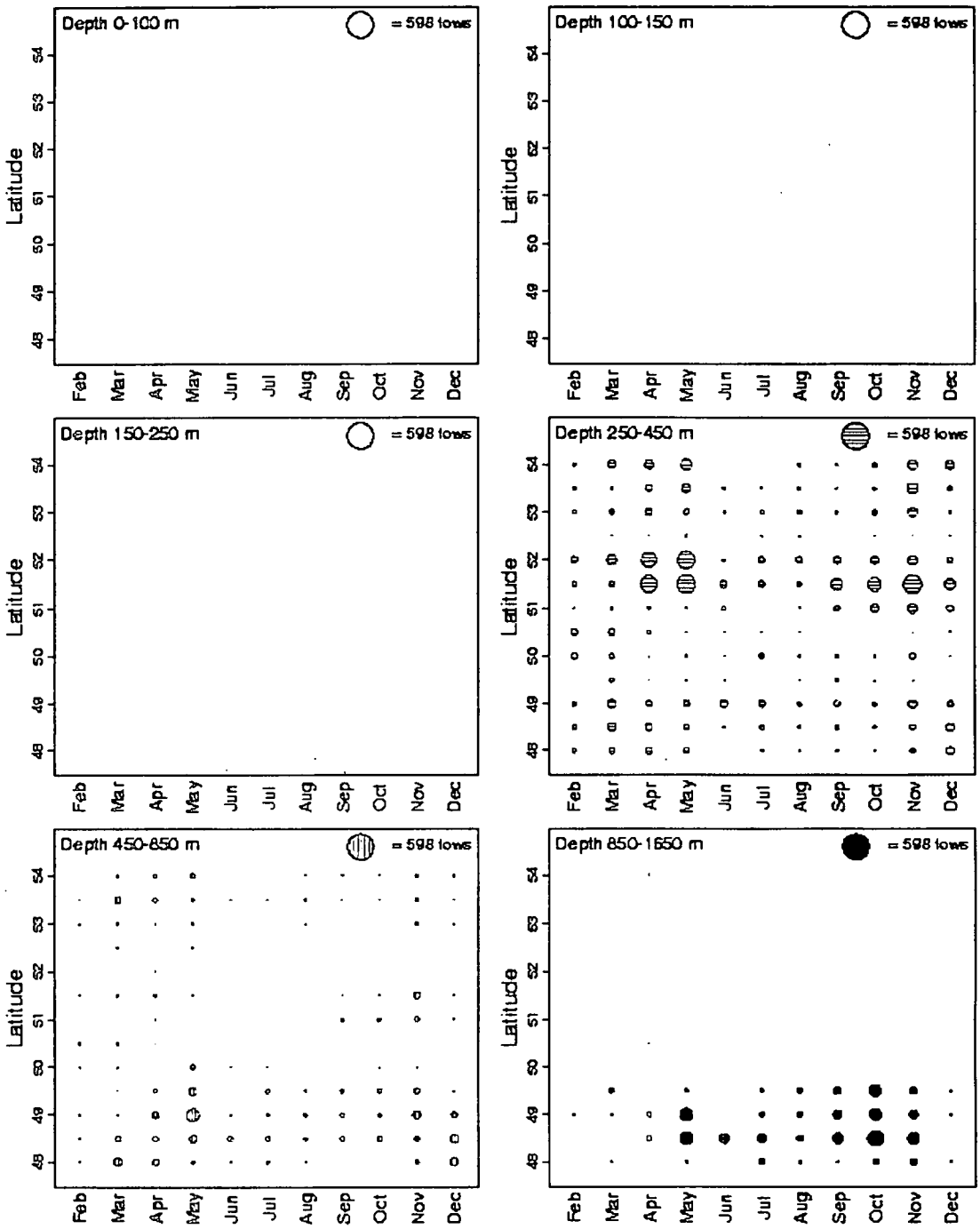


Figure 2.2. Number of tows by depth, latitude, and month in 1996.

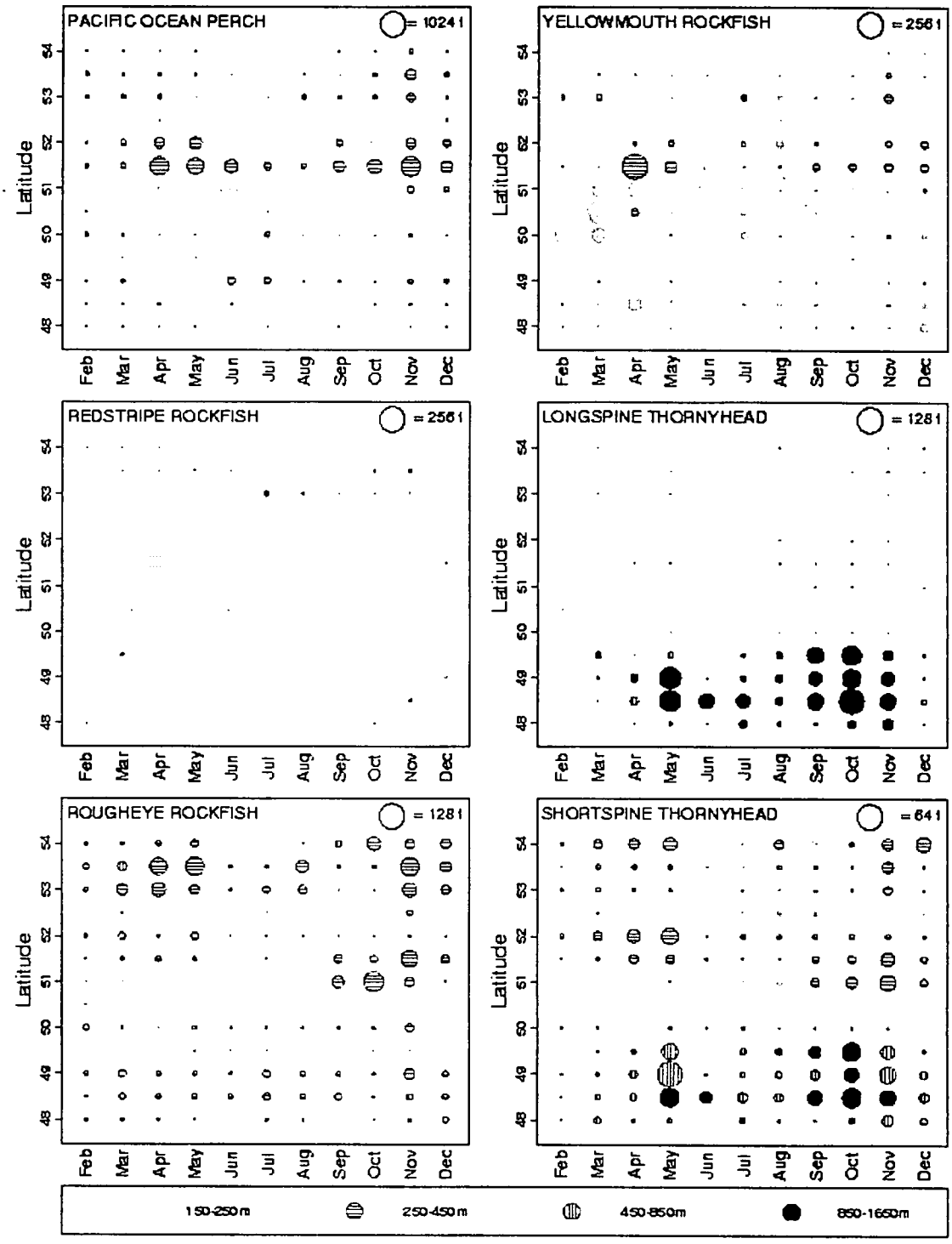


Figure 2.3. 1996 catch biomass and mean depth by species, month, and latitude.

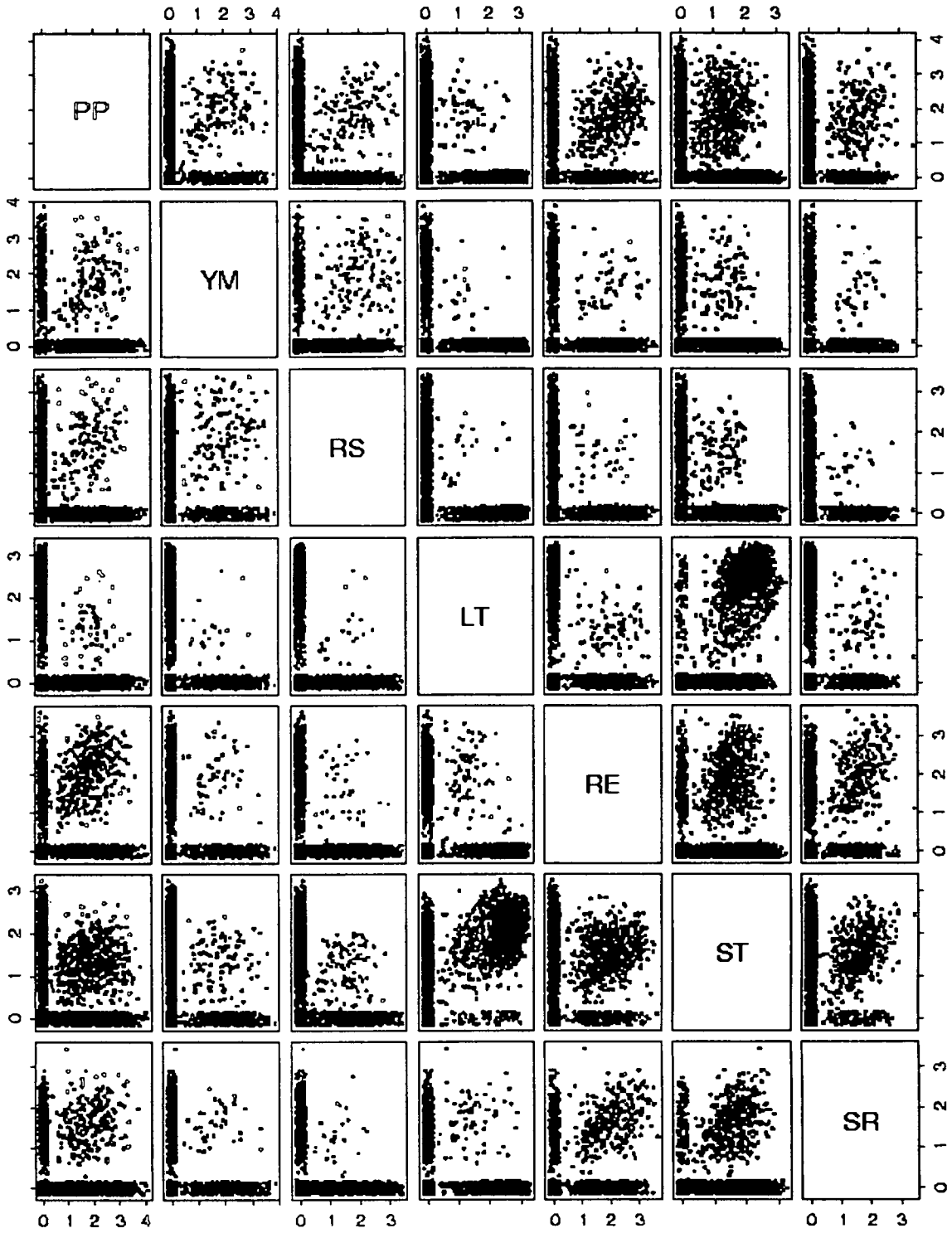


Figure 2.4. Jittered pairs plot for slope rockfish species in area 3C, based on a logarithmic transformation of catch biomass.

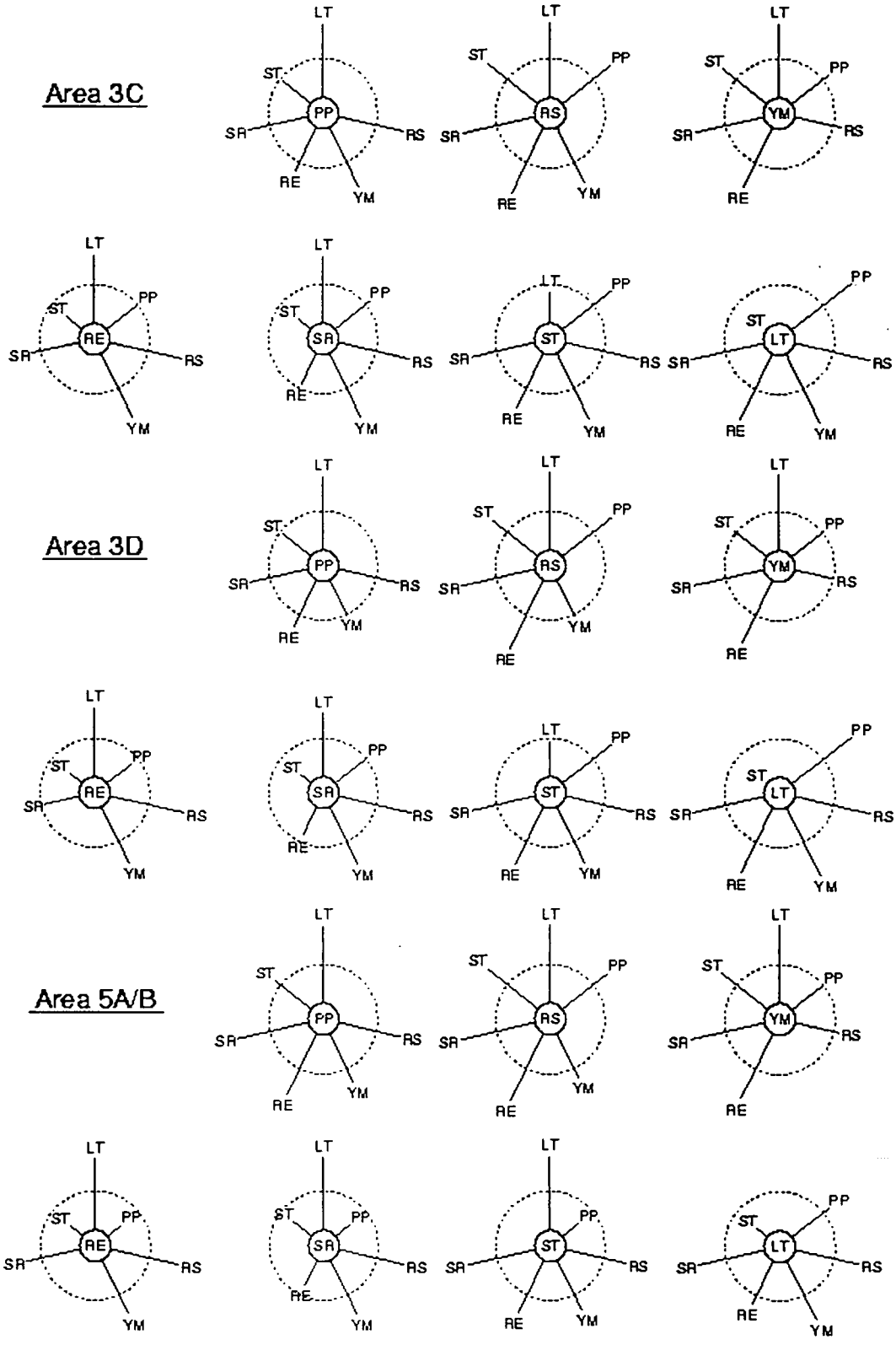


Figure 2.5. Star plots portraying species associations within statistical areas.

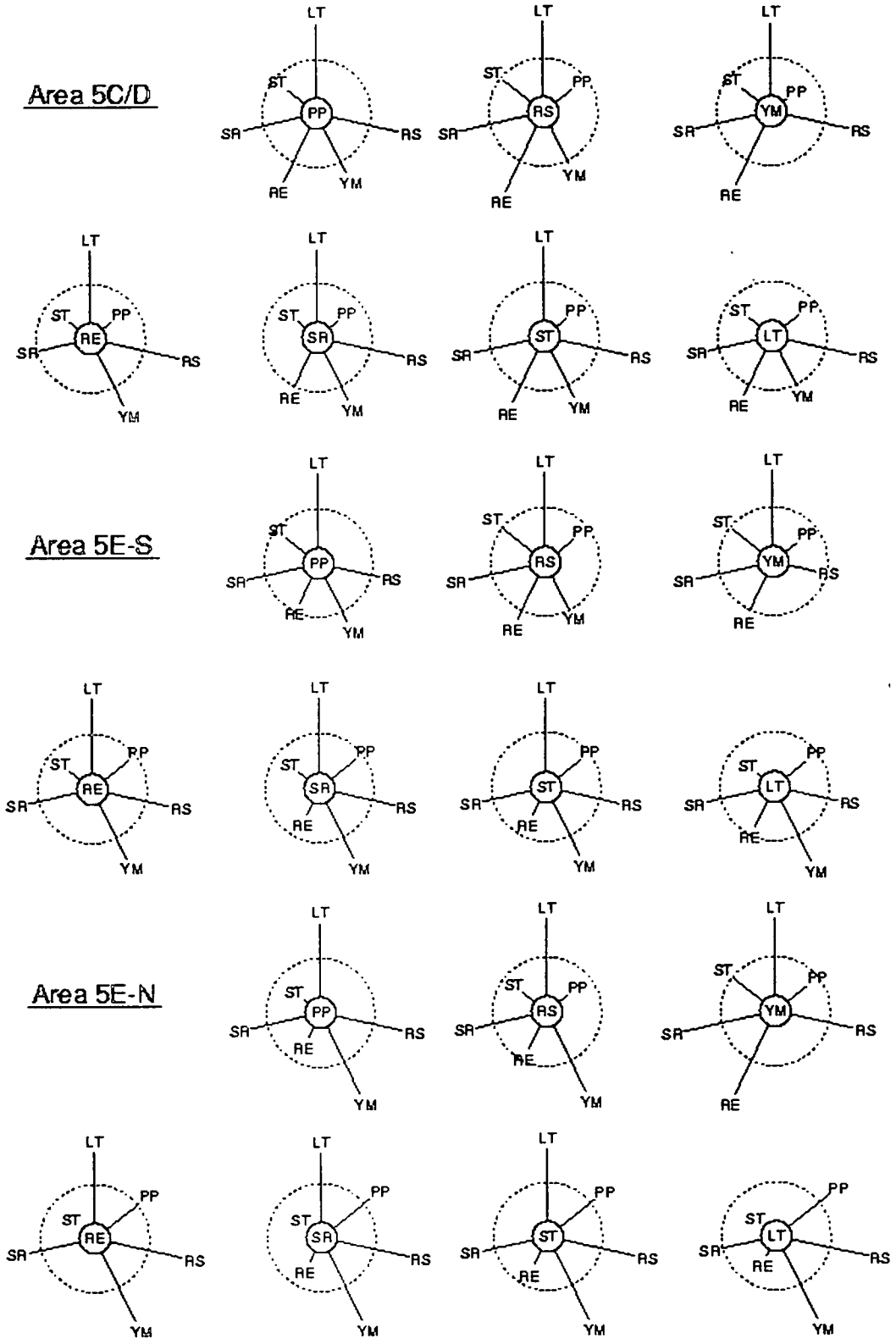


Figure 2.5. Continued.

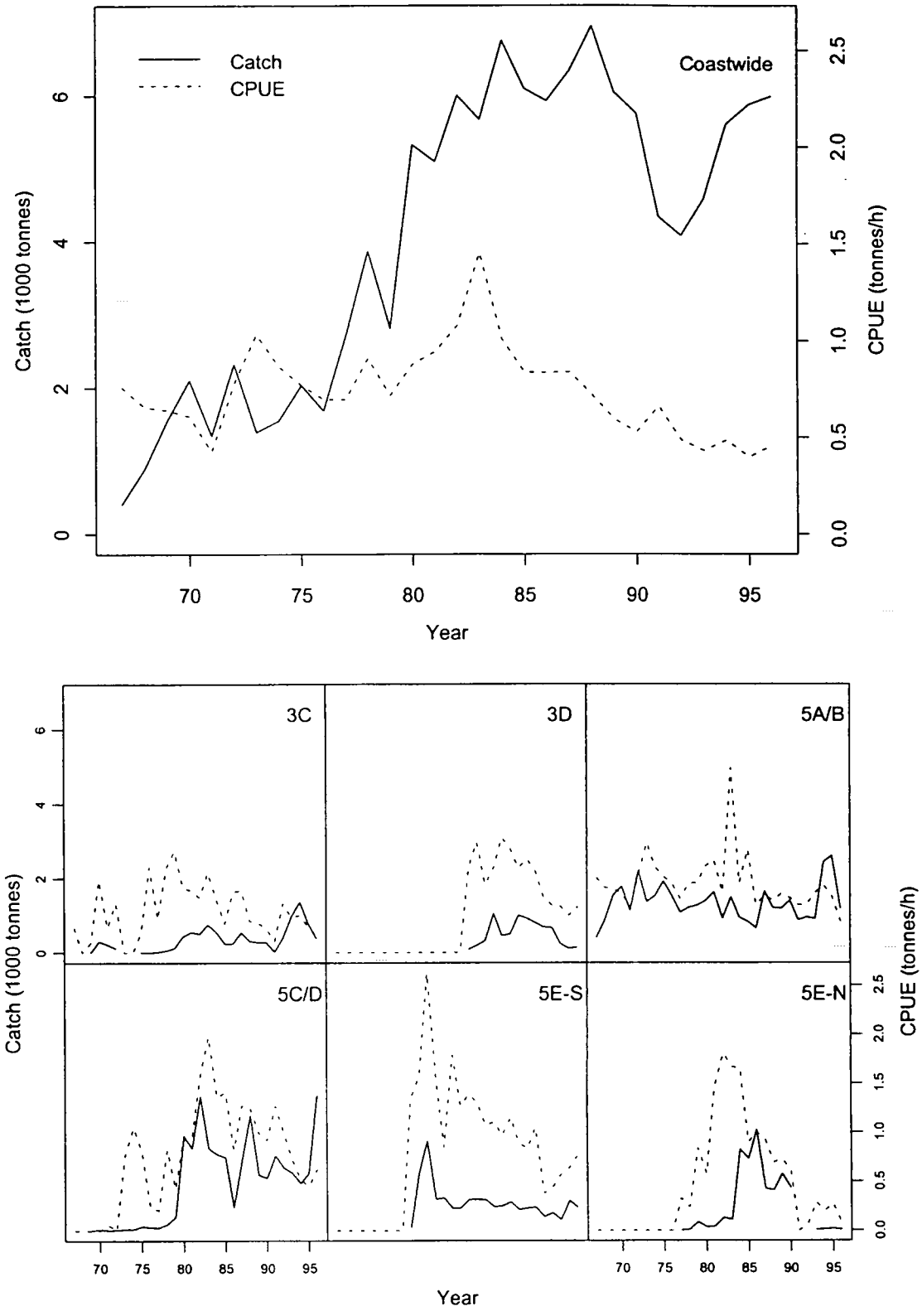


Figure 3.1. Canadian trawl catch and CPUE for Pacific ocean perch coastwide and by major statistical area.

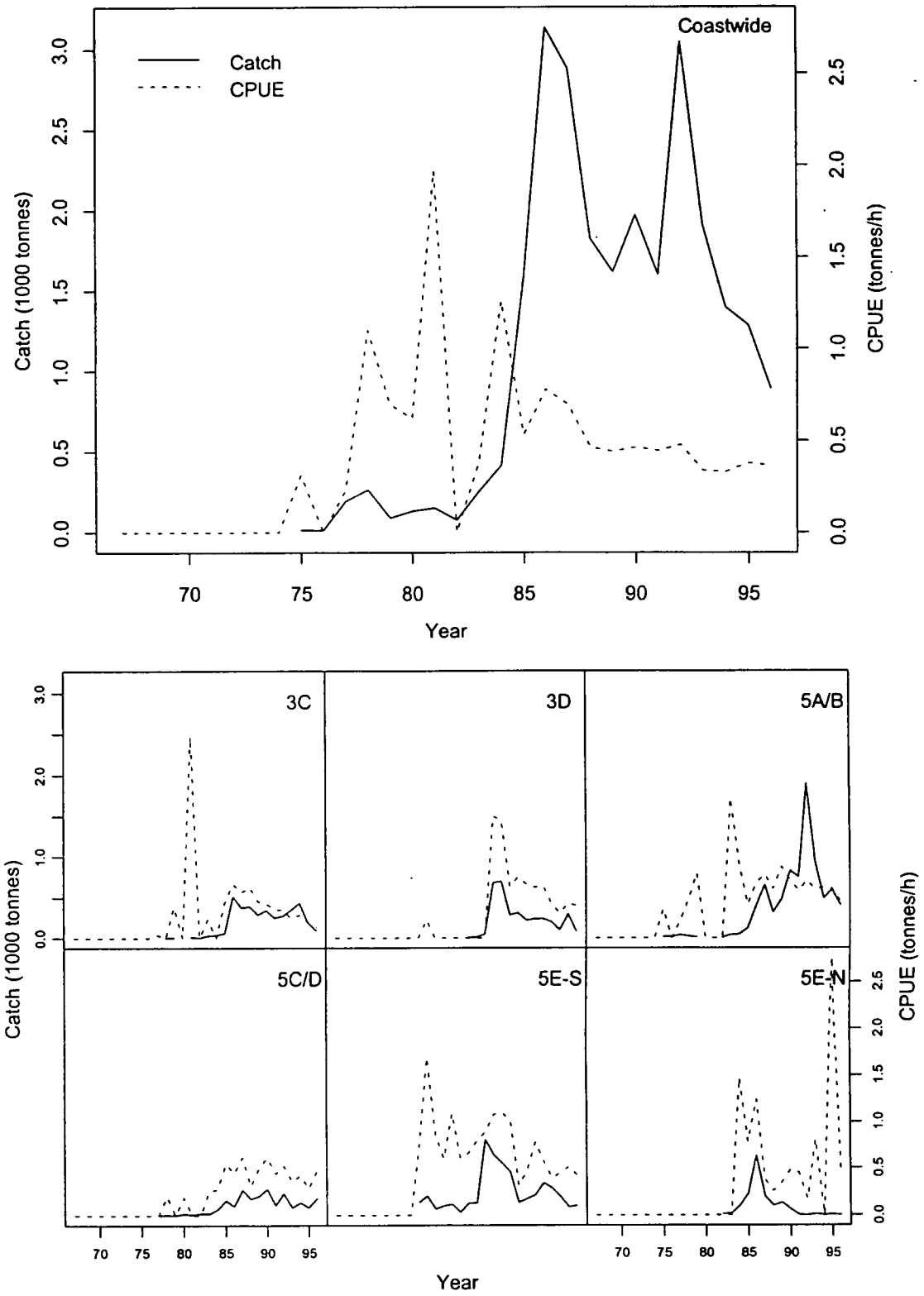


Figure 3.2. Canadian trawl catch and CPUE for redstripe rockfish coastwide and by major statistical area.

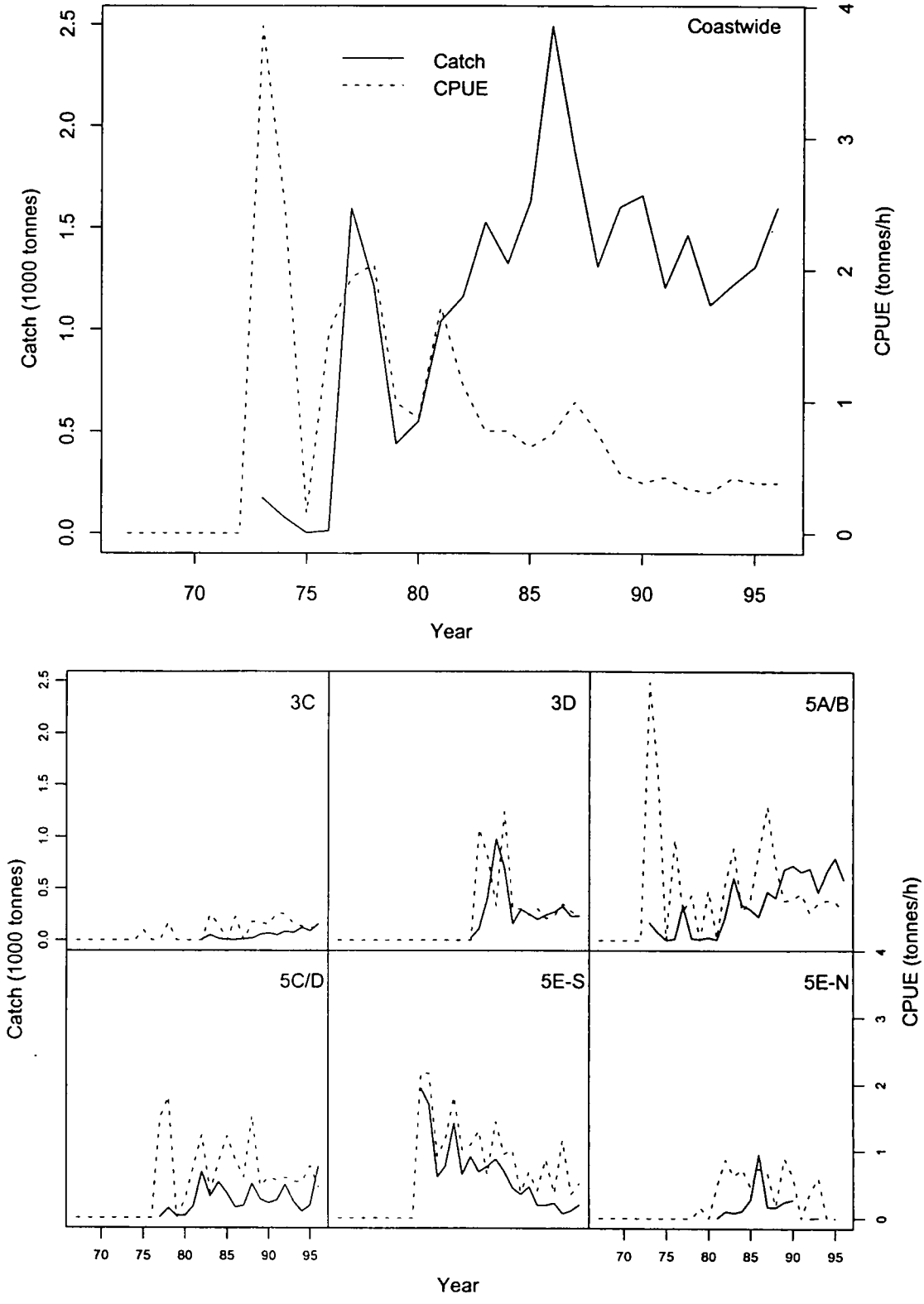


Figure 3.3. Canadian trawl catch and CPUE for yellowmouth rockfish coastwide and by major statistical area.

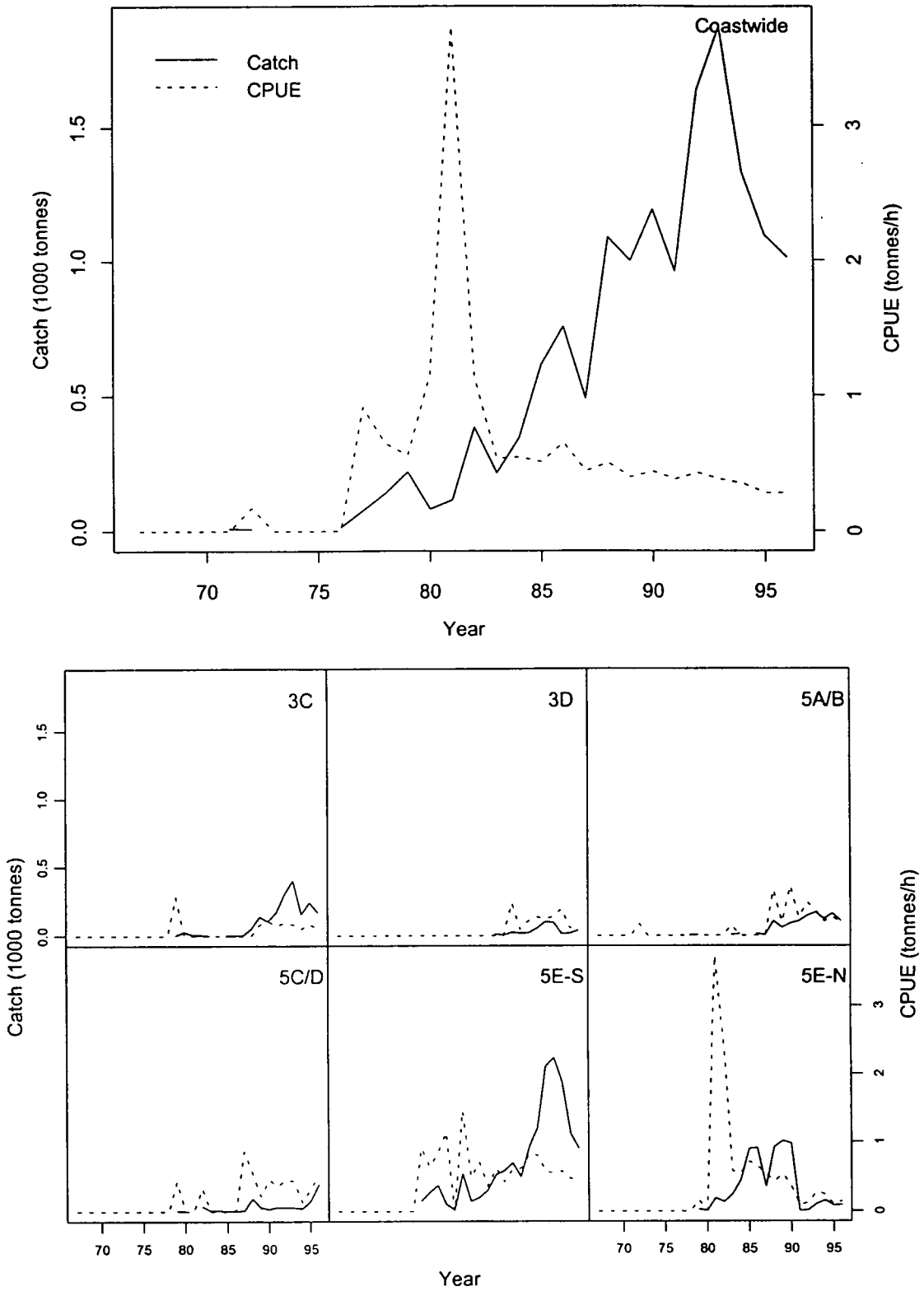


Figure 3.4. Canadian trawl catch and CPUE for rougheye rockfish coastwide and by major statistical area.

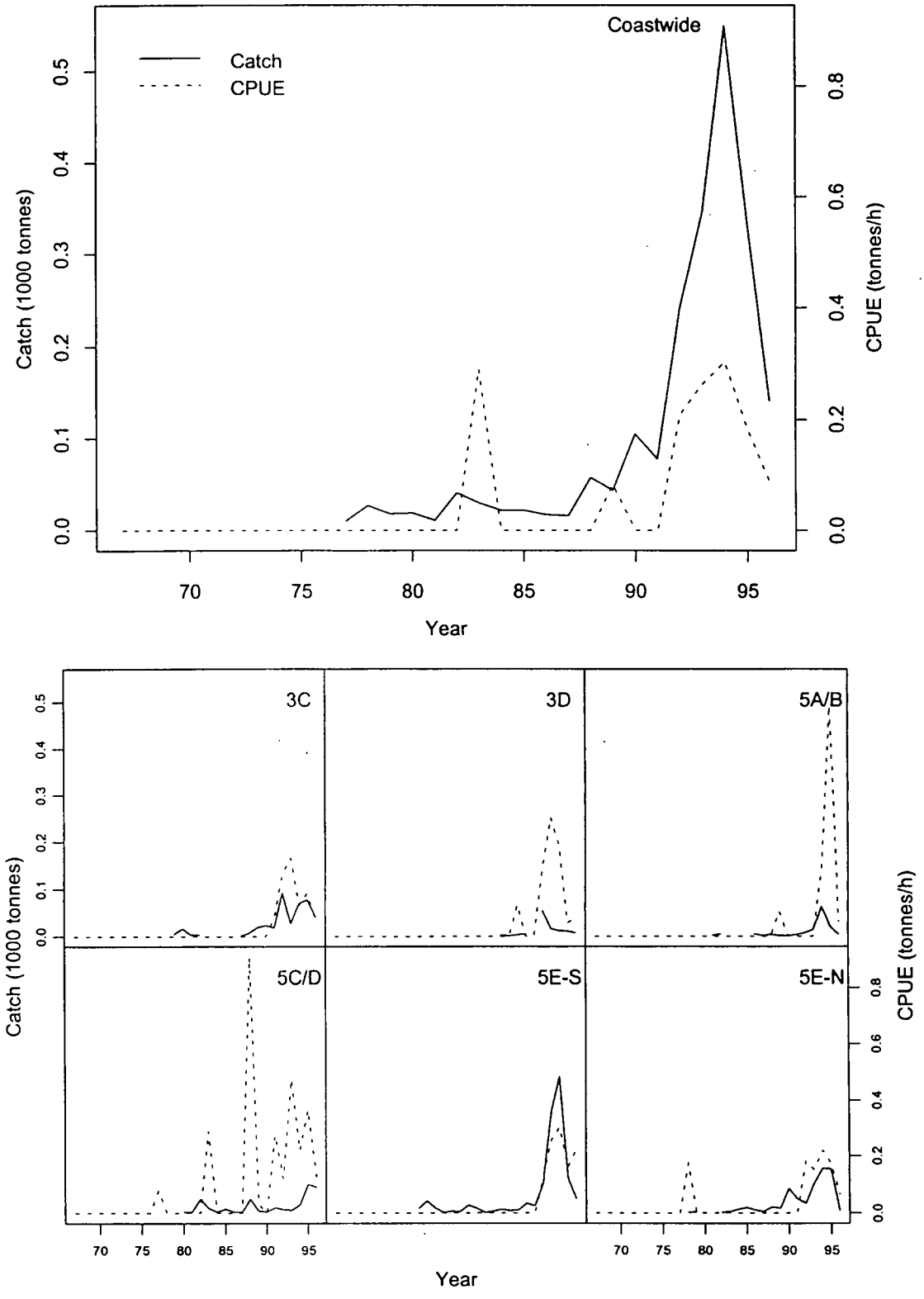


Figure 3.5. Canadian trawl catch and CPUE for shortraker rockfish coastwide and by major statistical area.

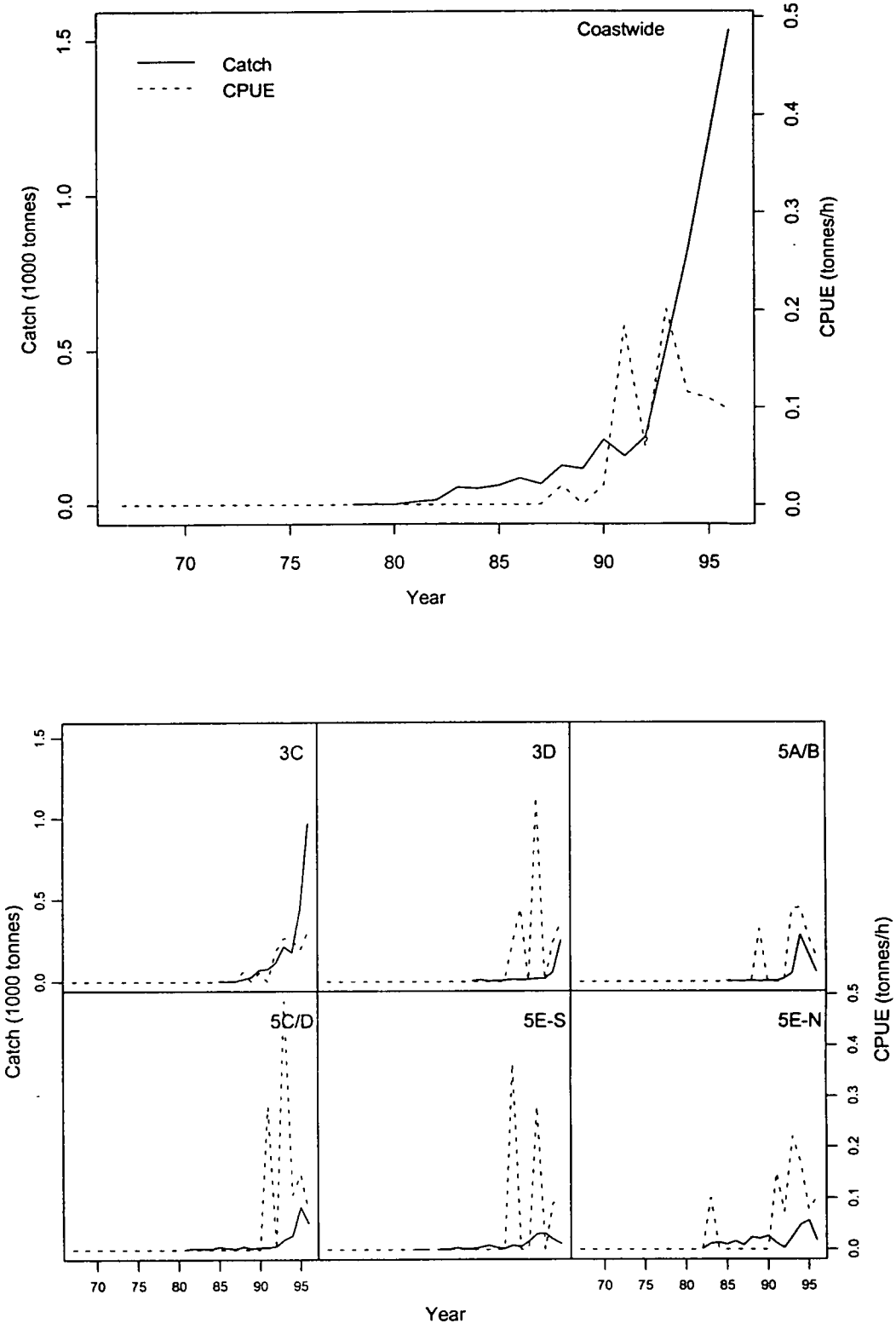
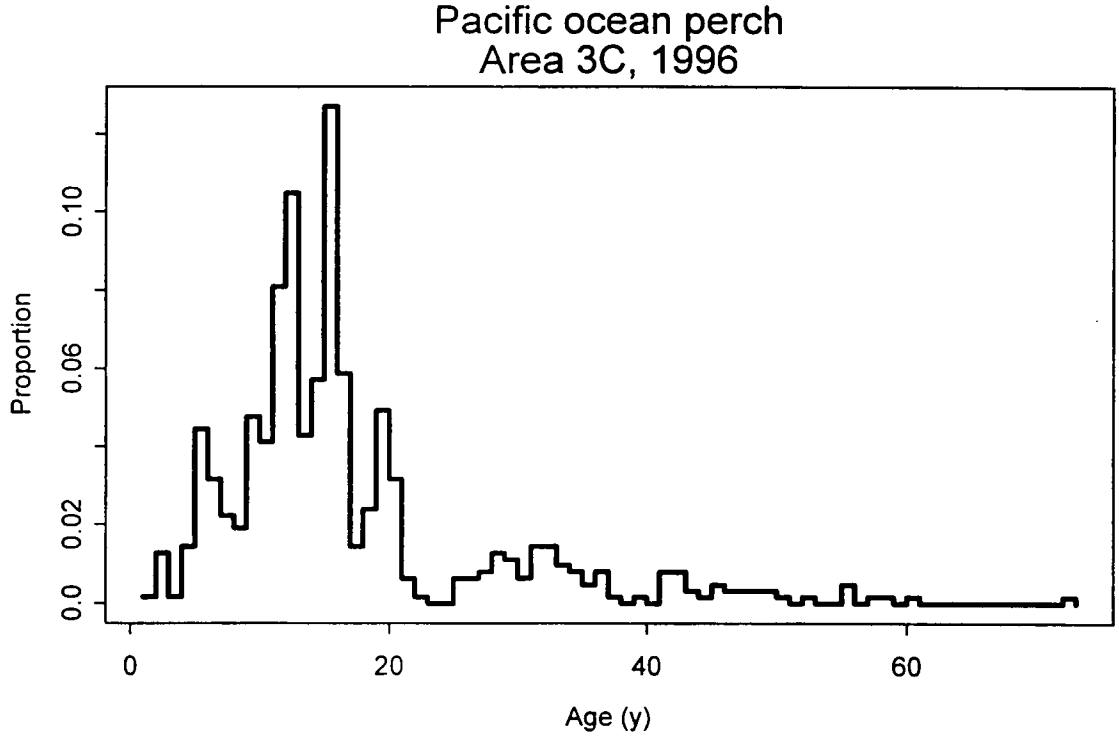


Figure 3.6. Canadian trawl catch and CPUE for longspine and shortspine thornyhead coastwide and by major statistical area.



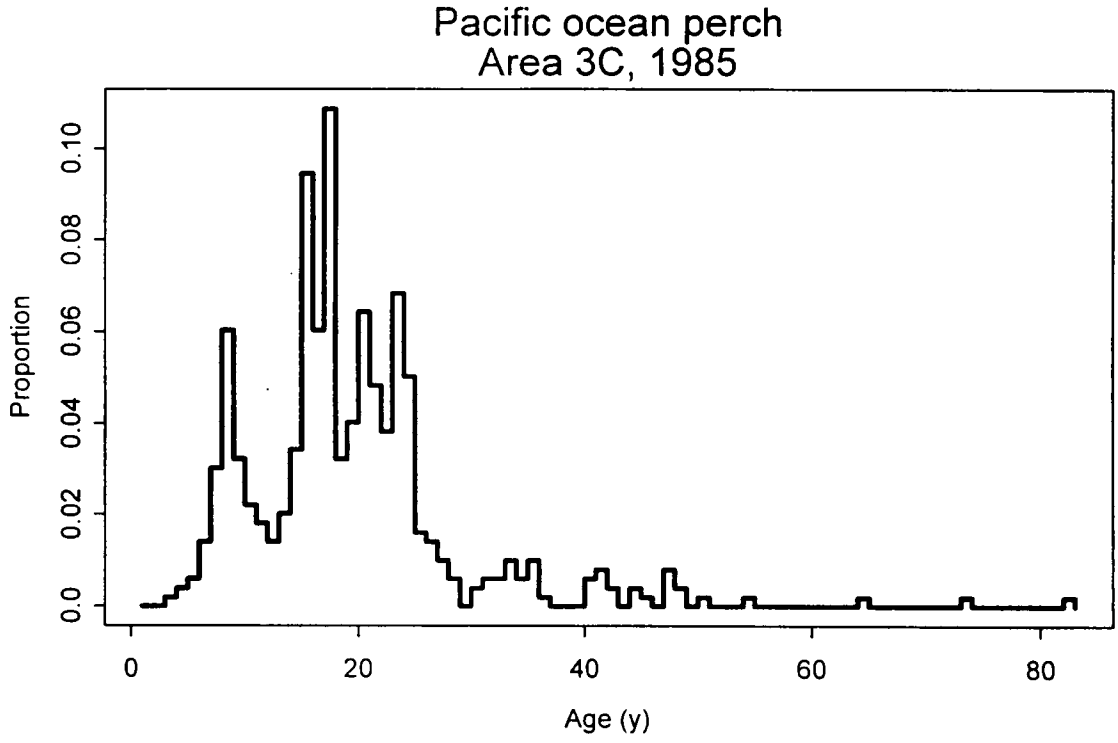


Figure 4.1. Age proportions of Pacific ocean perch sampled on biomass surveys conducted off the west coast of Vancouver Island in 1985 and 1996.

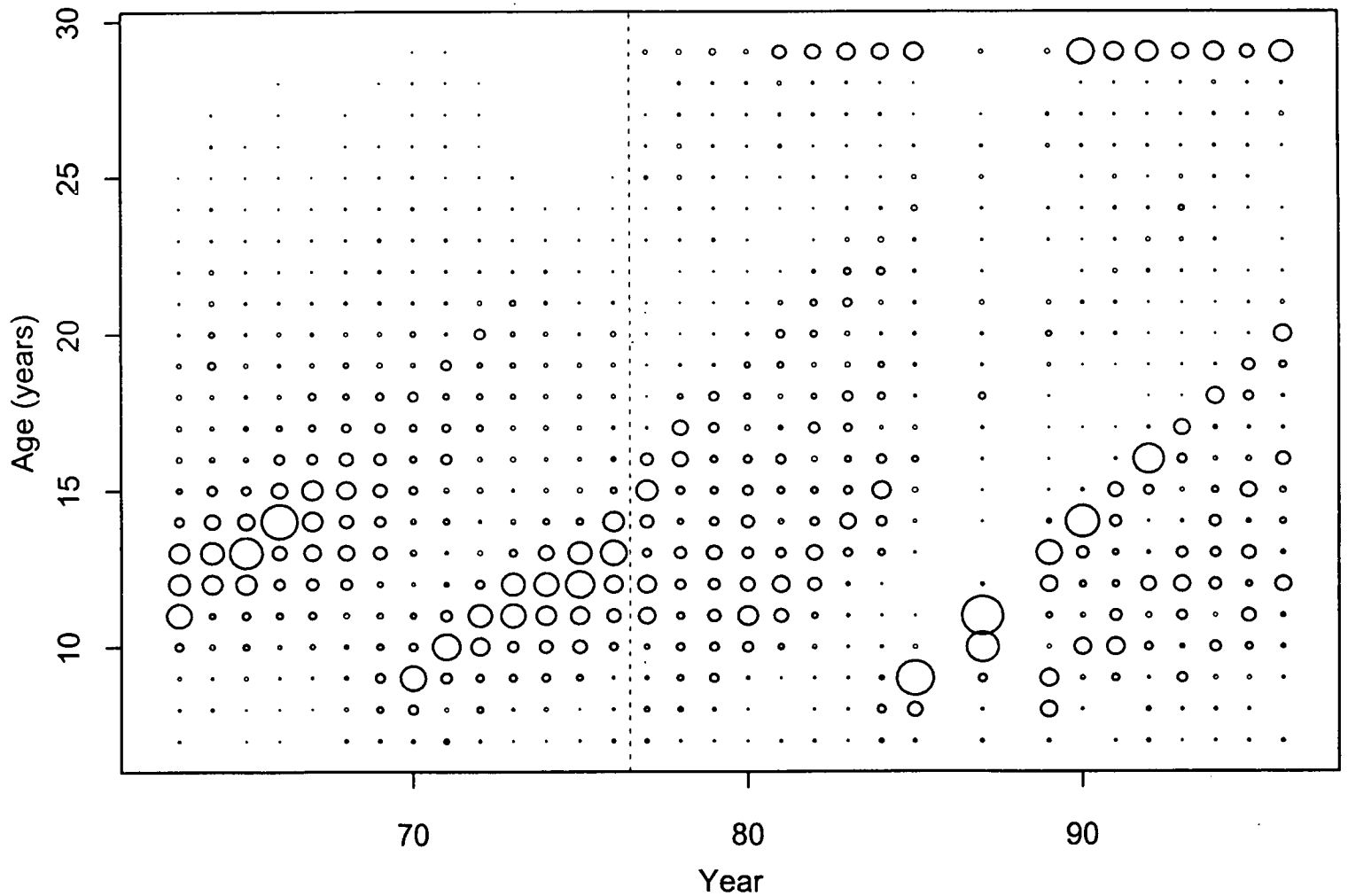


Figure 4.2. Proportion at age for Goose Island Gully. Early data (1963-76) are from surface readings of otoliths, while later data are from break-and-burn readings. The radius of each circle is proportional to the observed proportion at age, where the data are scaled to sum to 1 for each column, and data are grouped for ages 29 and older. No data are available for 1986 or 1988.

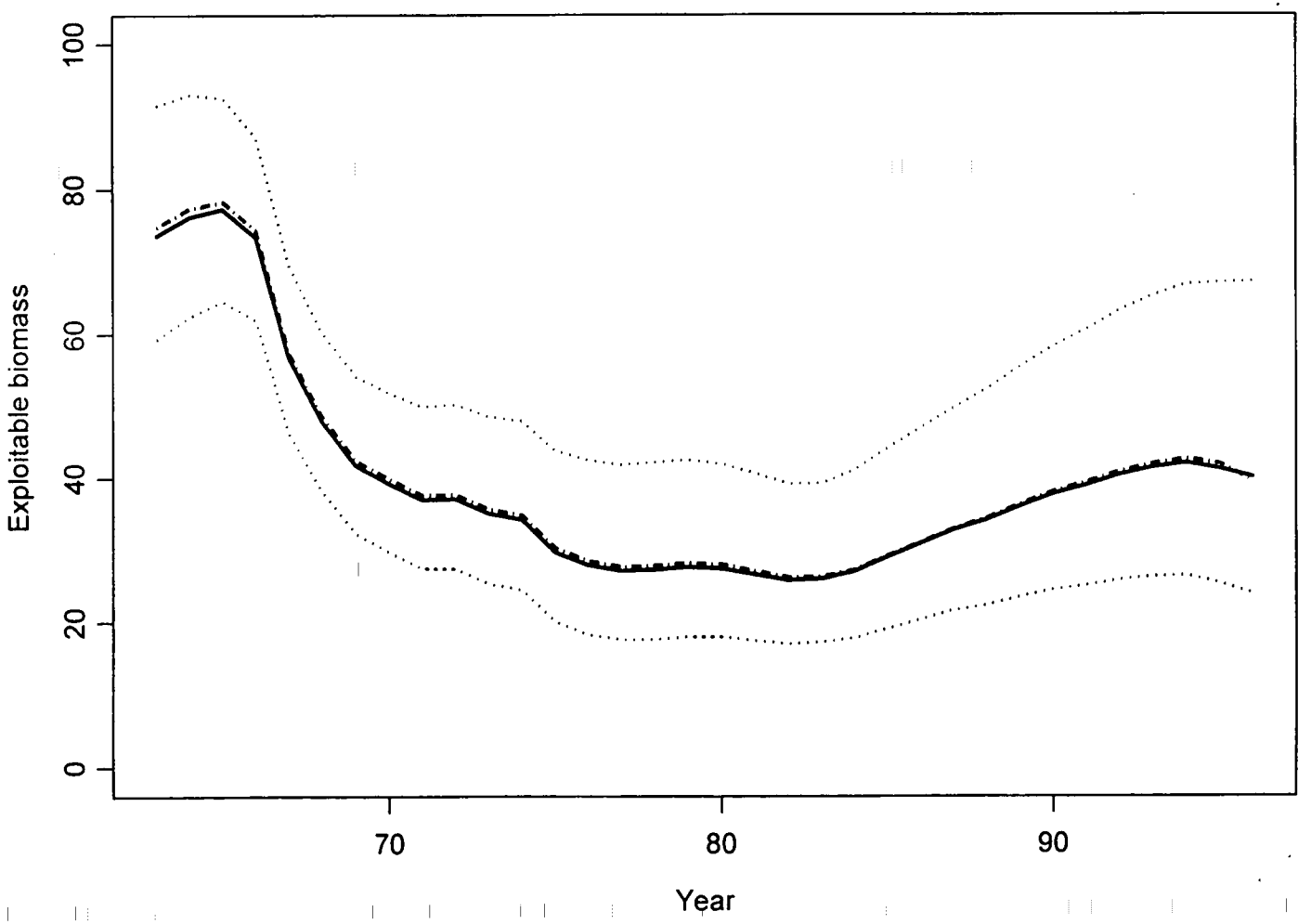


Figure 4.3. Exploitable biomass trajectory and 95% confidence interval estimated from model runs. The center dashed line shows the results of the model run presented in Richards and Olsen (1996).

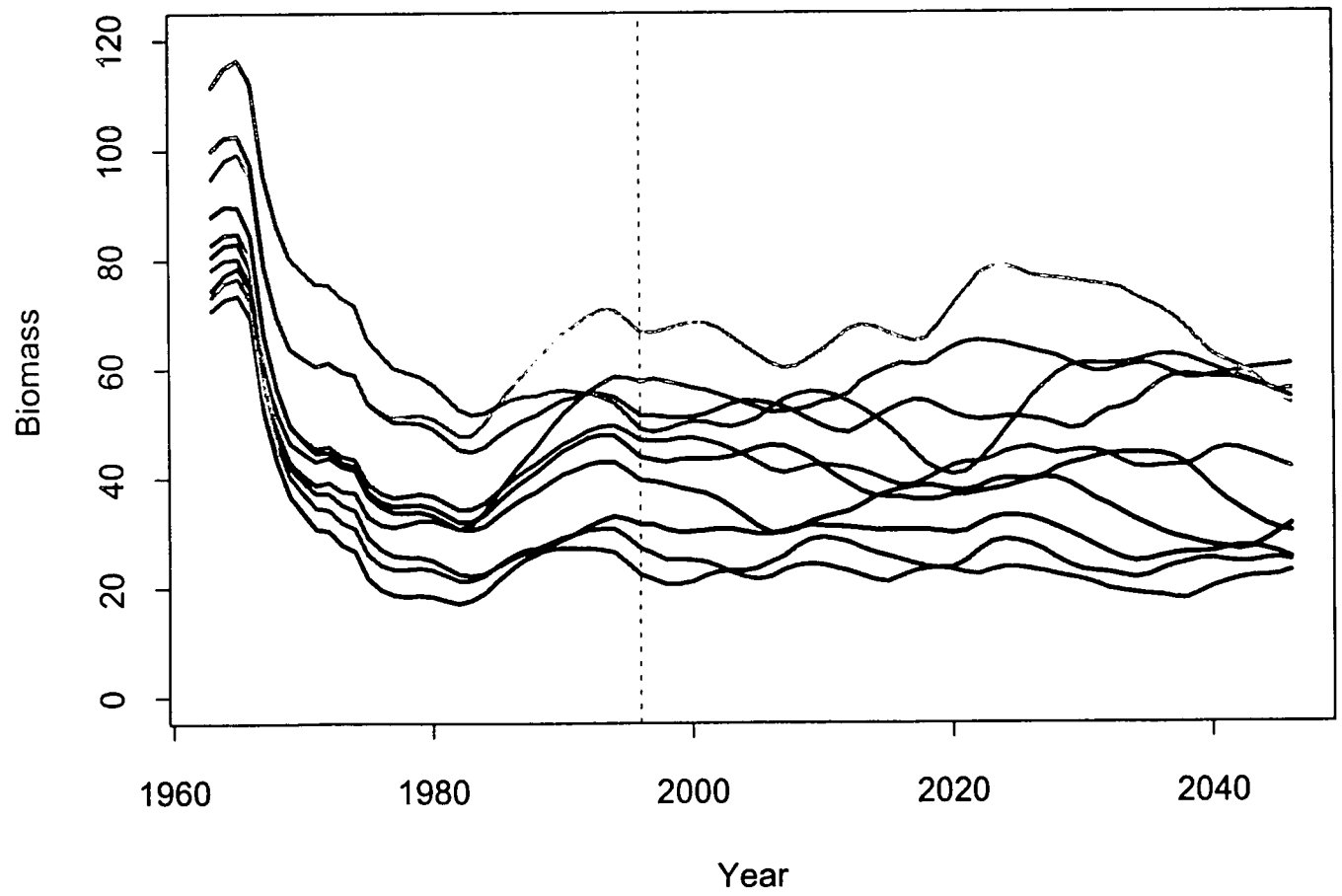


Figure 4.4. Ten sample trajectories of stock biomass (1000 tonnes) from model reconstructions and forward projections under a catch policy of 2,000 tonnes. The vertical line identifies the final year of reconstruction.

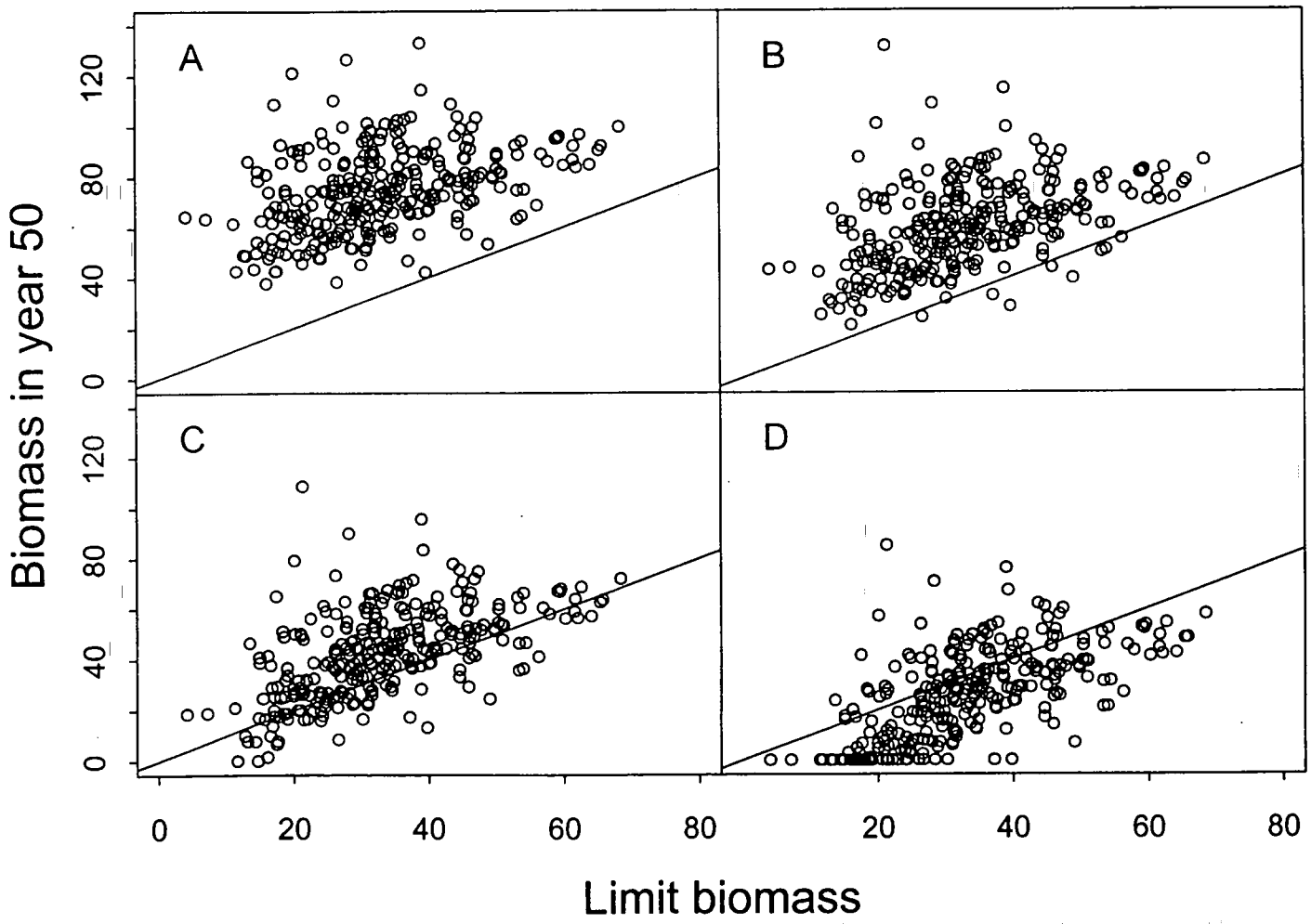


Figure 4.5. Projected biomass in year 50 (1000 tonnes) in relation to historical estimates of 1977 biomass under catch policies of (A) no fishing, (B) 1,000 tonnes, (C) 2,000 tonnes, and (D) 3,000 tonnes. The solid line identifies the condition where biomass in year 50 equals the estimated 1977 biomass.