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Analysis of longline logbook data for the west coast  
Vancouver Island yelloweye rockfish fishery

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## Abstract

Logbook data from the West Coast of Vancouver Island management region (statistical areas 11, 21 - 27, 111, 121 - 127) longline fishery from 1986 to 1996 are described and trends in catch and effort data are discussed. Logbook catch and effort data are recorded on a finer scale than similar data on fish slips. The relationship between catch per unit of effort indices and fish abundance, is unknown for inshore rockfish. Fishing patterns over the time series have changed with decreasing proportions of yelloweye rockfish in the catch, an expanded range of mean fishing depths and decreases in soak time and number of hooks fished. Some of these changes can be explained by a shift away from fishing yelloweye rockfish to fishing other rockfish species including quillback, redbanded and rougheyeye rockfish. This shift in fishing may have resulted directly from factors external to the actual fishing activity, such as, changes in the management of the fishery or market demand. Logbook data are preliminary as only half of the records are keypunched for the 1989 to 1992 period. In general, yelloweye rockfish catch (kilograms) per unit of effort (soak time in hours) (CPUE) is declining and quillback and redbanded rockfish CPUEs are increasing. Further analyses for the West Coast of Vancouver Island and other management regions of the coast are pending.

## Résumé

Les données des registres de la pêche à la palangre de la région de gestion de la côte ouest de l'île de Vancouver (zones statistiques 11, 21-27, 111, 121-127) sont décrites pour de 1986 à 1996 et l'on traite des tendances des prises et de l'effort. Les données sur les prises et l'effort des registres sont notées à une échelle plus fine que sur les bordereaux de vente. La relation entre l'indice des prises par unité d'effort et l'abondance du poisson n'est pas connue pour le sébaste côtier. L'allure de la pêche en fonction du temps a changé et l'on note une baisse de la proportion de sébaste aux yeux jaunes au sein des captures, un accroissement de la profondeur de pêche moyenne et une diminution du temps de mouillage et du nombre d'hameçons utilisés. Certains de ces changements peuvent être expliqués par un déplacement de la pêche du sébaste aux yeux jaunes vers celle d'autres sébastes, comme les sébastes à dos épineux, à bandes rouges ou à oeil épineux. Ce déplacement peut s'expliquer par des facteurs extérieurs à la pêche même, comme une modification de la gestion des pêches ou des marchés. Les données des registres sont préliminaires car seulement la moitié des données ont été saisies pour la période de 1989 à 1992. De façon générale, les captures de sébaste aux yeux jaunes (kilogrammes) par unité d'effort (temps de mouillage en heures), ou PUE, sont à la baisse et celles des sébastes à dos épineux ou à bandes rouges sont à la hausse. Il sera procédé à d'autres analyses des pêches de la côte ouest de l'île de Vancouver et d'autres régions de gestion de la côte.

## Introduction

From the inception of the Zn hook and line rockfish fishery logbook records have been a licence requirement. Until recently these records have not been available for stock assessment purposes. Changes in the way information is collected from the fishery has resulted in a new focus on using logbook data for stock assessment. Fish slips, which provided basic catch and effort data in the past, are no longer available for the Zn fishery. Logbooks are currently the only source of location-specific catch and effort data. Catch and effort data from logbooks are identified in greater detail than similar data on fish slips. Thus, using fishery trends determined from logbook data for stock assessment purposes should be an improvement from previous analyses. This paper is a preliminary look at the logbook data for the yelloweye rockfish (*S. ruberrimus*) longline fishery in the west coast Vancouver Island management region (statistical areas 11, 21 - 27 and 111 and 121 - 127).

The structure of the logbook data is described with an emphasis on the advantages of this data over fish slip data. The fishery is described by the data trends in the logbook records. Catch per unit of effort indices are estimated by statistical area over the 1986 to 1996 data series. A discussion of CPUE trends, influences affecting those trends, future directions for logbook analyses and recommendations for additional work are detailed.

A similar paper is presented for PSARC review on the Zn rockfish fishery in the Strait of Georgia (Kronlund and Yamanaka 1998.). Both papers result from preliminary analyses of the Strait of Georgia handline fishery (Haigh and Richards in prep.) and represent the first steps in analyses planned for logbook data coastwide.

### 1. Background

Past inshore rockfish stock assessments have relied on fish slip data to determine catch and estimate catch per unit effort trends (Yamanaka and Kronlund 1997). Two major problems with the fish slip data were that they did not capture weight information by species for rockfish prior to 1995 (i.e. yelloweye rockfish were rolled up with other red rockfish into a 'red snapper' category and all other species of rockfish were rolled up into a 'other rockfish' category) and the area fished was estimated for the entire catch on a trip basis. These problems with the fish slip data together with changes in the management of the fishery led to the elimination of the fish slip requirement for the Zn fishery in 1996.

Changes in fishery management included enforcing the submission of complete logbook records within a week of landing and the initiation of a mandatory dockside monitoring program. Catch by species for every Zn landing is now obtained from the dockside monitoring program. On the logbooks, catch is identified by species and set. Sets are identified by location and sets are described by soak times and numbers of hooks. Catch weights by species is an improvement over the grouped rockfish categories on the fish slips. The improvement in measures of fishing location and fishing effort are enormous. Details of data fields contained in the Zn logbooks, commercial fish slips, dockside monitoring program are in Appendix A. The overall vision is for an integrated database that would receive outputs from the dockside monitoring and logbook programs,

merge and resolve species catch by location and output data for use by management and stock assessment. To date the fish slip information has been replaced by dockside monitoring and logbook data. However, the link between these two data sources is not yet in place.

## 2. History of Logbooks in the Zn fishery

Since the institution of the hook and line rockfish licence category Zn, in 1986, there has been a mandatory logbook program (Hand et al. 1990). Zn licences were not issued by Fisheries and Oceans Canada (DFO) without the receipt of logbook records for the previous year of fishing. Initially, logbook records were sent directly to the Pacific Biological Station (PBS)(1986-88) where records were keypunched into a data file on the VAX system. When licences were renewed from year to year, messages were sent to licencing from PBS stating whether a logbook had or had not been received from a particular fisher. This was simply an indication of presence or absence of a log record. In 1989, logbooks were turned over to DFO Offshore Division where they were collected and used for licensing as well as enforcement purposes. Through the years, the requirements for filling out and submitting logbook records became increasingly stringent.

In 1994, an industry funded logbook program was initiated. All Zn fishers are required to purchase specific logbooks and submit the completed records within a week of landing any catch under a Zn licence. The cost of the logbook includes a fee for keypunching the records and processing the data. Fishers submit logbook records at the time of offloading to the port monitor or directly to the contractor (J. O. Thomas and Associates) for keypunching. Logbook records that are not properly filled out are then forwarded to DFO Groundfish Management Unit. DFO notifies fishers to correct or complete their logbooks and resubmit them. After keypunching the logbook records are sent electronically to the Pacific Biological Station as ASCII text files. Currently the logbook data reside in a Microsoft Access database (Haigh and Richards 1997).

The logbook has changed with the addition of more data fields over time (Haigh and Richards 1997). Changes to the recording of catch include using a piece count from 1986 to 1988, using round weights from 1989 to 1993 and using a piece count by set and total round weight estimate by trip from 1993 to 1996. Changes to the recording of effort include using the number of total hooks fished per set from 1986 to 1988 and 1994 to 1996 and using the number of hooks per skate and the number of skates fished per set from 1989 to 1993 for longline gear.

In 1997, logbook records for the 1989 to 1992 period were shipped back to PBS where pages were sorted and sent out for keypunching. To date, all logbook records for the Strait of Georgia management region are keypunched. For the west coast of Vancouver Island management region, less than half of the records are keypunched and work is progressing on the remaining records. As funds become available, logbook records from the remaining regions outside of the Strait of Georgia will be keypunched.

### 3. Logbook data used in the analyses

Records included in this working paper are from the West Coast Vancouver Island (WCVI) management region which includes statistical areas 11, 111, 21 to 27 and 121 to 127. Logbook records for the years 1986 to 1988 and 1993 to 1996 are complete and records for the intervening years 1989 to 1992 represent less than half the data available. Key punching of the remaining records is ongoing.

All data records were extracted from the database (Haigh and Richards 1997) for WCVI statistical areas and for longline gear (52,164 records). Records containing data for rockfish species comprise 79% of all records. These rockfish records were further selected if the target species was identified as rockfish or was left blank. Records were dropped from the analysis if the target species was identified non-rockfish (e.g. halibut, dogfish, salmon). The targetted rockfish (or blank) records are referred to as rockfish sets (36,988 records).

The catch was recorded in pieces for some years and in weight for others. Because of this inconsistency, weight estimates were made and assigned by species to standardize catch. We estimated a median weight by species using 1995 and 1996 WCVI logbook data. Where both weights and pieces were recorded, a piece weight was estimated. Then the median piece weight by species was used to determine weights from pieces for all previous years in the data where pieces were recorded and weight was missing.

For some analyses, records were selected for directed rockfish fishing and are referred to as directed rockfish sets. This was determined by first estimating by set, the species of fish that made up the highest weight proportion of the catch. All sets, in which a rockfish species (*Sebastes*) comprised the highest proportion of the catch, were then selected from the data. From these rockfish sets, if the target species was identified as a non-Zn species, ie. halibut or dogfish, these records were removed from the data. Yelloweye rockfish records were further extracted from this data and used in analyses (9,135 records).

For the catch per unit of effort analyses, all records were filtered for data where fishing time was less than 24 hours and the number of total hooks fished was less than 5000. Data records which fell outside of these criteria contained information that was lumped somehow over sets, days or even trips. No distinction is made between statistical areas inside or outside the surpline. Therefore, outside statistical areas 111, 121 to 127 are grouped with inside statistical areas 11, 21 to 27, respectively.

### 4. Comparison of the logbook and fish slip data

The move to replace fish slips with logbooks for catch and effort data from the Zn fishery follows the assumption that the information recorded on logbooks is an improvement over the information contained on fish slips. In general this is true, however, there are a few important points that should be mentioned.

1. There are numerous missing data fields in logbook records.
2. The accuracy of logbook data records is unknown.
3. There are missing logbooks.
4. Logbooks only provide information from the Zn hook and line rockfish fishery.
5. Prior to analyses, intensive processing of the logbook data is required.

A high proportion of the logbook data is missing one or more data fields. This causes a whole suite of problems from data handling to analysis. At least fish slip data fields were complete. In addition to this, the fish slip was checked for accuracy by the fisher as this was usually the final settlement for his fish. We have no easy way to check the accuracy of the data on logbooks. Apart from the unkeypunched logbook data records for the years 1989 to 1992, there are very few records for the years 1986 to 1988. This problem is due to the catch of rockfish in other line fisheries where there is no Zn logbook requirement. In the early years, more rockfish were taken in other non-Zn fisheries (Yamanaka and Richards 1992). Fish slips prior to 1996 accounted for all commercial hook and line rockfish catch. The logbook database is currently maintained in a temporary database by Stock Assessment Division staff. Consequently, data input and quality control are performed by the assessment biologists, rather than by the Catch Statistics Unit of DFO, as was the case for fish slip data. This situation has the advantage that logbooks could eventually be examined shortly after receipt, but at the cost of considerable time spent processing data.

#### 4.1 Catch and Effort

Catch by species was not available on the fish slip records prior to 1994. Fish slips recorded rockfish under three species categories; Pacific ocean perch (*Sebastes alutus*), reedi (*S. reedi*) greenies (*S. flavidus*), and two combined species categories; red snapper and other rockfish. All red rockfish were recorded under the category 'red snapper' and all other rockfish species were recorded under the category 'other rockfish'. Catch on logbooks is identified by species. In all years, yelloweye rockfish is the predominant rockfish species recorded. The number of rockfish species recorded on the logbooks has increased from a low of eight in 1986 to a high of 24 in 1995. The primary species caught in the Zn fishery are shown in Figure 1.

Less catch is reported on logbooks than fish slips for both yelloweye rockfish and other rockfish species. This is expected as fish slips report on catch in all commercial hook and line fisheries, including the Zn fishery. The total catch and effort for red snapper from fish slips and for yelloweye rockfish from logbooks for the west coast Vancouver Island (statistical areas 11, 111, 21 - 27 and 121 - 127 combined) are shown in Figure 2. Similar data for other rockfish from fish slips and all other rockfish species, except yelloweye rockfish, are shown in Figure 3. Large discrepancies, 200 t for yelloweye rockfish and 100 t for other rockfish species combined are evident in years prior to 1993 (1989 to 1992 missing data) but this improves between 1994 and 1996.

Measures of fishing effort from the logbook data reflect the trends in catch better than effort from the fish slips (Figures 2 and 3). In the logbook, fishing effort is recorded as the time the fishing gear is in the water and is referred to as soak time in hours. Additional fishing effort is recorded as the total number of hooks fished. The fish slip data reported the fishing days for a trip as

fishing effort. For the longline fishery, effort measured in hours soaked better reflects the time spent engaged in fishing than the number of days fished for a trip.

#### 4.2 Catch by statistical area

Figure 4 shows the fish slip and logbook data for red snapper and yelloweye rockfish, respectively, by statistical area. Disparity between these data can be explained by a problem in recording area fished on the fish slips. When only one area is fished over an entire fishing trip, the area fished recorded on the fish slips is accurate. However, once two or more areas are fished in a single trip, the total trip catch is apportioned equally among all areas. In the logbook data, the area fished is recorded for all catch by string of gear fished. In statistical area 27, for 1993, more yelloweye rockfish is reported on logbooks than fish slips and the reverse is true for statistical area 11. Fish slip records for 1995 and 1996 are not complete. Determining statistical area fished from logbooks is a large improvement over the fish slip data. Logbooks also provide finer resolution in later years (1989 to present) by recording vessel position in latitude and longitude or LORAN bearings.

### 5. Description of the fishery

Longline fisheries have an extensive history on this coast. Early fisheries deploying longline gear were in pursuit of halibut, dogfish and lingcod. From the beginning, rockfish were caught incidentally in these other fisheries. When rockfish values increased, a directed rockfish fishery developed. On the west coast of Vancouver Island, the total catch of rockfish fluctuated between 25 and 150 t between 1956 and 1985 (Yamanaka and Kronlund 1997). With the introduction of the Zn licence for the hook and line rockfish fishery in 1986, rockfish catch increased to almost 580 t.

Figure 5 gives an account of the rockfish longline fishery on the west coast of Vancouver Island between 1986 and 1996 from Zn logbook records. Panel 1 shows the number of longline vessels reporting catch on logbooks. The number of vessels increased from 37 in 1986 to a high of 81 vessels in 1996. About 60 vessels were active in the fishery between 1987 and 1994 (missing data for 1989 to 1992). Limited entry, in 1993, was not effective in reducing fishing effort, for this region, in terms of vessels, from previous years. After limited entry an increase in the number of vessels participating in the fishery is apparent. Panel 2 shows that the total number of fishing sets increased from 442 in 1986 to a high of 2726 in 1993. In 1996, the number of sets decreased by about one third of the 1993 level. Panel 3 shows the total catch of yelloweye rockfish and the combined catch of quillback, redbanded and rougheye rockfish. The rockfish longline fishery on the WCVI has primarily been a fishery for yelloweye rockfish. Yelloweye rockfish accounts for almost all of the longline rockfish catch from 1986 to 1992. A change is evident in 1993 with a decline in yelloweye rockfish catch and an increase in quillback, redbanded and rougheye rockfish catch. Almost 450 t of yelloweye rockfish was recorded on logbooks in 1993 compared with 160 t in 1996.

At the beginning of the Zn fishery, 30% (11) of the vessels accounted for 80% of the yelloweye rockfish catch (Figure 6). This was equivalent to about 9 t of yelloweye rockfish for these 11 vessels. In 1993, 25% (14) of the vessels caught 80% of the yelloweye rockfish (25t per vessel). Presently, in 1996, the catch is spread more evenly throughout the fleet and 45% (39) of the vessels caught 80% of the yelloweye rockfish (3 t per vessel).

### 5.1 Summary of logbook data by statistical areas

Boxplots are used to summarize the logbook data by year for each statistical area. West coast statistical areas 21 and 22 have very few data points and are excluded from the data represented in this section. Statistical areas are plotted from 27 and 11 at the top of the page to 23 and 24 at the bottom of the page to represent their geographic distribution from north to south. All rockfish records in the database were used in the plots unless otherwise stated. The box represents the quartiles of the data with a black bar representing the median (Cleveland 1993). Whiskers show the extremes of the data with very extreme points shown outside of the brackets. The width of the box is proportional to the number of observations for the box. Statistical areas are referred to as areas.

The proportion of yelloweye rockfish in the directed rockfish sets has declined since about 1991 (Figure 7). Proportions of yelloweye rockfish in the northern areas (27, 11, 26, 25) were generally higher than those in the southern areas (24 and 23) in the first half of the series. In the later half of the series, declines are dramatic in areas 25 to 27. By the end of the series, yelloweye proportions in the catch are between 0.4 and 0.5 throughout all areas. These declines in proportions of yelloweye rockfish in the catch, in years since 1993 are probably due to an expansion of the fishery into other rockfish species. What was once a yelloweye rockfish fishery is now a mixed rockfish fishery.

Mean fishing depths were estimated as the mean of the minimum and maximum depths fished. Mean fishing depths have decreased in later years in all areas except 27 (Figure 8). Fishing depths in areas 27 and 26 are around 100 m and in all other areas is notably shallower at 50 m. The range of fishing depths has increased in recent years in areas 25 to 27 and can be explained by the change in fishing for rockfish species other than yelloweye. Quillback rockfish are generally shallower than yelloweye rockfish and redbanded rockfish are generally deeper.

Measures of fishing effort in terms of soak time in hours and number of hooks fished are shown in Figures 9 and 10, respectively. Soak time and the number of hooks are related in that it takes more time to fish more hooks. Therefore, when the number of hooks is high, by default soak times are longer.

Soak time has decreased in recent years compared to the early fishery (1986 to 1988) in all areas except 23. Soak times used to be 8 to 12 hours but are now closer to 4 hours, except in areas 11 and 23 where soak times averaged about 10 hours in 1996. There is no clear trend in the total number of hooks fished over time. In recent years the median number of hooks fished per set is about 800, with the exception of areas 11 and 23 where the median number of hooks fished is between 1000 and 2000. It appears that the area 11 and 23 fishery has changed in different ways



from areas 24 to 27. More hooks and longer soak times in areas 11 and 23 is the trend, whereas in the other areas, in general, less hooks are used and shorter soak times.

Yelloweye rockfish catch per hour of soak time (CPUE) by month for all years is shown in Figure 11. Cycles of increasing and decreasing CPUE are seen in all areas. In the southern areas 23 and 24, CPUE is high in January, February and July, August and low in March to May and September to December. In the northern areas, CPUE is low in May to June and high in September and October. These seasonal cycles are likely linked to the reproductive cycle of yelloweye rockfish. Months of parturation for rockfish vary by latitude. Reports for yelloweye rockfish show the months of April to June for North-Central California and June to August for the Gulf of Alaska (Echeverria 1987).

The time series of yelloweye rockfish CPUE is shown in Figure 12. Similar time series for quillback rockfish and redbanded rockfish are shown in Figures 13 and 14. There is a general trend of lower yelloweye CPUE in the fishery in later years. This general trend is coincident with a increase in quillback and redbanded CPUE. Declining trends in yelloweye CPUE in areas 11 and 23 since 1992 are coupled with increasing quillback CPUE. In area 24 and 26, there appears to be an increase all three rockfish CPUEs over the series. Area 27 shows a declining trend in yelloweye CPUE since 1989. Redbanded rockfish CPUE increases in area 27 after 1993.

Yelloweye rockfish CPUE tends to be higher in areas 24 to 27 and lower in areas 11 and 23. This is exactly the reverse for quillback rockfish CPUE. Redbanded rockfish tends to be caught at higher rates in areas 24, 26 and 27.

Trends in yelloweye rockfish CPUEs are more pronounced when hooks are incorporated into effort. Yelloweye rockfish catch per hook hour of soak time are shown in Figure 15. Catch rates are highest in areas 24 to 26 and lowest in area 23.

Set locations recorded by latitude and longitude are available over the years 1989 to 1996. For yelloweye, quillback and redbanded rockfish, CPUEs are shown in Figures 16, 17 and 18, respectively. Due to the absence of geo-referenced data in the early years 1986 to 1988 and the lack of complete records for the years 1989 to 1992 analyses here are incomplete. The increase in CPUE for quillback and redbanded rockfish are apparent over time.

## 5.2 Summary of CPUE estimated by vessel

The WCVI rockfish fishery has seen an increase in the number of active vessels in the fishery since the creation of the Zn licence (Figure 5). Individual vessels have contributed to the overall landings of the fishery to varying extents over time (Figure 6). In the early years, few fishers contributed the majority of the landings. The participation of individual vessels in the fishery among years has also been variable. Logbook records for each vessel were grouped by year and estimates of CPUE were determined by vessel and year. All the vessel CPUEs were then used to determine an overall annual CPUE. Using these overall annual vessel CPUEs, time series were constructed.

Mean and median yelloweye rockfish catch per hour of soak time (CPUE) are shown by statistical area in Figure 19. For the years 1989 to 1992 there are missing data. These years are shown as points, in contrast to the lines which show years of complete data. Means are unweighted. CPUEs show declines in mean values in areas 11, 25 and 27, however, median values show declines in area 11 only. Increasing trends are seen in area 23, 24 and 26.

## 6. Discussion

### 6.1 Data problems

Problems with data quality, (mis-reporting, under-reporting or keypunching errors) can not be detected in the data file. Obvious gross errors were flagged and resolved on an individual basis. Overall, the data are unfiltered. What is reported on the logbooks is keypunched in the database. The problem of poor quality in some of the data is diluted to some extent by the quantity of data records.

The data for the incomplete years (1989 to 1992) show some high catch rates and may represent the peak of the 'fishing up' period on the WCVI. This would appear to be the case from fish slip data (Figure 2). The lack of contrast in the data in these preliminary analyses could be a result of missing the period in which the fishery reached its peak and began to decline. Thus, further analyses of the WCVI data will be completed once keypunching is complete.

### 6.2 Problems with interpreting CPUE trends

Catch per unit of effort indices rely on a relationship with fish abundance for interpretation. This relationship between CPUE and inshore rockfish stock abundance is unknown. We assume that this relationship is proportional, however, there are the following elements related to inshore rockfish which challenge this assumption.

#### 6.2.1 Rockfish biology

Yelloweye rockfish, and inshore rockfish in general, are sedentary as adults and are not known to undertake any significant migrations or movement patterns on a statistical area scale. Declines in CPUE indices summarized over entire statistical areas are not likely to result from large scale emigration of fish. That said, inshore rockfish are not likely to venture beyond a very limited area, on the scale of kilometres (Matthews 1990), not statistical areas. This creates a problem when trying to interpret seemingly stable CPUEs over a large statistical area. CPUEs have the potential to remain artificially high over a period when a series of reefs with high rockfish abundance are successively fished.

### 6.2.2 Fishing patterns

Alterations in fishing pattern may cause changes in CPUE that are unrelated to fish abundance. The targetting of fishers on different species of rockfish in the fishery will cause apparent declines in CPUE for one species of rockfish and increases in others.

Changes in fishing effort over time also affect CPUE. Catch as a function of effort (soak time and hooks) may not be constant over time. Other significant changes to fishing effort are not accounted for by measuring soak times and number of hooks. Advances in marine technology have improved the ability of fishers to locate fish and store fishing positions for future use. Hence, catchability is changing over time with unknown influences on CPUE.

### 6.2.3 Fishery management

Trends in the catch and effort indices can not be examined without some regard for the rules used in conducting the fishery. The Zn fishery is heavily influenced by and inextricably linked to the resource management regime. The number of vessels participating in the fishery, the number of fishing events each vessel completes and the type and amount of fish caught in any given year precipitate directly from the rules used to conduct the fishery (Figure 5). These rules have variable affects on the fishery.

For the Zn fishery on the west coast of Vancouver Island, the notable management decisions are as follows:

1. 1986 Introduction of an unlimited Zn licence.
2. 1991 Setting of a total allowable catch (TAC) and quota management.
3. 1993 Limited entry fishery and fishery closure from 1 January to 30 April.
4. 1994 Trip limits implemented for yelloweye and other rockfish.
5. 1995 Introduction of dockside monitoring, species aggregate quotas, fishing options and fishing period catch limits.
6. 1996 Change in species aggregates and monthly fishing period catch limits.

These management tactics were all applied to the fishery to limit catch (1 to 4) and to extend the fishing season (4 to 6). It is debatable whether all these measures have limited the fishery and influenced fishery CPUE indices. Quotas for red snapper and other rockfish were exceeded on the WCVI in all years from 1991 to 1994 (Yamanaka and Kronlund 1997). This argues against significant management influence on the fishery prior to 1994. The drastic reduction in fishing season from 328 days in 1991 to 48 days in 1994, in addition to trip limits, seem to have had the greatest limiting effect on the catch of red snapper. Coincident with the limits on red snapper and the

reduction in red snapper landed, there is an expansion of other rockfish species in the catch. Management tactics have probably had a significant effect on yelloweye rockfish CPUE since 1994.

## 7. Summary

The fishery has changed over time, not only with vessels and fishing patterns, but also with an increase in the species of rockfish making up the catch. These changes in the fishery together with the influences of management actions applied to the fishery create uncertainty when interpreting fishery CPUE indices. However, these points can be made:

1. Changes in the fishery are obvious for areas 11 and 23. Shallower depths fished, longer soak times and increasing catch rates for quillback rockfish probably account for the decreasing catch rates for yelloweye rockfish over the series.
2. No similar changes in depths fished or soak times have taken place in the area 27 fishery. Declines in yelloweye rockfish catch rates are evident from 1989 yet there are no coincident increases in catch rates for other rockfish until 1994. This may be evidence for a decline in yelloweye rockfish in area 27.
3. Interpretations of fishery CPUEs post 1994 can not be attempted without additional data from the dockside monitoring program.

## 8. Recommendations

With the elimination of fish slip data in 1996, the focus for stock assessment has turned to logbook records. Interpreting data from logbook records is an improvement over the data from fish slip records. Catch is identified to species and location fished, and measures of fishing effort better reflect the actual fishing activity. Recommendations for the logbook data are:

1. Development of a permanent database that links logbook data with dockside monitoring data. The completion of such a database would require keypunching of historical logbook data coastwide, with appropriate quality control measures and resolution capabilities similar to that established for the trawl observer and validation data.
2. Continue work with industry to increase compliance with providing logbook data, including a review of mandatory and optional fields.
3. Complete analysis of the WCVI logbook data upon entry of all historic data into the database, with subsequent analyses of the Central Coast, North Coast and Queen Charlotte Islands logbook data. Further analysis should include modeling of the variance components of CPUE measures and determination of whether fishing period trip limits are influencing CPUE. The later objective requires linking the individual's fishing options

and fishing periods housed in the dockside monitoring data with catch and effort data contained in logbooks and the appropriate trip limits imposed by management

For inshore rockfish stock assessment, there is a need to associate apparent declines in CPUE with changes in rockfish population biology that indicate some adverse fishing effect. To this end, in 1997, there were fishing charters which were directed at collecting biological samples of yelloweye and redbanded rockfish from the WCVI and the west coast of the Queen Charlotte Islands(QCI) (Yamanaka and Kronlund 1998.). Two locations were selected in each of the WCVI and QCI areas, one location was described as heavily fished and the other lightly fished. Standardized gear sets were completed in these two locations. Information on catch rates, catch compositions and set locations were collected in addition to biological samples. These types of data may assist in interpreting logbook catch data by verifying catch rates by location, verifying catch compositions, and determining whether there is a change in the rockfish population biology between these two locations. The first step in this research is to determine whether biological characteristics of lightly and heavily exploited stocks can be reliably distinguished through industry sampling programs. Analysis of these data will begin when data become available (early 1998).

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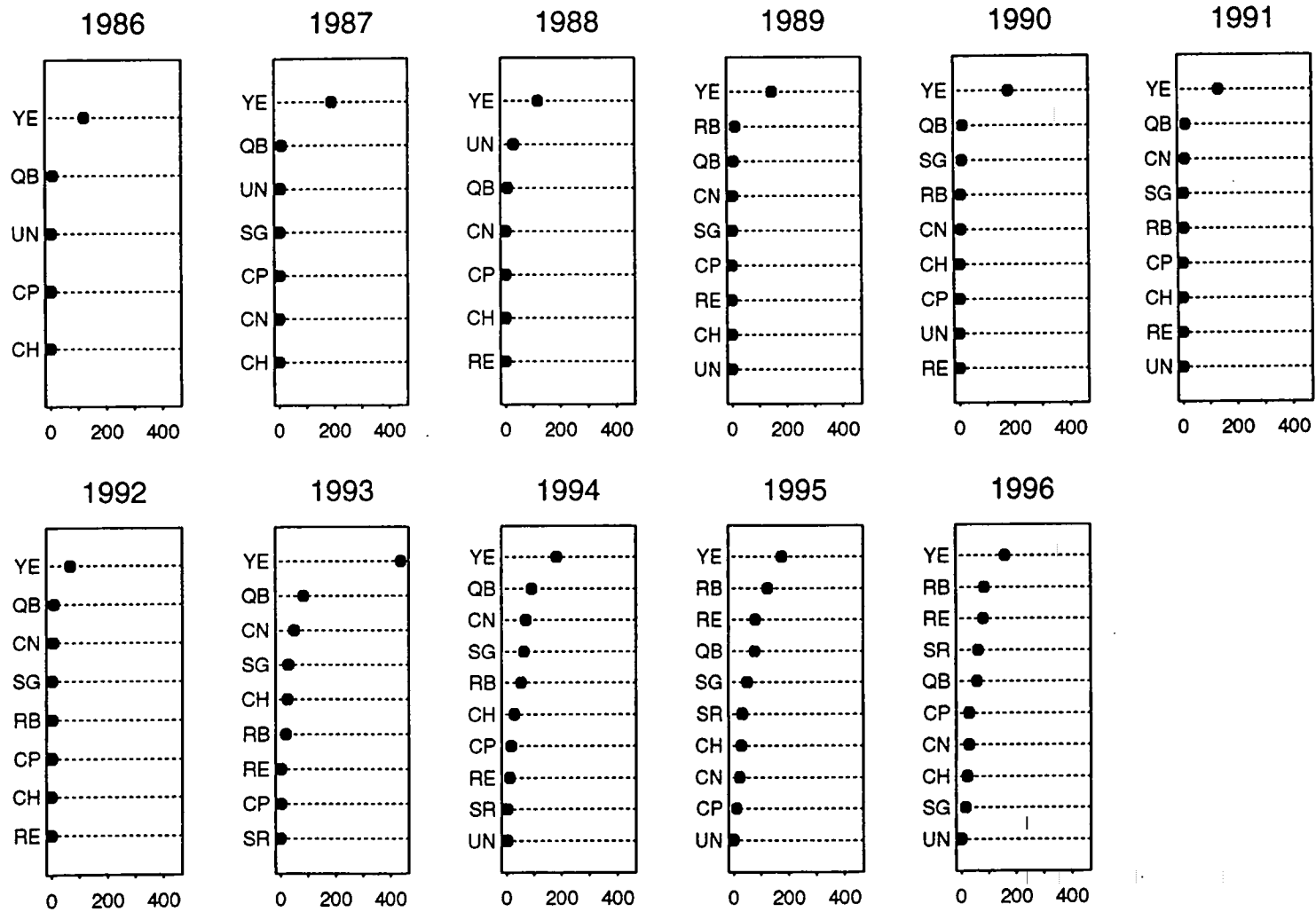


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## yelloweye rockfish WCVI longline

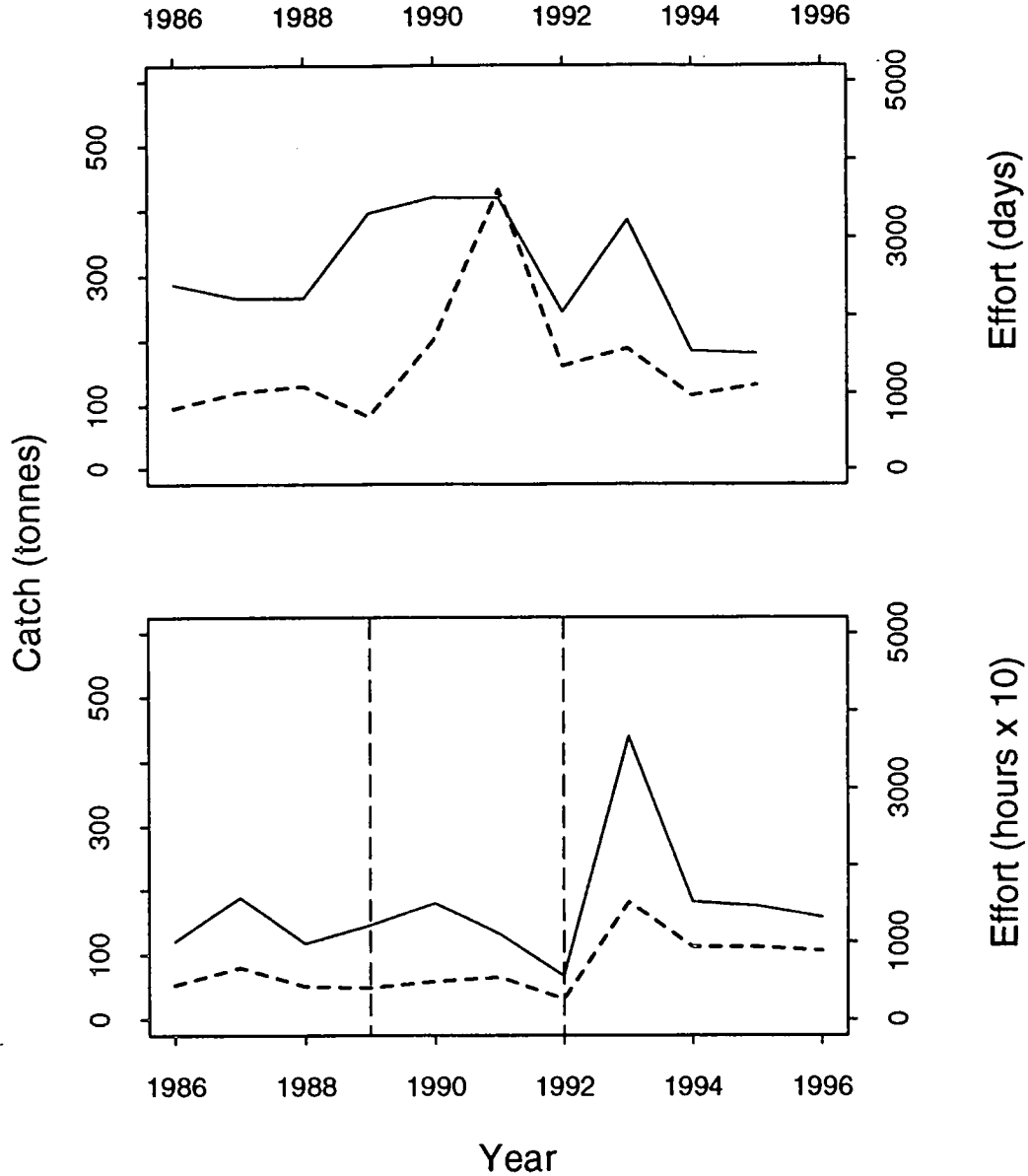


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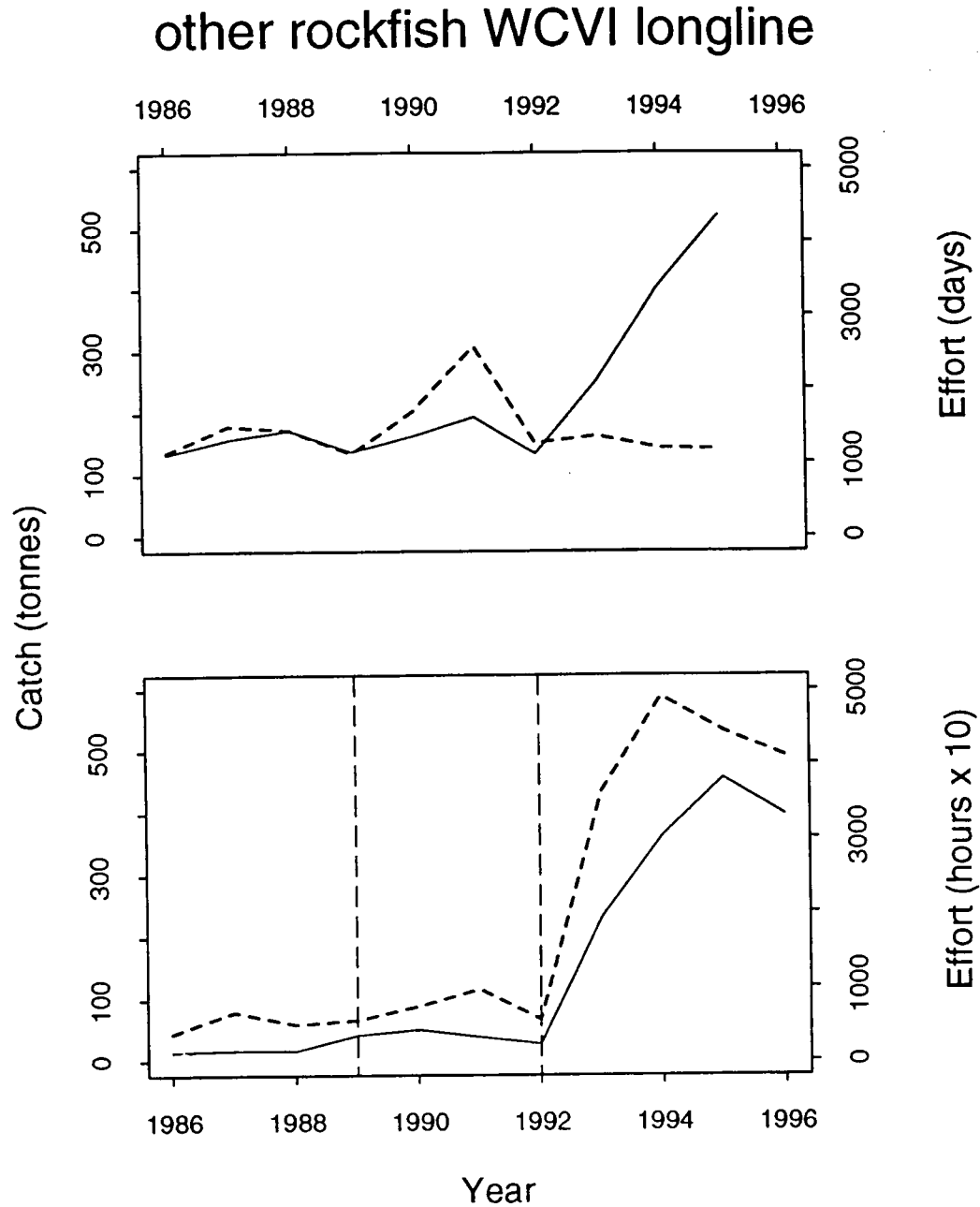


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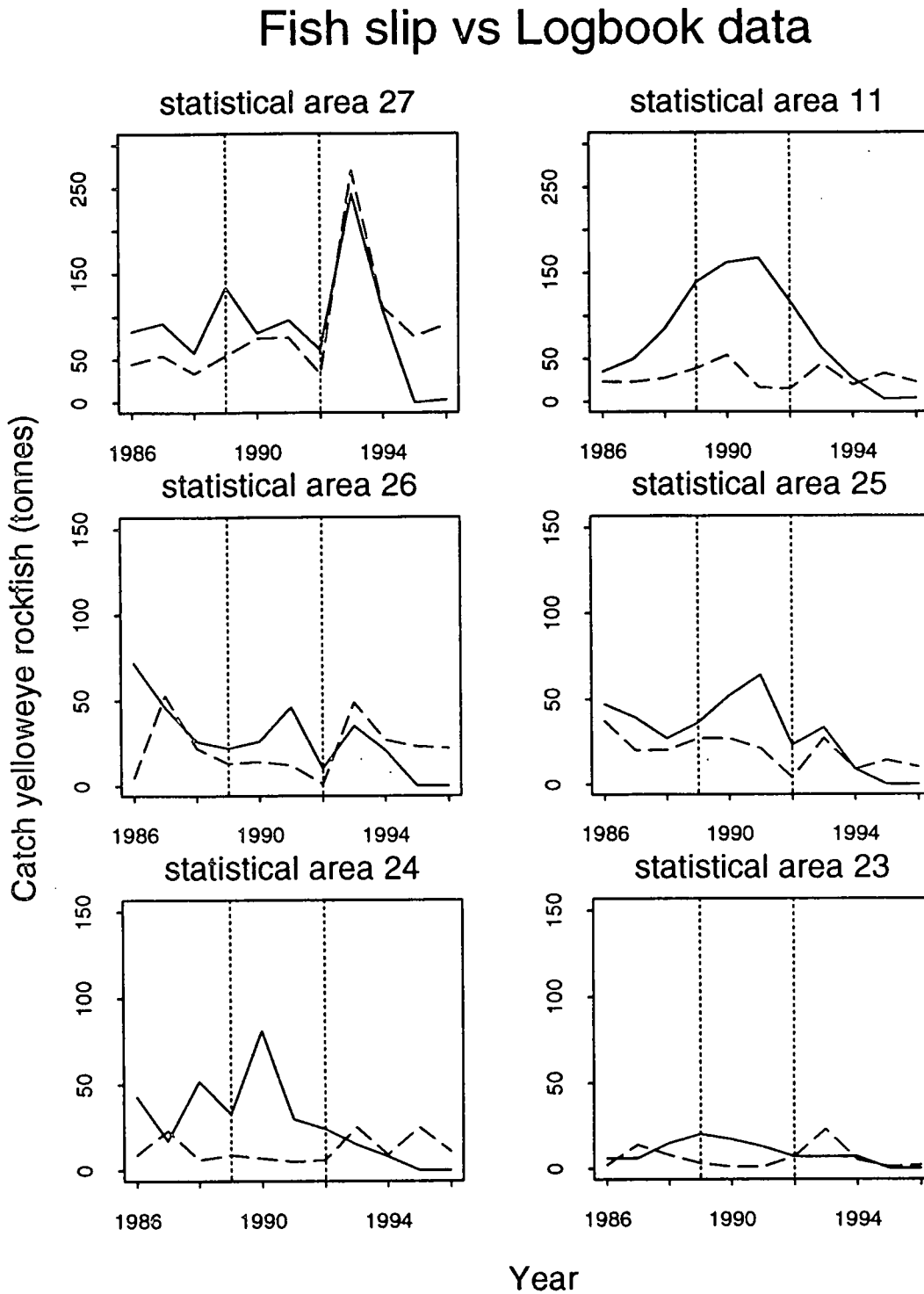


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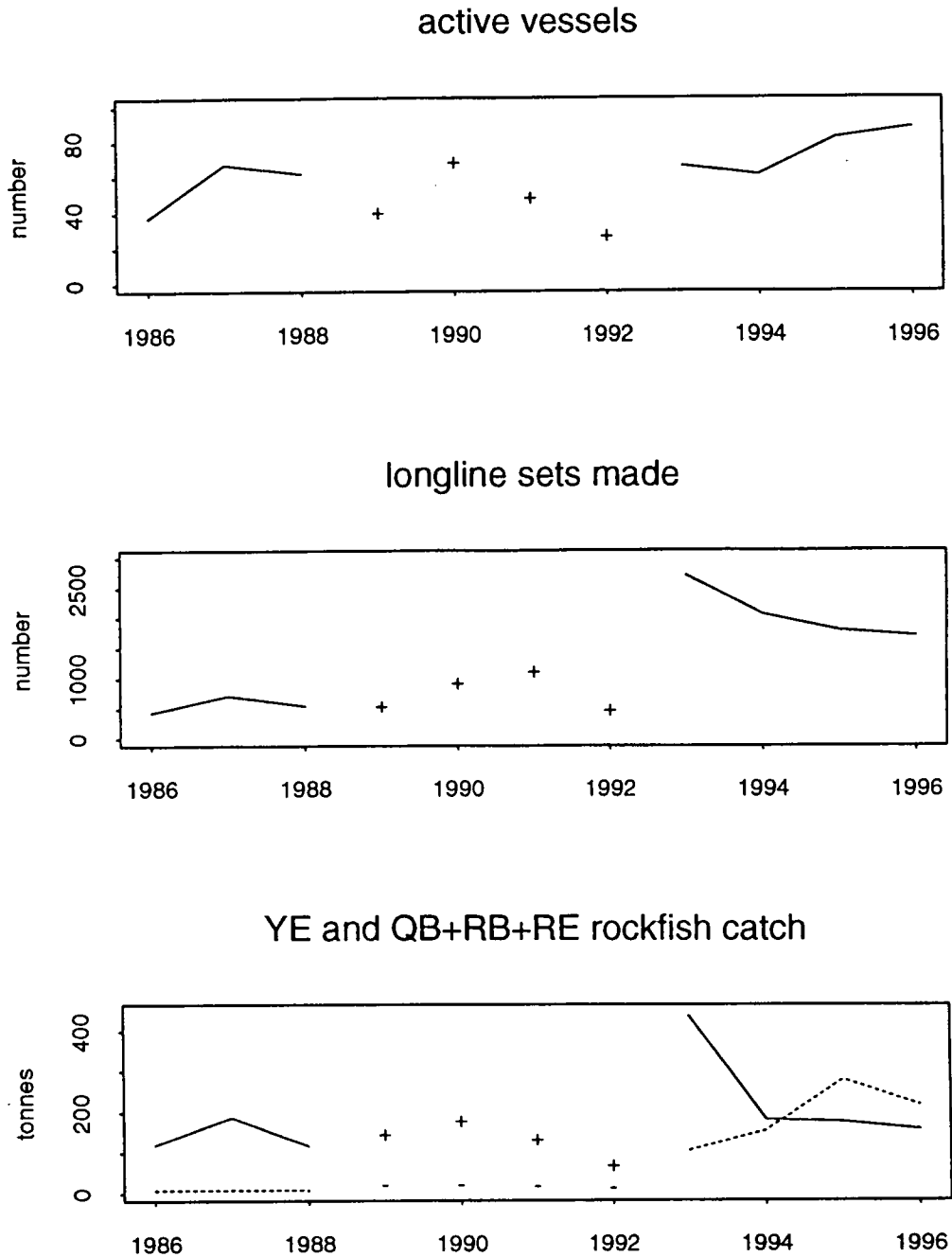


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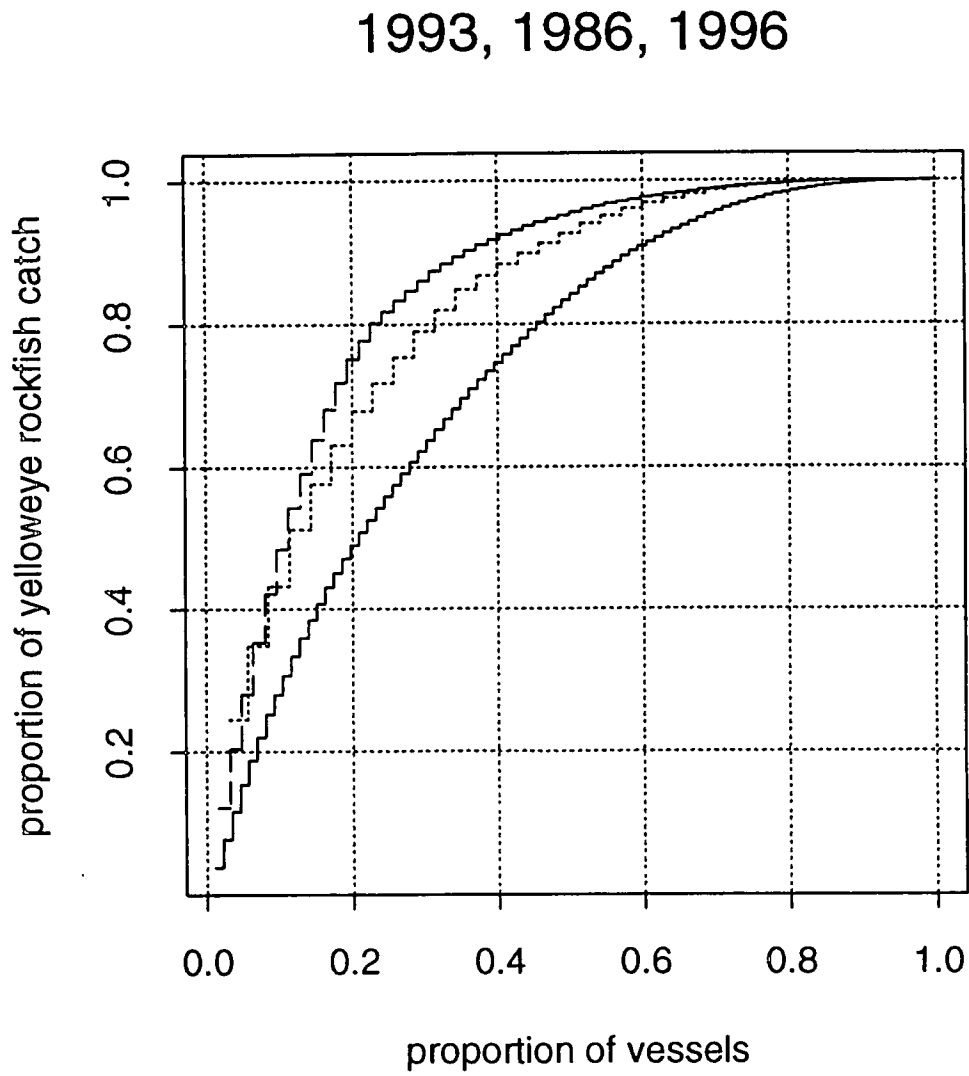


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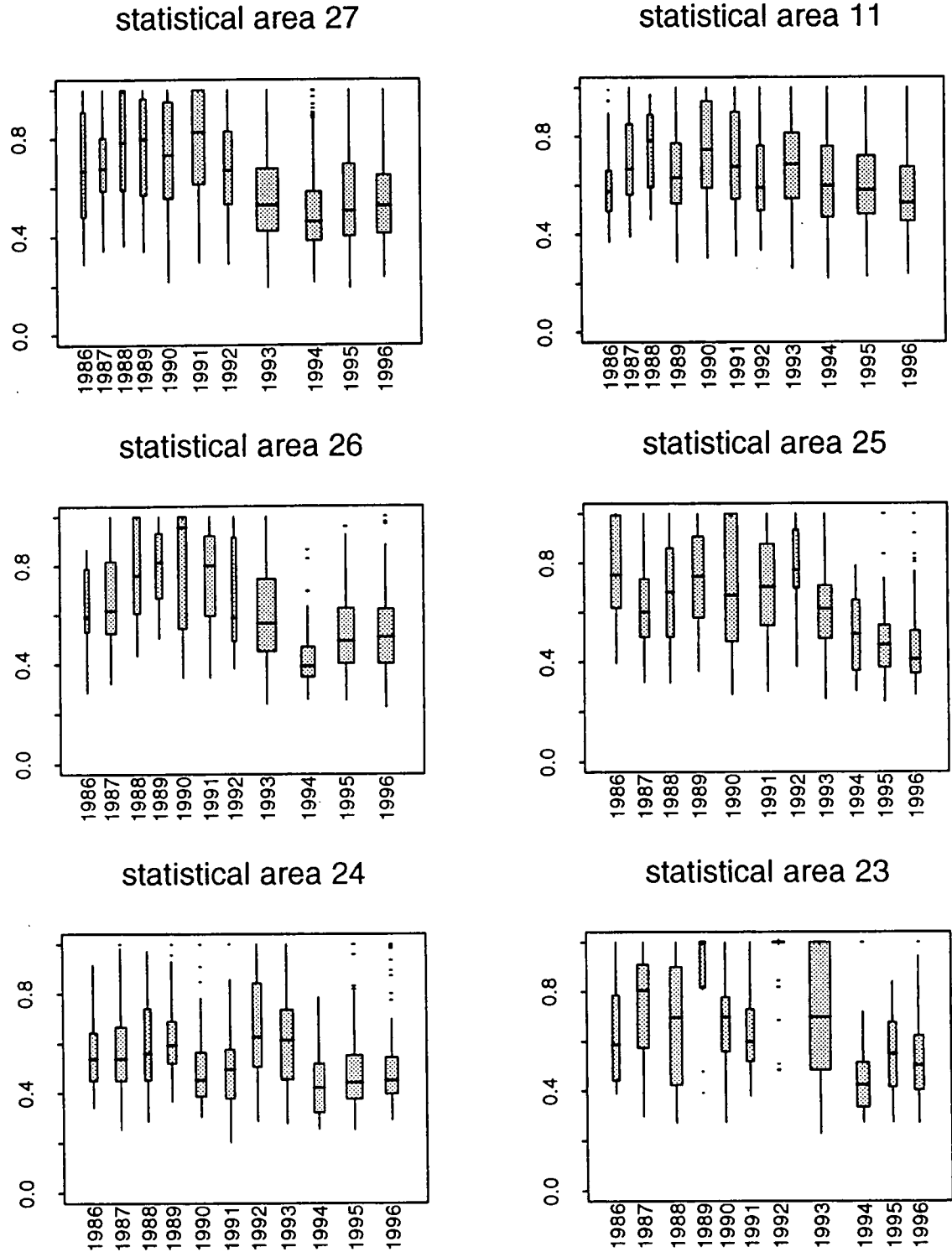


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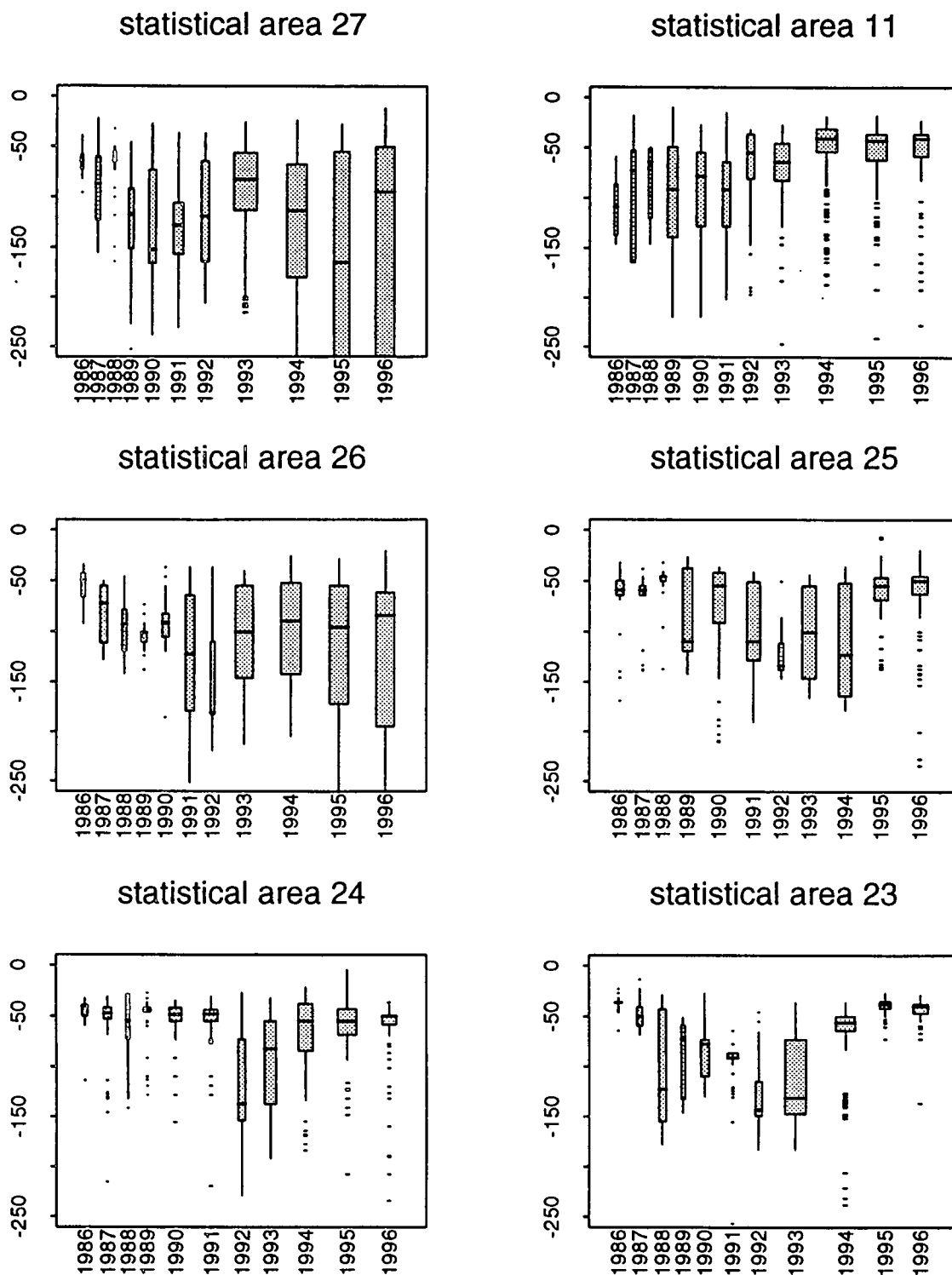


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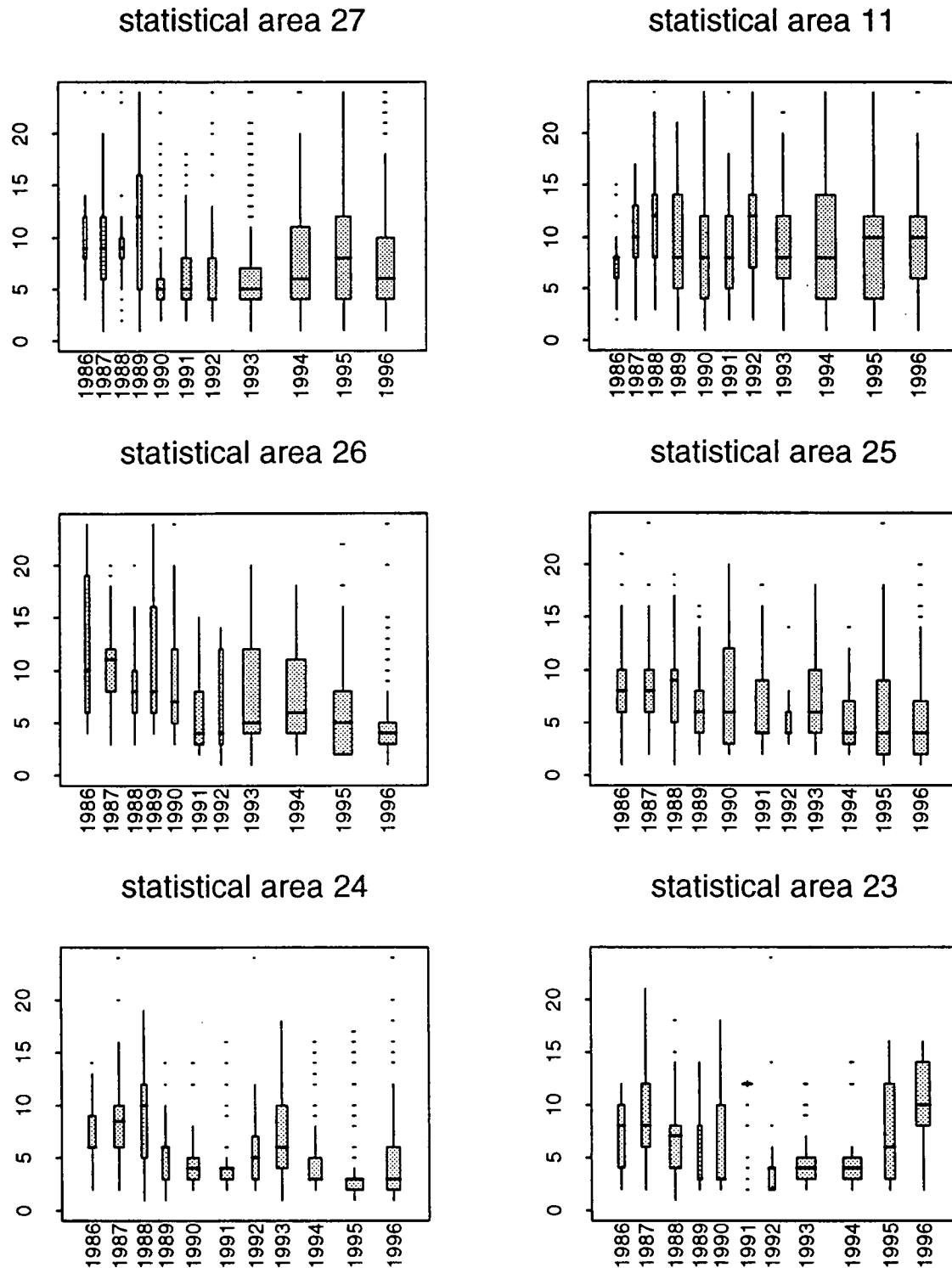


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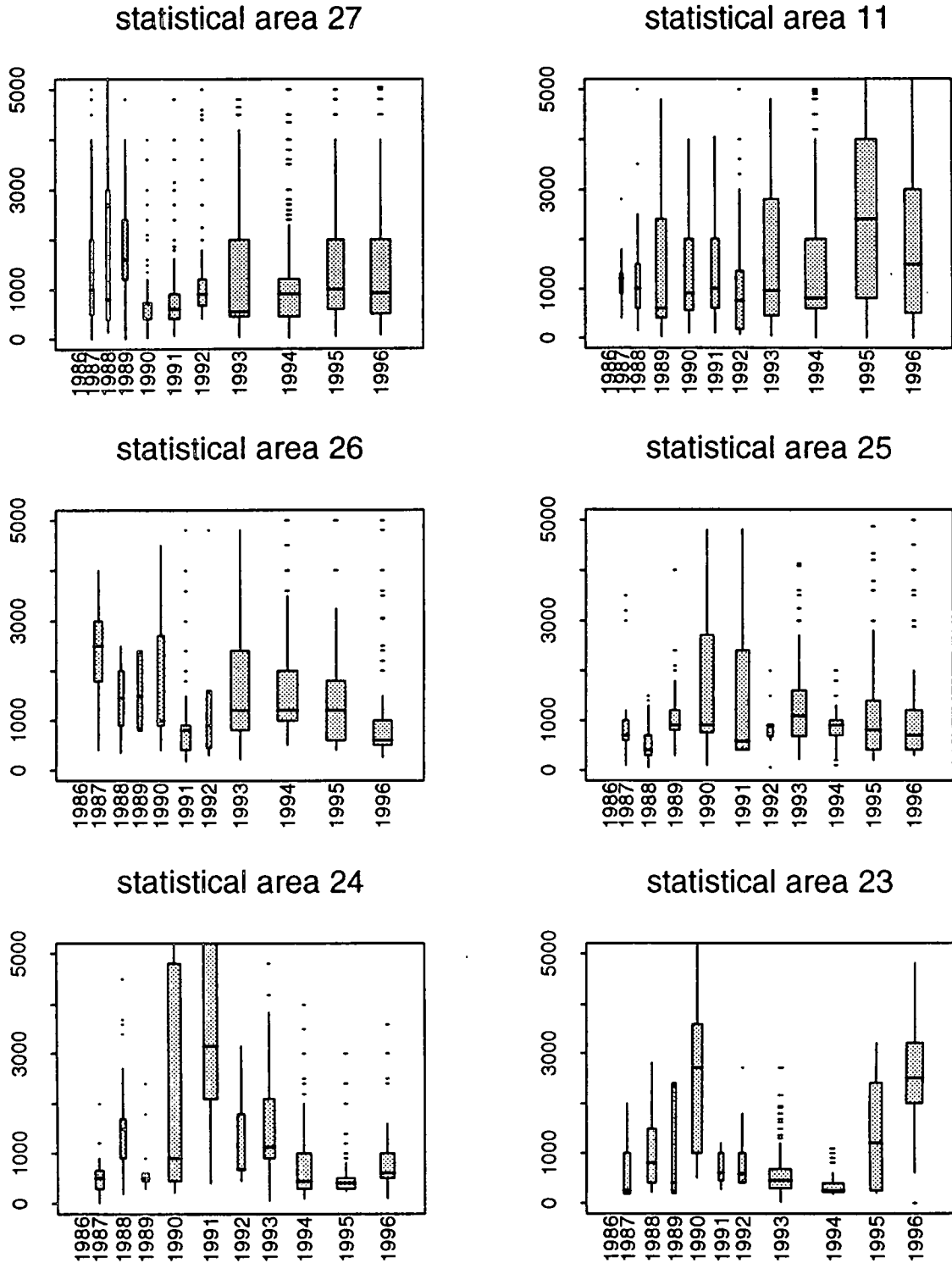


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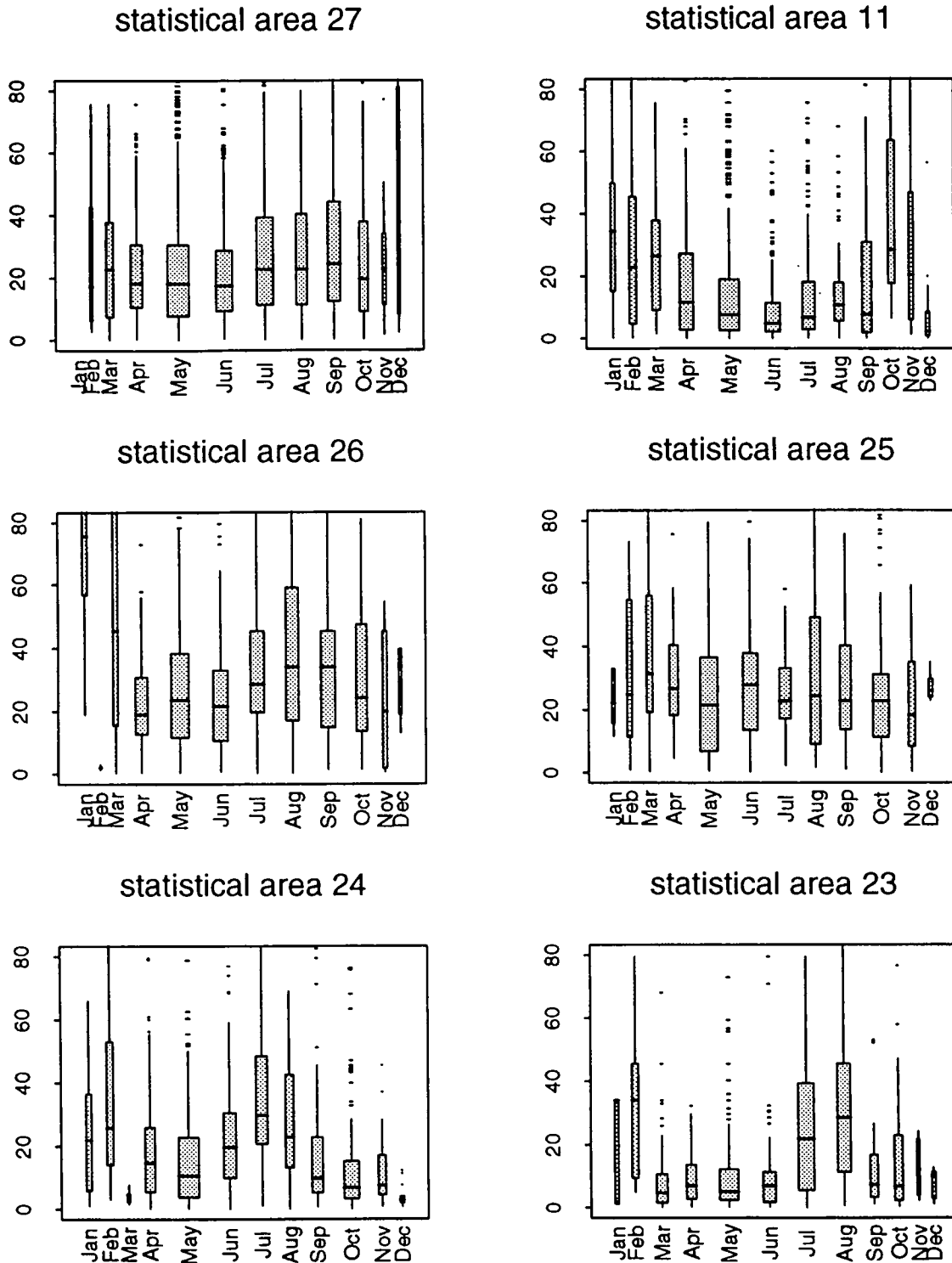


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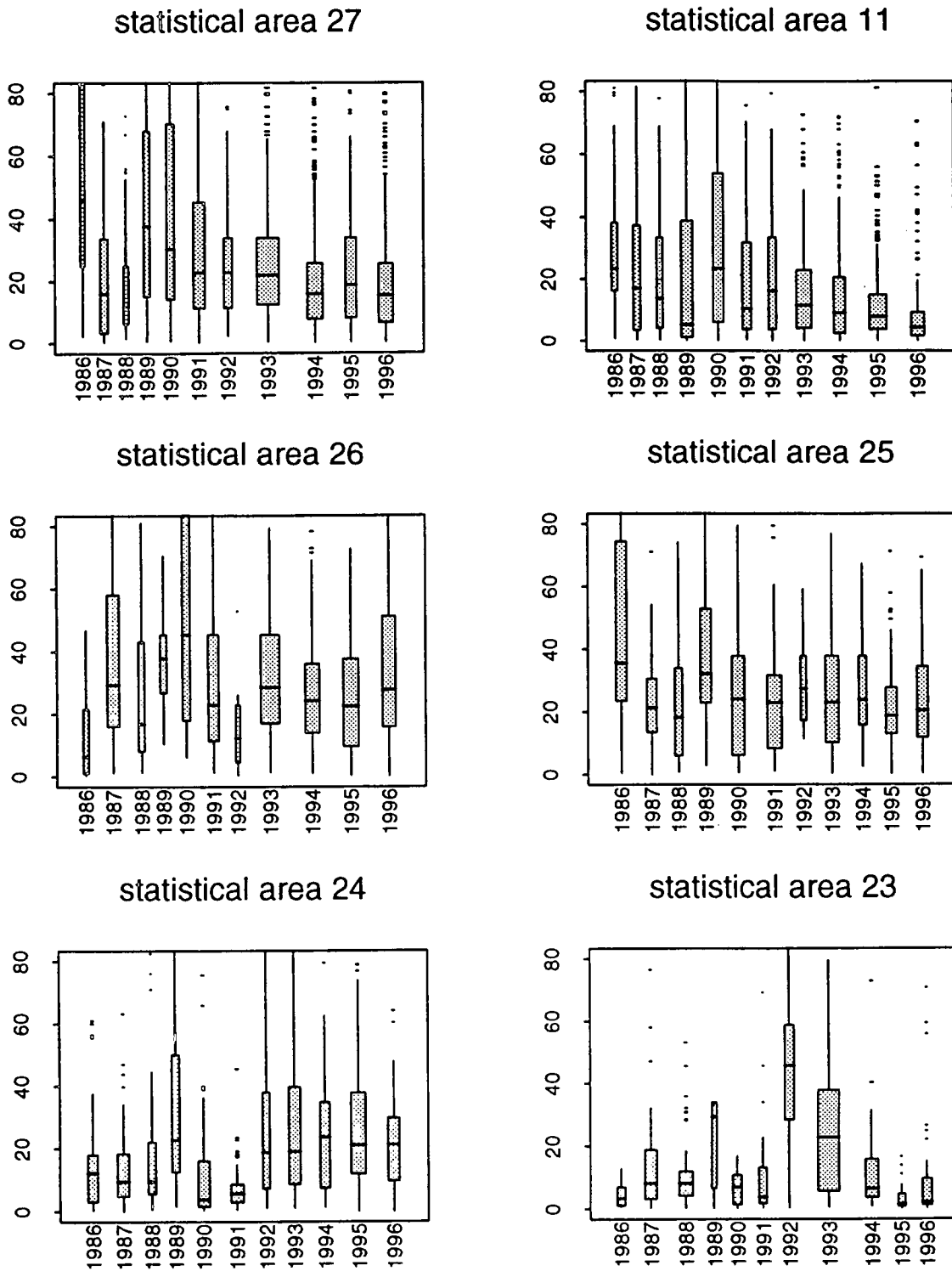


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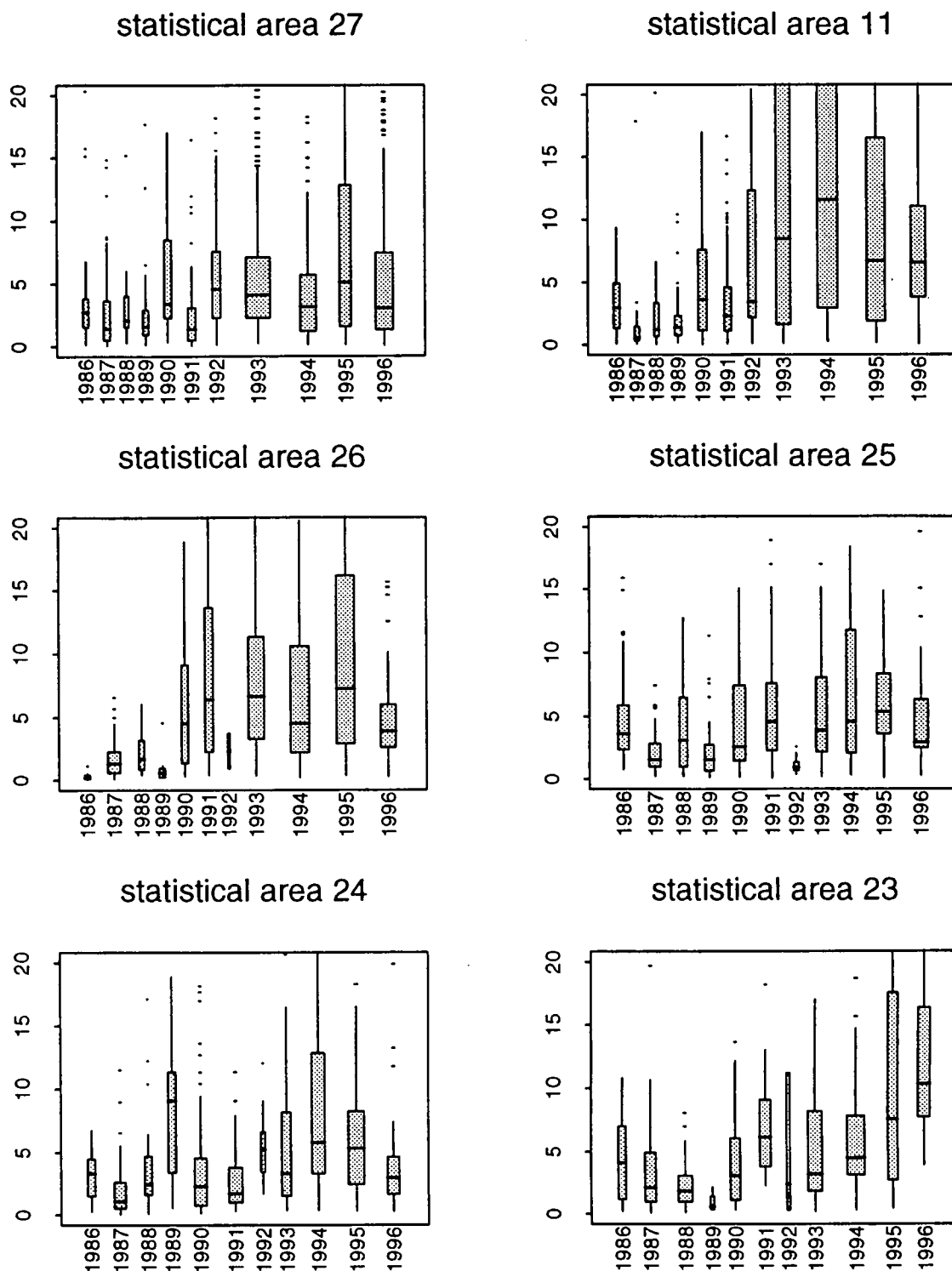


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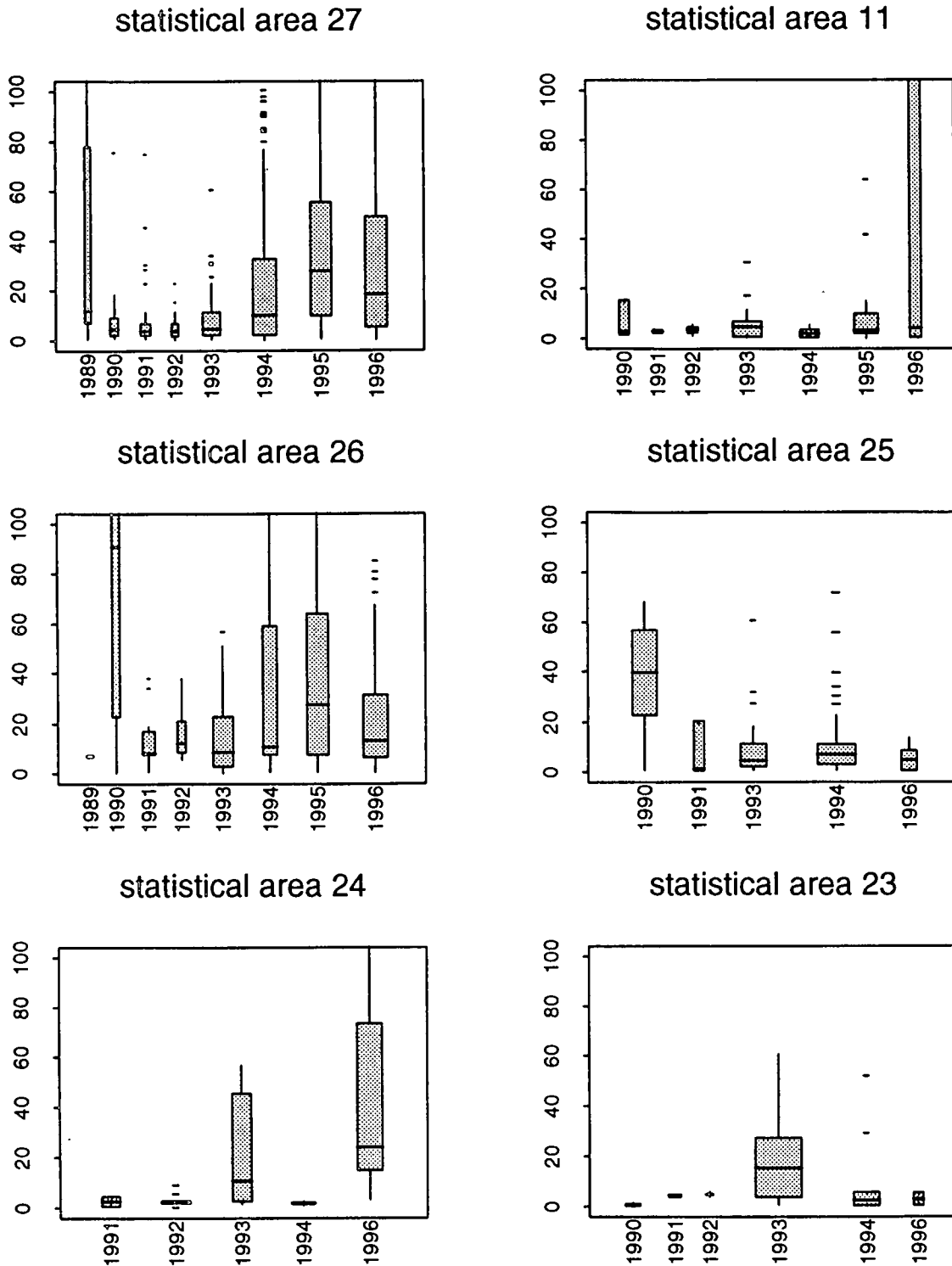


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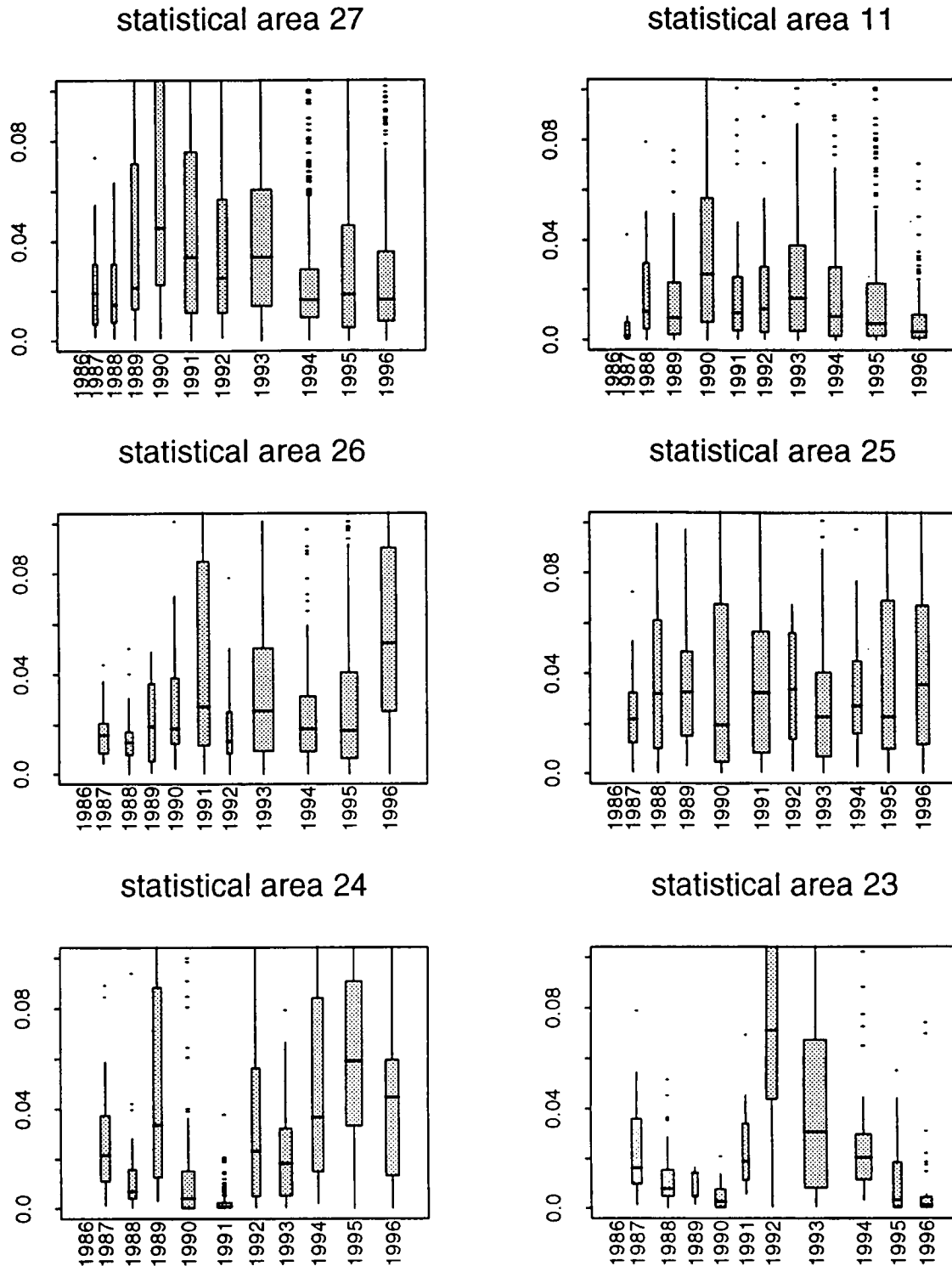


Figure 15. Yelloweye rockfish catch per unit of effort in kilograms per hook hour from logbook data for the years 1986 to 1996 by statistical area. Boxplots summarize annual data by depicting a box for the 1st and 3rd quartiles of the data, a black bar for the median and whiskers for the extremes of the data. Very extreme data are shown beyond the whiskers as dashes. Box widths vary in proportion to the amount of data they contain relative to the other boxes in each plot.



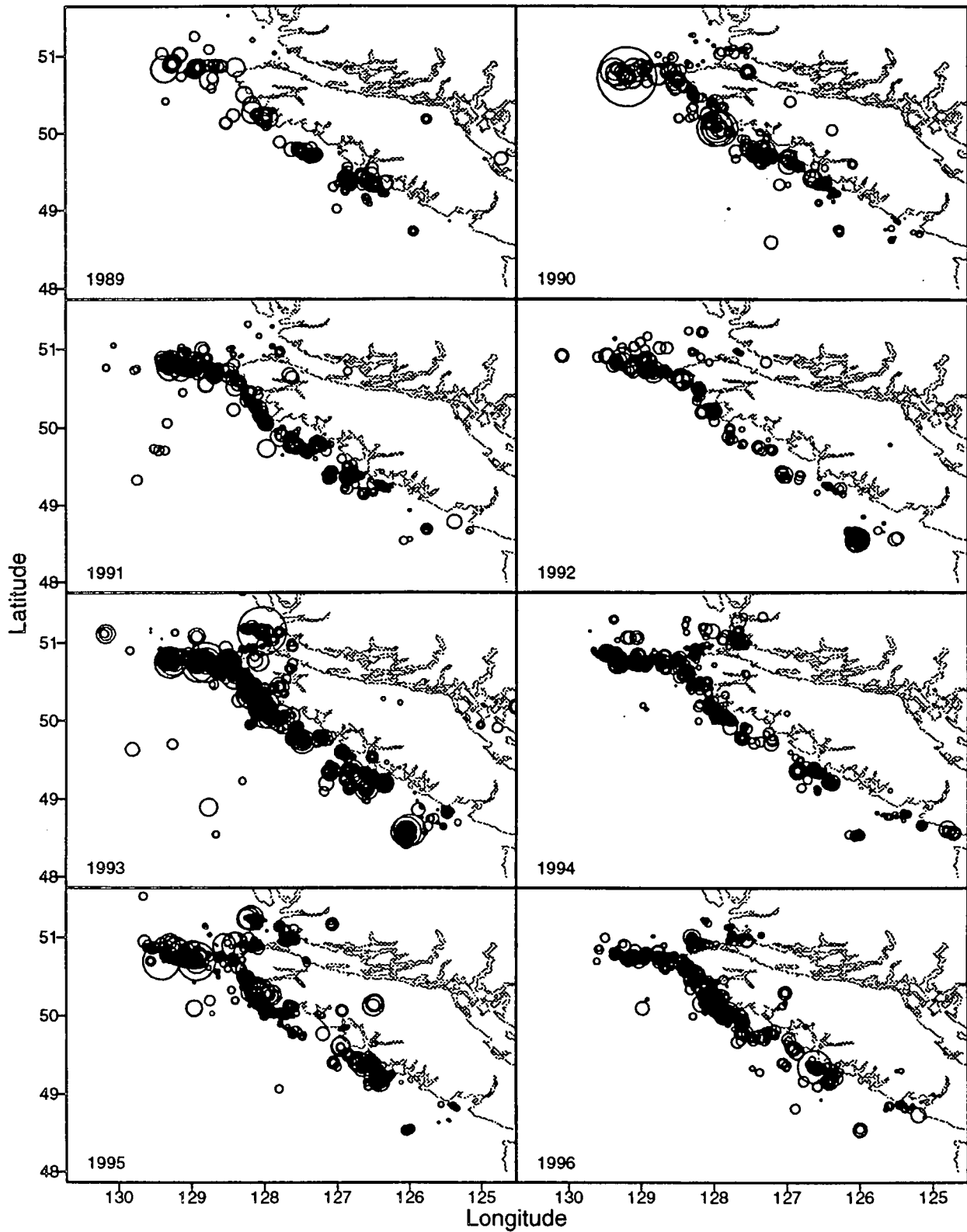


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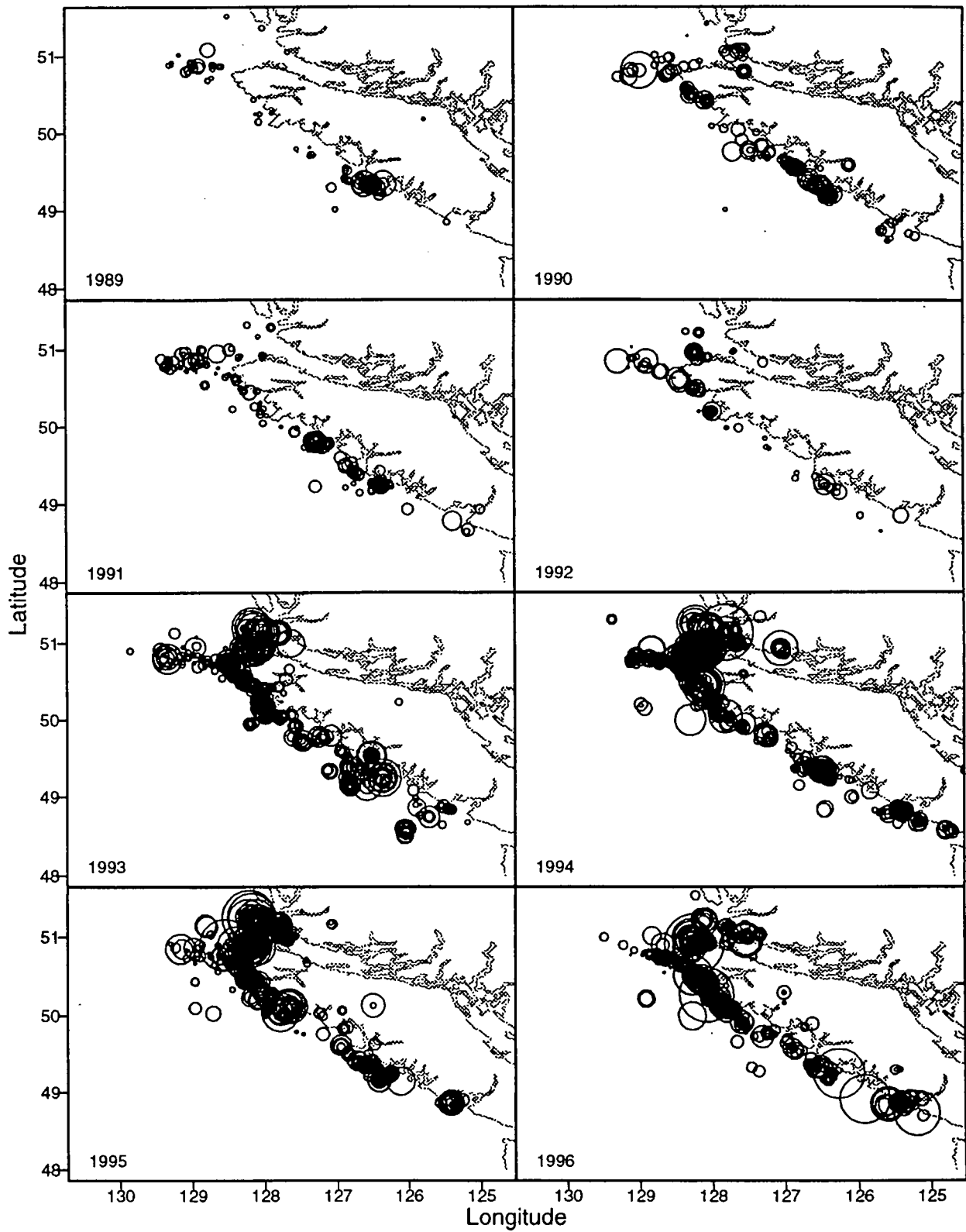


Figure 17. Quillback rockfish catch per unit of effort in kilograms per hour from logbook data plotted by set location and year for 1989 to 1996. There are missing data for the years 1989 to 1992. The largest circle is  $\sqrt{13}$  kg/hr.

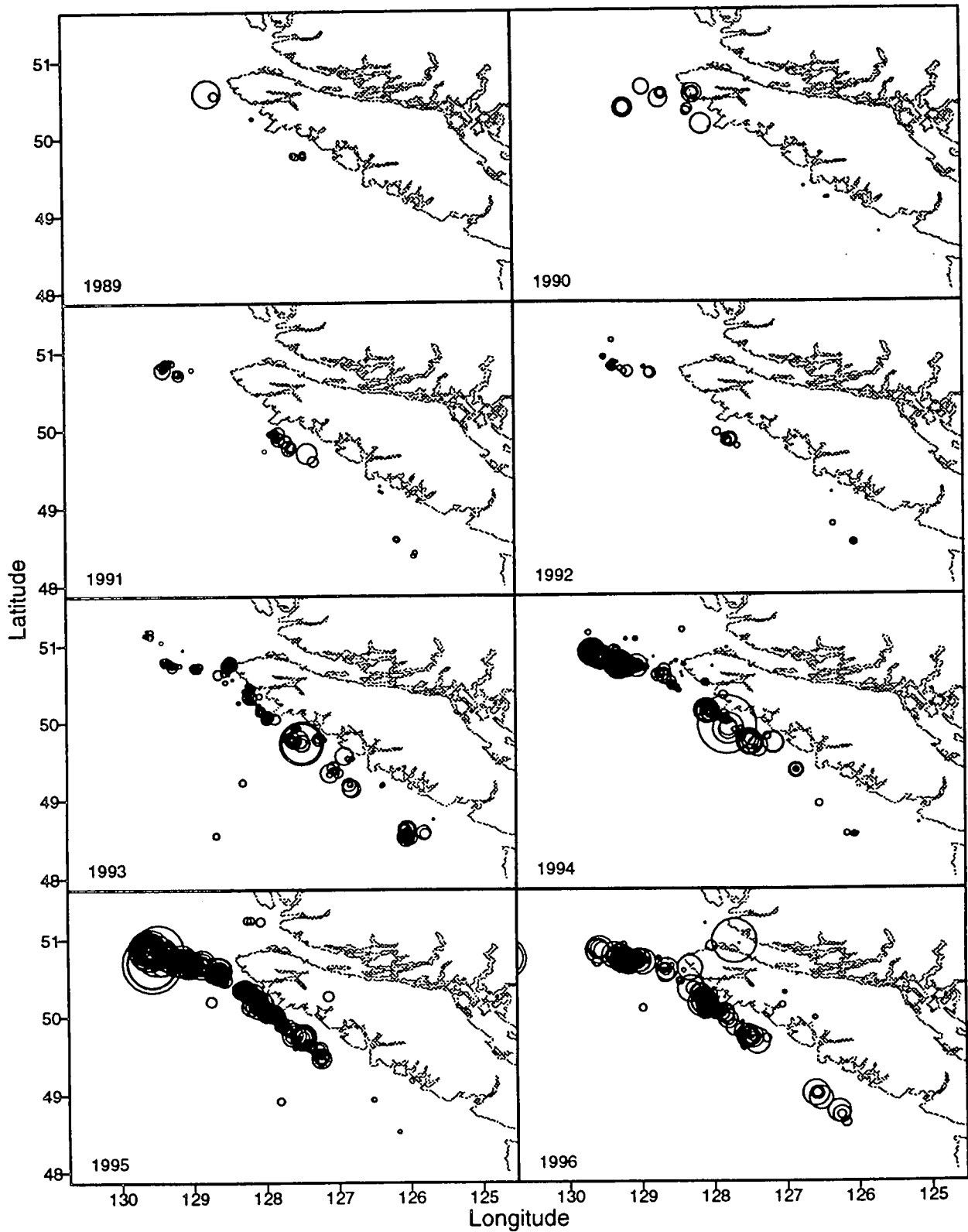


Figure 18. Redbanded rockfish catch per unit of effort in kilograms per hour from logbook data plotted by set location and year for 1989 to 1996. There are missing data for the years 1989 to 1992. The largest circle is  $\sqrt{25}$  kg/hr.

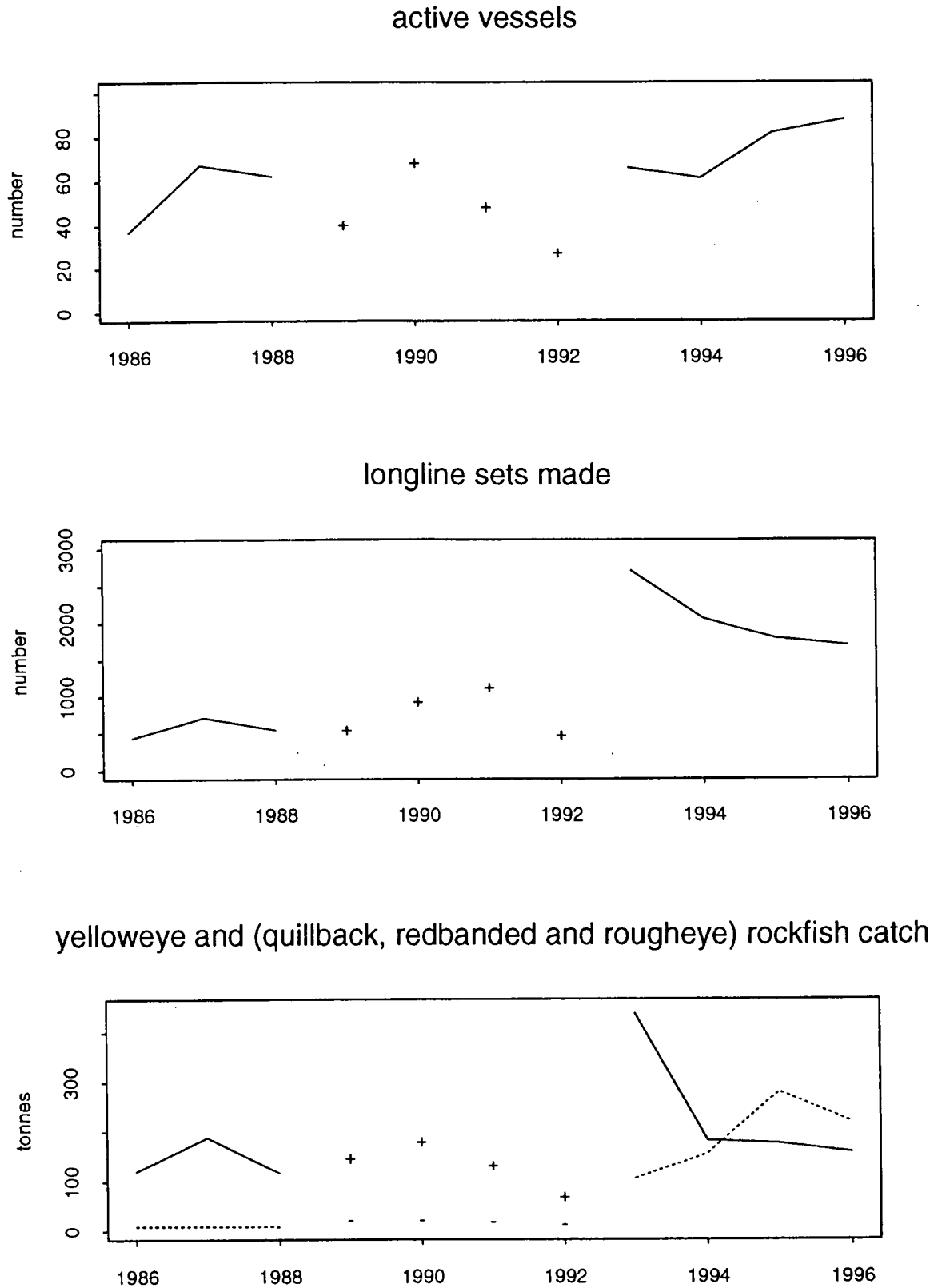


Figure 19. Yelloweye rockfish mean (solid line) and median (dashed line) vessel catch per unit of effort in kilograms per hour from logbook data for the years 1986 to 1996. Years with missing data are shown as points.

## Appendix A. Logbook, fish slip, and dockside monitoring data fields.

Zn Logbooks	Fish Slips	Dockside Monitoring
CFV number	data_type	hail in number
captain	acceptance_status	offload log number
target species	keypunch_date	tab number
bait type	slip_number	CFV number
gear type	detail_line_number	vessel name
number hooks / string	gear	licence id number
number strings / lines	period	reference number
date	year	landing number
latitude	month	captain
longitude	day	landing port
minimum depth fished	days_fishing	buyer
maximum depth fished	stat area	offloader
statistical area	district	offload date
statistical subarea	processing_region	monitoring hours
time fished	location	fishing method YE
YE pieces	disposal	amount landed YE
QB pieces	company	fishing method Agg. 1 QB
CP pieces	plant	amount landed Agg. 1 QB
species 1	landing_status	fishing method Agg. 1 CP
pieces 1	species	amount landed Agg. 1 CP
species 2	sp_future	...
pieces 2	landed_form	(for all species landed)
...	std_form	...
species 12	pieces	YE amt quota mgmt area A
pieces 12	weight	YE amt quota mgmt area B
YE round weight	price	...
QB round weight	value	(all quota species,
CP round weight	cfv_type	all management regions)
round weight 1	cfv_person	record flag
round weight 2	licence	incident
...	licence_future	overage YE
round weight 12	packer_cfv	relinquished YE
	calc_pieces_weight_flag	...
date unloaded	calc_price_flag	(for all quota species)
hail report number	filler	...
buyer / processor		relinquishment
comment		comment
error		

## Appendix B. Management tactics for the "Outside" Inshore Rockfish Fishery

Year	Management Tactics
<1986	No restrictions on commercial fishing
1986	<b>Implementation of the Zn Licenced fishery</b> 1362 Zn licences issued <b>Logbooks:</b> <ul style="list-style-type: none"> <li>• logbook program implemented</li> </ul>
1987 to 1989	No restrictions on commercial fishing 1987: 1935 Zn licences issued 1988: 2105 Zn licences issued 1989: 2319 Zn licences issued
1990	2396 Zn licences issued <b>TAC</b> <ul style="list-style-type: none"> <li>• NC, CC, QCI, WCVI total quota of 650t rockfish</li> </ul> <b>Area closure:</b> <ul style="list-style-type: none"> <li>• CC: portions of area 7 closed</li> <li>• WCVI: inside surfline closed 01 Jan to 30 Apr</li> </ul>
1991	<b>Zn Area Licencing:</b> 592 inside, 1595 outside <b>Fixed season closure:</b> NC, CC, QCI: open 01 Jan <b>Area closure</b> <ul style="list-style-type: none"> <li>• CC: rotational closure introduced in area 7</li> <li>• WCVI: inside surfline closed 01 Jan to 30 Apr</li> </ul> <b>TAC:</b> <ul style="list-style-type: none"> <li>• NC: yelloweye (YE) 80t, other rockfish (OR) 20t (quotas achieved 05 Aug)</li> <li>• QCI: YE 200t, OR 100t (quotas achieved 11 Sept)</li> <li>• CC: YE 100t, OR 100t (quotas achieved 06 Jul)</li> <li>• WCVI: YE 250t, OR 150t (quotas achieved 10 Dec)</li> </ul>
1992	<b>Zn Area Licencing:</b> 70 inside (limited entry), 1223 outside <b>Fixed season closure:</b> <ul style="list-style-type: none"> <li>• NC: closed 01 Jan to 16 Jan</li> </ul> <b>Area closure:</b> <ul style="list-style-type: none"> <li>• CC: rotational closure in area 7, subareas 7-25 to 7-28 open</li> <li>• WCVI: inside surfline closed 01 Jan to 30 Apr</li> </ul> <b>TAC:</b> <ul style="list-style-type: none"> <li>• NC: YE 80t (open in subareas 103-105 until 31 Dec, 72t taken)</li> <li>• NC: OR 20t (quota achieved 05 Jun)</li> <li>• QCI: YE 200t (quota achieved 02 Jul)</li> <li>• QCI: OR 100t (open to 31 Dec, 47t taken)</li> <li>• CC: YE 100t (quota achieved 17 May)</li> <li>• CC: OR 100t (quota achieved 08 May)</li> <li>• WCVI: YE 250t (quota achieved 27 Jul)</li> <li>• WCVI: OR 150t (quotas achieved 27 Jul)</li> </ul>
1993	<b>Zn Area Licencing:</b> 73 inside, 178 outside <b>Limited entry - coastwide</b> <ul style="list-style-type: none"> <li>• implemented outside, 178 license holders</li> </ul> <b>Area closure:</b> <ul style="list-style-type: none"> <li>• WCVI closed 01 Jan to 30 Apr</li> <li>• CC: rotational closure in area 7, subareas 7-1, 7-2, 7-17 to 7-24, and 7-32 open</li> </ul> <b>Catch-limited opening:</b>

	<ul style="list-style-type: none"> <li>◦ open 01 Jan to first of 15 Jun or until 66% TAC taken</li> <li>◦ open 15 Sep to first of 31 Dec or until balance of TAC taken</li> </ul> <p><b>overall TAC:</b></p> <ul style="list-style-type: none"> <li>◦ NC: YE 94 t, OR 63 t</li> <li>◦ QCI: YE 308 t, OR 109 t</li> <li>◦ CC: YE 138 t, OR 104 t</li> <li>◦ WCVI: YE 313 t, OR 160 t</li> </ul> <p><b>Zn allocation:</b></p> <ul style="list-style-type: none"> <li>◦ NC: YE 80t (open 1 Jan to 15 Jun, 15 Sep to 31 Dec)</li> <li>◦ NC: OR 60t (open 1 Jan to 15 Jun, 15 Sep to 31 Dec)</li> <li>◦ QCI: YE 200t (open 1 Jan to 30 Apr, 15 Sep to 4 Oct)</li> <li>◦ QCI: OR 100t (open 1 Jan to 31 Dec)</li> <li>◦ CC: YE 100t (open 1 Jan to 4 Apr)</li> <li>◦ CC: OR 100t (open 1 Jan to 4 Apr, 15 to 26 Sep)</li> <li>◦ WCVI: YE 250t (open 1 May to 24 Oct)</li> <li>◦ WCVI: OR 150t (open 1 May to 21 Aug)</li> </ul>
1994	<p><b>Zn Area Licencing:</b> 74 inside, 181 outside</p> <p><b>Limited Entry - coastwide</b></p> <ul style="list-style-type: none"> <li>◦ 181 vessels licensed outside</li> </ul> <p><b>Logbooks:</b></p> <ul style="list-style-type: none"> <li>◦ logbooks revised</li> <li>◦ user-pay program implemented</li> </ul> <p><b>Fixed season closure:</b></p> <ul style="list-style-type: none"> <li>◦ WCVI: closed 01 Jan to 14 Apr</li> </ul> <p><b>Catch-limited opening:</b></p> <ul style="list-style-type: none"> <li>◦ QCI: YE open 01 Jan to first of 15 Jun or 66% of quota achieved, open for balance of quota 15 Sep</li> <li>◦ NC: YE,OR open 01 Jan to 15 Jun or until 66% of quota achieved, open for balance of quota 15 Sep</li> <li>◦ CC: YE,OR open 01 Jan to 15 Jun or until 66% of quota achieved, open for balance of quota 01 Nov</li> <li>◦ NC, CC: when YE or OR quota attains 66% of quota, the other quota will close the first of 15 Jun or when quota is within 10% of the 66% cutoff</li> </ul> <p><b>Area closure:</b></p> <ul style="list-style-type: none"> <li>◦ rotational closure in area 7: areas 7-3 to 7-16 and 7-29 to 7-31 open</li> <li>◦ WCVI: Swiftsure closure</li> </ul> <p><b>overall TAC:</b></p> <ul style="list-style-type: none"> <li>◦ NC: YE 60 t, OR 76 t</li> <li>◦ QCI: YE 302 t, OR 80 t</li> <li>◦ CC: YE 113 t, OR 103 t</li> <li>◦ WCVI: YE236 t, OR 159 t</li> </ul> <p><b>Zn allocation:</b></p> <ul style="list-style-type: none"> <li>◦ NC: YE 60t (open 1 Jan to 15 Jun, 15 to 21Sep)</li> <li>◦ NC: OR 60t (open 1 Jan to 15 Jun, 15 Sep to 21 Oct)</li> <li>◦ QCI: YE 200t (open 1 Jan to 11 Apr, 15 to 21 Sep)</li> <li>◦ QCI: OR 54t (open 1 Jan to 31 Dec)</li> <li>◦ CC: YE 100t (open 1 Jan to 27 Feb, 1 to 10 and 17 to 29 Nov)</li> <li>◦ CC: OR 100t (open 1 Jan to 30 Mar, 1 to 29 Nov)</li> <li>◦ WCVI: YE 200t (open 15 Apr to 1 Jun)</li> <li>◦ WCVI: OR 150t (open 15 Apr to 24 Sep)</li> </ul> <p><b>Trip limits:</b></p> <ul style="list-style-type: none"> <li>• combined POP, YE, RS 4.5 tonnes (~10,000 lb)</li> </ul>

	<ul style="list-style-type: none"> <li>• combined CA, SG 4.5 tonnes (~10,000 lb)</li> <li>• combined YE, WI 4.5 tonnes (~10,000 lb)</li> <li>• combined RE, ST, Idiots 6.8 tonnes (~15,000 lb)</li> </ul>
1995	<p><b>Limited entry:</b></p> <ul style="list-style-type: none"> <li>• 183 vessels licensed outside</li> </ul> <p><b>Dockside monitoring of landings:</b></p> <ul style="list-style-type: none"> <li>• user pay validation for all landings of Zn license holders</li> </ul> <p><b>Fixed season closure:</b></p> <ul style="list-style-type: none"> <li>• WCVI: closed 01 Jan to 14 Apr</li> </ul> <p><b>Catch limited opening:</b></p> <ul style="list-style-type: none"> <li>• QCI, NC, CC, WCVI: when 90% of the YE quota has been taken in any one management area, all waters outside the surfline will close (balance of YE quota available inside surfline as bycatch for directed fishing on A1+A2)</li> <li>• QCI, NC, CC, WCVI: when 90% of the A1+A2 quota has been taken in any one management area, all waters inside the surfline will close (balance of YE quota available outside the surfline as bycatch for directed fishing on YE)</li> </ul> <p><b>Area closure:</b></p> <ul style="list-style-type: none"> <li>• subareas 13-2 to 13-9, 13-11 and 13-27</li> <li>• rotational closure in area 7: subareas 7-25 to 7-28 open</li> </ul> <p><b>Aggregate management:</b></p> <ul style="list-style-type: none"> <li>• catch managed using YE and 6 species aggregates</li> </ul> <p><b>overall TAC:</b></p> <p>NC: YE 60 t, A1&amp;2 63 t  QCI: YE 291 t, A1&amp;2 76 t  CC: YE 118 t, A1&amp;2 105 t  WCVI: YE 231 t, A1&amp;2 144 t</p> <p>coastwide:</p> <p>A3 8,925 t  A4 735 t (RE only, no quota on ST or Idiots)  A5 8,522 t  A6 no quota</p> <p><b>Zn allocations:</b></p> <ul style="list-style-type: none"> <li>• NC: YE 47 t, A1+A2 60t</li> <li>• QCI: YE 189 t, A1+A2 50t</li> <li>• CC: YE 100t, A1+A2 100t</li> <li>• WCVI: YE 195t, A1+A2 135t</li> </ul> <p><b>Fishing options:</b></p> <ul style="list-style-type: none"> <li>• Option A: <ul style="list-style-type: none"> <li>• directed fishing A1 per fishing period</li> <li>• an allowance of YE, A2 to A6 per landing</li> <li>• restricted to a maximum of 4 landings of any rockfish each fishing period</li> </ul> </li> <li>• Option B <ul style="list-style-type: none"> <li>• directed fishing on A3 to A6 combined per fishing trip</li> <li>• allowance of A1, A2, and YE combined per landing</li> <li>• restricted 4 landings of any rockfish per fishing period</li> </ul> </li> <li>• Option C <ul style="list-style-type: none"> <li>• directed fishing on A3-A7 per fishing period</li> <li>• by-catch allowance of A1,A2,YE combined per landing</li> <li>• restricted 4 landings of any rockfish per fishing period</li> </ul> </li> </ul> <p><b>Fishing period catch limits:</b></p> <ul style="list-style-type: none"> <li>• Option A <ul style="list-style-type: none"> <li>• 7,000 lb. A1 per fishing period</li> </ul> </li> </ul>



	<ul style="list-style-type: none"> <li>◦ a quantity of A2 and YE combined &lt; 50% of A1 per landing</li> <li>◦ a quantity of A3 to A6 combined &lt; A1 per landing</li> <li>◦ a quantity A2-A5, A7 combined &lt; 100% of total A1 per landing</li> <li>◦ overage on each of A1 and A6 combined to a maximum of 10% per fishing period is deducted from the vessel's next fishing period</li> <li>◦ no restriction on the number of landings per period</li> <li>◦ Option B <ul style="list-style-type: none"> <li>◦ 4,000 lb A1, A2 and YE combined per fishing period</li> <li>◦ a quantity A3 to A6 combined &lt; 150% of A1, A2 and YE combined per landing</li> <li>◦ restricted to 4 landings of any rockfish per fishing period</li> </ul> </li> <li>◦ Option C <ul style="list-style-type: none"> <li>◦ trip limit quantities of A3 to A6 per landing: <ul style="list-style-type: none"> <li>A3: 10,000 lb</li> <li>A4: 15,000 lb</li> <li>A5: 15,000 lb</li> <li>A6: 10,000 lb</li> </ul> </li> <li>◦ a quantity of A1, A2, and YE combined not to exceed 10% of A3 to A6 combined per landing</li> <li>◦ restricted to 4 landings of any rockfish per fishing period</li> </ul> </li> </ul>
1996	<p><b>Limited entry:</b></p> <ul style="list-style-type: none"> <li>◦ 168 vessels licensed outside</li> </ul> <p><b>Dockside monitoring of landings:</b></p> <ul style="list-style-type: none"> <li>◦ user pay validation for all landings of Zn license holders</li> <li>◦ inclusion of lingcod and dogfish</li> </ul> <p><b>Fixed season closure:</b></p> <ul style="list-style-type: none"> <li>◦ WCVI closed 01 Jan to 31 Apr</li> </ul> <p><b>Catch limited opening:</b></p> <ul style="list-style-type: none"> <li>◦ CC: 01 Jan until 60t taken; re-open 01 Nov for balance of quota</li> <li>◦ Option A vessels restricted access to area when 90% of A1+A2 taken</li> <li>◦ Option B vessels restricted access to area when 90% of YE taken</li> </ul> <p><b>Area closure:</b></p> <ul style="list-style-type: none"> <li>◦ CC: rotational closure in area 7: subareas 7-1, 7-2, 7-17 to 7-24 and 7-32 open</li> <li>◦ WCVI: Swiftsure closure</li> </ul> <p><b>Aggregate management:</b></p> <ul style="list-style-type: none"> <li>◦ species composition of aggregates revised to include YE and 7 species aggregates</li> </ul> <p><b>overall TAC:</b></p> <p>NC: YE 60 t, A1+2 63 t  QCI: YE 291 t, A1+2 76 t  CC: YE 118 t, A1+2 105 t  WCVI: YE 231 t, A1+2 144 t</p> <p>coastwide:</p> <ul style="list-style-type: none"> <li>A3 1,813 t</li> <li>A4 1,794 t</li> <li>A5 6,585 t</li> <li>A6 6,725 t</li> <li>A7 monthly limit</li> </ul> <p><b>Zn allocations:</b></p> <ul style="list-style-type: none"> <li>• NC: YE 38t, A1+A2 62t</li> <li>• QCI: YE 135t, A1+A2 43t</li> </ul>

- CC: YE 119t, A1+A2 116t (open 01 Jan until 60% A1+A2 taken, re-open 01 Nov for remaining 40%)
- WCVI: YE 155t, A1+A2 152t

**Fishing options:**

- Option A:
  - directed fishing A1 per fishing period
  - an allowance of A6 per fishing period
  - an allowance of A2 to A5, and A7 combined per landing
  - no restriction on the number of rockfish landings per fishing period
- Option B
  - directed fishing on YE per fishing period
  - allowance of A1 per landing
  - allowance of A2 to A7 combined per landing
  - no restriction on the number of rockfish landings per fishing period
- Option C
  - directed fishing on A3-A7 per fishing period
  - by-catch allowance of A1, A2 and YE combined per landing
  - no restriction on the number of rockfish landings per fishing period

**Fishing period catch limits:**

- Option A
  - 2,500 lb. A1 per fishing period
  - 500 lb A6 per fishing period
  - a quantity of YE < 50% of A1 per landing
  - a quantity of A3 to A6 combined < A1 per landing
  - a quantity A2-A5, A7 combined < 100% of total A1 per landing
  - overage on each of A1 and A6 combined to a maximum of 10% per fishing period is deducted from the vessel's next fishing period
  - no restriction on the number of landings per period
- Option B
  - 3,000 lb YE combined per fishing period
  - a quantity of A1 < 20% of YE per landing
  - a quantity of A2 to A7 combined < 100% YE per landing
  - overage of YE < 20% per fishing period is deducted from the vessel's next fishing period
  - restricted to 4 landings of any rockfish per fishing period
- Option C
  - fishing period limits that vary depending on how much quota has been taken:
    - A3: 5,000 lb (<80% TAC), 1,000 lb (80-100% TAC)
    - A4: 7,500 lb (<80% TAC), 1,000 lb (80-100% TAC)
    - A5: 6,000 lb (<80% TAC), 1,000 lb (80-100% TAC)
    - A6+A7: 10,000 lb (<80% TAC), 1,000 lb (80-100%)TAC
  - an overage for each of A3 to A5, and A6 to A7 combined < 20% per fishing period shall be deducted from the vessel's next fishing period