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A descriptive analysis of commercial catch and effort data for ling from New Zealand waters

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EXECUTIVE SUMMARY

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Commercial catch and effort data from the Ministry of Fisheries QMS database were analysed to show how the fisheries for ling in the New Zealand EEZ have operated from the 1989–90 fishing year until 1998–99. Catches from 10 areas were analysed (Northland, East North Island, East South Island, Chatham Rise, Southland, Sub-Antarctic, Bounty Platform, West South Island, Cook Strait, Kermadec). Significant fisheries for ling occur in all areas except Kermadec, although most landings (95%) are taken from areas to the south of and including Cook Strait. Total landings increased steadily to peak in 1997–98.

Ling are taken primarily by two fishing methods: longline (39% of total landings) and bottom trawl (50%). Most of the line catch is from target fisheries for ling. There are target ling longline fisheries in all areas except Kermadec. Most are clearly seasonal, with peak catches and fishing activity at times when ling are probably aggregating to spawn. Of the landings of ling taken by bottom trawl, about 80% are taken as a bycatch of fisheries targeting hoki. Significant target trawling for ling occurs only in Southland and Sub-Antarctic.

The remaining ling catch is taken by setnet fisheries targeting ling (3% of total landings), and midwater trawl fisheries primarily targeting hoki (8%).

Standardised CPUE analyses of the major target longline fisheries around the South Island are currently used as inputs into ling stock assessments. There is potential for similar analyses to be conducted on longline data from the Northland and East North Island areas, and it is recommended that this work be carried out. Some trawl fisheries targeting hoki, but with a significant bycatch of ling, may provide useful CPUE indices. However, any trawl fisheries suitable for CPUE analysis would need to have remained relatively constant in area, season, and method over several years. It is recommended that the West South Island trawl fishery is the most worthy of such an analysis.

1. INTRODUCTION

This report is in fulfilment of Objective 2 of Project LIN1999/01, Ling stock assessment.

A descriptive analysis of commercial catch and effort data has been completed for only the LIN 7 Fishstock (author's unpublished data). This report presents a descriptive analysis of all the ling fisheries in the New Zealand EEZ, from 1989–90 to 1998–99. The analysis aimed to show how the various fisheries for ling operate and how they have evolved, and, hence, to identify fisheries which may provide series of CPUE data for use as indices of relative abundance in stock modelling. It also aimed to define seasonal and areal patterns of fish distribution.

2. METHODS

Commercial catch and effort data for all landings of ling from fishing years 1989–90 to 1998–99 were extracted from the MFish catch and effort database. Tows or sets where ling were listed as the target species but not reported in the catch were also extracted. The data were error checked for particularly large catches and for incorrect positions, and separated by fishing method.

The data extracted were reported by fishers on either CELR (Catch, Effort and Landing Return) or TCEPR (Trawl, Catch, Effort and Processing Return) forms. TCEPR forms record trawl tow by tow data, with positions generally given by latitude and longitude (which are converted to statistical area, see Figure 1). A CELR data entry is a summary of a day's fishing (which may comprise several sets or tows), with position usually given by statistical area (although sometimes by latitude and longitude). Longline, setnet, and fish pot landings are always recorded on CELR forms. Trawl catches can be reported on either form, but, in general, smaller "inshore" vessels use CELR forms and larger "deepwater" vessels report on TCEPR forms. Consequently, data from the "inshore" and "deepwater" trawl fleets were analysed separately. [Note: "Inshore" vessels can, and sometimes do, fish in the same areas as the "deepwater" fleet, but any of the "deepwater" fleet with a registered length greater than 43 m are restricted to waters at least 12 n.miles off shore.]

The fishing methods examined were: deepwater bottom trawl, deepwater midwater trawl, inshore bottom trawl, inshore midwater trawl, longline, setnet, and fish pots. Longline data can be further divided into bottom longline, dahn line, and trot line methods. Landings by the three lining methods are summarised by area and fishing year, but throughout most of this analysis all the line catch was combined.

The catch and effort data were summarised to provide descriptive statistics showing how the various fisheries for ling operate and how they have evolved. Summary statistics (listed below) were produced and examined for trends. The catch data from the statistical areas were combined so that the groupings generally approximated the various administrative ling stocks, with two major exceptions. The Bounty Platform section of LIN 6 was examined separately, and a Cook Strait area comprising parts of LIN 2 and LIN 7 was created. The areas are: Northland, East North Island (East NI), East South Island (East SI), Chatham, Southland, Sub-Antarctic, Bounty, West South Island (West SI), Cook Strait, and Kermadec (Table 1).

For all landings combined
- catch by area, by fishing year
- catch by area and method, for each fishing year

For each fishing method in each area where ling catches average more than 80 t annually
- catch by month, by year
- catch by main target species, by fishing year

For each fishing method in each area where ling is one of the top two target species and ling catches average more than 80 t annually

- mean catch per tow/set, by fishing year
- mean trawl headline height/setnet length/number of hooks per set, by fishing year
- mean vessel length and power, by fishing year

Also, for the TCEPR bottom trawl, TCEPR midwater trawl, and bottom longline fleets, positions of catches were plotted, by fishing year, and by month with all years combined, where latitudes and longitudes were available.

3. RESULTS

3.1 All landings data

Annual landings by area, from all methods combined, are listed in Table 2. Significant landings have been taken in all areas except Kermadec, where they are negligible. Landings from outside the New Zealand EEZ (extra territorial) were also negligible before 1998–99. The bulk of landings are taken in five areas around the South Island: East SI, Chatham, Southland, Sub-Antarctic, and West SI. This pattern of landings is consistent with ling distributions derived from research trawls (Anderson et al. 1998).

Annual landings from all methods combined, by statistical area, are listed in Appendix A. This appendix demonstrates that landings levels from adjacent statistical areas can vary markedly. The micro-spatial landings pattern are discussed in Section 3.4.

Total landings from fishing years 1989–90 to 1998–99, by fishing method, for each area are listed in Table 3. Half the landings are taken by bottom trawl, with longline catches making up a further 39%. The longline fishery is the most productive method in each area except for East SI, Southland, and Sub-Antarctic, where bottom trawl is the primary method. Remaining landings are taken by midwater trawl (8% of the total), setnet (2.5%), and fish pots (0.1%).

3.2 Landings summaries by fishing method and area

Ling are taken by a variety of fishing methods in each of the areas. Summaries of catch by fishing method, by area and fishing year are presented in Tables 4 and 5.

The deepwater bottom trawl fishery is particularly important in the East SI, Chatham, Southland, and Sub-Antarctic areas, with annual landings generally in excess of 1000 t. The West SI fishery is only slightly less productive. In the most recent years, landings by this method have exceeded 100 t annually in all areas except Bounty. The inshore bottom trawl fishery produces low levels of landings (i.e., generally less than 100 t annually) in all areas except Sub-Antarctic and Kermadec, where catches are negligible. Landings by this method from West SI have generally been between 100 and 200 t annually.

The deepwater midwater trawl fishery has produced landings consistently greater than 300 t annually only in the West SI area. East SI, Cook Strait, and Southland are the next most productive areas for this fishing method (averaging over 100 t annually). Landings from the inshore midwater trawl fishery are negligible in all areas except West SI and Cook Strait, although even in these areas catches seldom exceed 50 t annually.

The longline fishery is significant in all areas except Kermadec. It is particularly productive in the Chatham and Sub-Antarctic areas; recent landings levels have generally exceeded 2000 t annually. Other areas around the South Island (East SI, Southland, Bounty, and West SI) constitute a slightly less productive group of fisheries.

Setnet fishery landings are negligible in all areas except East SI and West SI, where they have generally been in excess of 100 t annually. Landings from fish pots are generally recorded only from East SI, but they average only about 20 t annually.

The catch by each fishing method over time, in each area, is depicted in Figure 2. Clearly, the importance of particular fishing methods can vary considerably between areas.

Fisheries in Northland and East NI exhibit similar trends. The most productive method is longline, but both the longline and deepwater bottom trawl fisheries have shown an increasing trend in landings over the time examined. A setnet fishery in East NI appears to have declined in importance. Other fisheries are generally negligible with no clear trends.

The most important East SI fishery is deepwater bottom trawl, followed by longline. Landings from both have exhibited a slight increasing trend over time (although the longline catch may now be declining). Trends are also apparent in landings levels from other fisheries; those from inshore bottom trawling have declined, and deepwater midwater trawl landings have increased in recent years.

The Chatham area basically supports two fisheries; longline and deepwater bottom trawl. Landings from the longline fishery increased rapidly to peak in 1994–95, and have since steadily declined. Landings from bottom trawling were relatively constant, but increased since 1997–98 to reach levels comparable to those from the longline fishery.

The Southland and Sub-Antarctic fisheries exhibit comparable trends. Most landings are taken by deepwater bottom trawl, with longline landings being secondary in importance. Landings from both methods in both areas have generally increased over the time examined, but particularly so for Sub-Antarctic longline. Other fisheries produce negligible landings.

The Bounty ling fishery is almost exclusively longline. It developed rapidly, and produced relatively high landings for 3 years. Since 1994–95, landings have been steady at about 400 t annually.

The West SI fishery is probably the most mixed from the point of view of the number of significant methods. Longlining appears to have been the most productive fishery since 1991–92, and it has exhibited a trend of increasing landings. Reported landings from the deepwater midwater trawl fishery have fluctuated widely, but have been at levels comparable to the longline fishery in recent years. However, it is strongly believed that catches from the trawl fishery were under-reported during the period 1989–90 to 1991–92 (Horn & Ballara 1999). Landings from the deepwater bottom trawl fishery have shown an increasing trend, with a catch in 1998–99 comparable to those from the midwater trawl and longline fisheries. Catches by inshore bottom trawl vessels have remained relatively constant at about 150 t annually, but inshore midwater trawlers exhibit a trend of increasing landings. A setnet fishery has declined over the period examined.

The most productive fishery in Cook Strait, deepwater midwater trawl, has shown a decline in landings. All other fisheries in this area appear to have fluctuated without trend.

3.3 Landings by reported position

Trawl vessels reporting landings on TCEPR forms generally reported the latitude and longitude of each trawl shot. Also, many of the large longlining vessels reported latitude and longitude of each set on the CELR forms. These data were summarised to produce plots of total ling catch by position, for three fishing methods (bottom trawl, midwater trawl, bottom longline). Plots by fishing year, and by month with all years combined are presented in Appendix B (Figures B1–B6). Note that these figures do not represent a complete picture of all ling landings by the three fishing methods; many inshore trawl vessels and longline vessels do not report (and are not required to report) shot position.

However, the presented data can be used to help identify any seasonal changes in ling abundance, and should indicate any areal changes throughout the 1990s in the major fisheries for ling.

3.3.1 Bottom trawl

Distribution of landings by fishing year has remained relatively constant throughout the 1990s (Figure B1). Several areas of particularly high abundance are apparent, i.e., the northwestern Chatham Rise adjacent to the Mernoo Bank, the area south and west of the Stewart-Snares shelf, Puysegur Bank, and off the northwestern coast of the South Island. Other areas with consistent catches of ling throughout the period are the Bay of Plenty, Wairarapa coast, and the north Chatham Rise west of Chatham Island. Fisheries have developed on the south Chatham Rise (from 1990–91), in Cook Strait (from 1993–94), south of the Auckland Islands Shelf (from 1991–92), on the Challenger Plateau (from 1997–98), and off Northland (from 1994–95). Patterns of ling landings from the eastern and southern Campbell Plateau have fluctuated markedly.

The distribution of bottom trawl ling landings by month is influenced largely by the movements of vessels targeting species other than ling, particularly hoki (Figure B2). Landings from the northwest and south Chatham Rise, and the Mernoo Bank are relatively consistent year round, except from July to September, when vessels shift to targeting spawning hoki off the northwest coast of the South Island. Landings from the east and south of the Stewart-Snares shelf are also relatively consistent throughout the year, with the exception of some drop-off during July and August. Some large catches south of the Stewart-Snares shelf from September to November are probably associated with ling spawning concentrations. An abundance of ling on Puysegur Bank from July to October could be similarly related. Landings of ling from the west coast hoki spawning fishery are particularly apparent from June to September. A concentration of landings from northwest of the Chatham Islands from September to January is related to a target fishery for spawning hake. Landings off the Wairarapa coast and in the Bay of Plenty are largely associated with a target scampi fishery.

3.3.2 Midwater trawl

Landings of ling by midwater trawl are concentrated in several distinct areas, and have been reasonably consistent throughout the 1990s (Figure B3). Significant landings from the target fisheries for spawning hoki off the northwest of the South Island and in Cook Strait have occurred in all years. Consistent landings from Puysegur Bank are also apparent. A midwater trawl fishery, primarily for non-spawning hoki, developed to the west of Mernoo Bank in 1990–91, and has since spread about half way along the Chatham Rise. Landings of ling bycatch from the target fishery for southern blue whiting are apparent in most years from the Bounty Platform, Pukaki Rise, and adjacent to the Campbell Island Rise. Significant quantities of ling have also been taken from the south of the Stewart-Snares shelf since 1992–93.

The distribution of midwater trawl ling landings by month is determined primarily by four target fisheries for other species (Figure B4). Fisheries for spawning hoki occur off the northwest of the South Island and in Cook Strait, from June to September. On the Chatham Rise, a target fishery for non-spawning hoki is conducted year-round, with the exception of a lull during the peak of the hoki spawning season. The target fishery for southern blue whiting occurs primarily in August and September on the Bounty Platform and Campbell Plateau. Landings from Puysegur Bank are taken almost exclusively from June to October.

3.3.3 Longline

Longline landings by fishing year demonstrate a gradual expansion of fishing grounds throughout the 1990s (Figure B5). The fishery on the Chatham Rise developed from 1989–90, and was well

established by 1991–92. The distribution of landings has been very consistent since the mid 1990s. The Sub-Antarctic fishery developed in 1990–91, and the distribution of catches appears to have expanded each year since then. The Bounty Platform fishery developed in 1991–92. Landings adjacent to Solander Island in the Southland area appear from 1991–92, and this location has been consistently very productive since then. Landings from off the central west coast of the South Island occur consistently from 1992–93. A group of sets on the Challenger Plateau in 1998–99 produced the bulk of the extra territorial landings in that year.

Landings from the western Chatham Rise occur consistently throughout the year, but there is a marked concentration of landings from the eastern Rise from July to October (Figure B6). This concentration is probably related to fishing on spawning aggregations of ling. The spawning season on the Chatham Rise appears to peak in September and October, and could extend from June to November in some years (Horn et al. 2000). Landings from the Southland area adjacent to Solander Island are taken almost exclusively from September to January. This period of time almost certainly includes the spawning season in that area. Landings from the Sub-Antarctic area exhibit no clear seasonal trends.

3.4 Descriptions of major ling fisheries by area

Each area (except Kermadec) supports at least one fishery which has produced an average of at least 80 t of ling annually over the period examined. Where ling is primarily a bycatch species of these fisheries, only the seasonality of the ling catch is presented below. Where ling is one of the top two target species in the fishery, and produces average annual landings of at least 80 t, a more detailed analysis of fishery characteristics is presented. The fisheries are examined by area.

3.4.1 Northland

Most ling taken by longline are caught in a target fishery for that species (Table 6). The fishery is clearly seasonal, with most landings taken during August and September (Figure 3). Landings tend to be concentrated in the Bay of Plenty and the deeper waters off east Northland. Catch rates have increased slightly, but steadily over time, as has effort per set (Figure 4). Trends in vessel characteristics are less obvious, but a slight overall increase in vessel power is indicated.

Ling taken by deepwater bottom trawl are almost exclusively bycatch of three distinct target fisheries, scampi, gemfish, and hoki (Table 6). Landings from the scampi fishery (primarily in the Bay of Plenty) have been consistent throughout the 1990s. The bycatch from the gemfish and hoki fisheries has only become significant in the mid to late 1990s. Landings peak generally in June, and August–September (Figure 3), which corresponds with periods of target fishing for gemfish.

Some of the landings reported as taken from statistical areas 3–7 in Northland are almost certainly in error. It was apparent that on some CELR forms QMA had been recorded in the statistical area field. Wherever an error was obvious, it was corrected and the landings were allocated to the relevant ling stock (see Appendix A, statistical areas 300, 400, 500, 600, and 700). However, it is likely that not all errors of this nature were identified.

3.4.2 East North Island

Virtually all ling taken by longline off the lower east coast of the North Island are from a target fishery for that species (Table 7). The fishery is strongly seasonal, with a landings peak between June and November (Figure 5). Catch rates appear to have increased slightly throughout the 1990s, while effort per set has approximately doubled (Figure 6). Trends in vessel characteristics indicate an overall increase in mean vessel power.

Ling have been a consistent bycatch of the deepwater bottom trawl fishery for scampi (primarily off the Wairarapa coast) throughout the 1990s (Table 7). However, the development in the mid 1990s of a target fishery for hoki in this area has led to an increase in the ling trawl bycatch. There is no clear seasonality in the catch of ling by deepwater bottom trawl (Figure 5).

3.4.3 East South Island

Virtually all ling taken by longline off the lower east coast of the South Island are from a target fishery for that species (Table 8). Most landings are from north of Banks Peninsula. The fishery does not exhibit any strong seasonality (Figure 7). High catches have been recorded in January, February, and October, but this trend is not consistent over all years. Catch rates increased steadily up to 1995–96, but have declined since then (Figure 8). The number of hooks per set has increased steadily throughout the 1990s. Vessel characteristics (length and power) have been relatively constant since 1991–92.

Ling are a major and consistent bycatch of the deepwater bottom trawl fishery for hoki, and a generally minor bycatch of trawl fisheries targeting various other species (Table 8). Consequently, the seasonal peaks in ling landings by trawl correspond to effort peaks in the hoki fishery in this area, i.e., before and after the hoki spawning season (Figure 7).

Ling are also a major bycatch of the deepwater midwater trawl fishery for hoki (Table 8). Ling landings from this method have steadily increased in the late 1990s, in conjunction with an increase in the use of this method to target hoki off east coast South Island, but primarily north of Banks Peninsula. There is a clear seasonal trough in landings in August, as vessels are targeting spawning hoki in other areas (Figure 7). Landings from other months fluctuate at low levels.

A target setnet fishery for ling has produced relatively constant landings of between 100 and 200 t annually (Table 8). Setnet operations are concentrated in statistical areas 18 and 24. There is a clear landings peak in this fishery around July, and a trough in September–October, although good landings levels can be derived from almost all months (Figure 7). Catch rates have remained constant over the examined duration of the fishery, although the average length of net per set has increased slightly (Figure 9). Trends in vessel characteristics indicate an overall increase in mean vessel size and power.

About 20 t of ling are taken annually in fish pots from statistical area 24. Ling is reported as the target species in this fishery for 80% of the landings.

3.4.4 Chatham

Virtually all ling taken by longline on the Chatham Rise are from a target fishery for that species (Table 9). This is New Zealand's largest target fishery for ling, with landings in excess of 2000 t annually since 1991–92. The fishery is strongly seasonal, with a landings peak from August to October (Figure 10). After initial fluctuations, catch per set has remained relatively constant since 1991–92 (Figure 11). However, effort per set has more than doubled over the same time period. Vessel length and power have been relatively constant since 1990–91.

Deepwater bottom trawling on the Chatham Rise produces a considerable quantity of ling each year from fisheries on a variety of target species (Table 9). The fishery for hoki is responsible for most of the ling bycatch, and ling landings have increased markedly since 1997–98. Landings from a hake target fishery have also shown a recent increasing trend. Landings reported as being from a ling target fishery have fluctuated widely (from 3 to 704 t annually), with no apparent trend. A weak seasonal peak in landings from September to December is apparent (Figure 10). Catch rates, and net and vessel

characteristics from the reported ling target fishery have fluctuated without any clear trends (Figure 12).

3.4.5 Southland

Most ling taken by longline in the Southland area are from a target fishery for that species (Table 10). Fishing with this method is almost exclusively confined to statistical area 30. The fishery is strongly seasonal with virtually all landings being from October to December (Figure 13). Catch per set has more than doubled throughout the 1990s, but effort appears to have increase about four-fold (Figure 14). Vessel length and power have been relatively constant since 1991–92.

Deepwater bottom trawl fisheries targeting ling and hoki account for most of the ling landings taken by this method in the Southland area (Table 10). However, significant landings (i.e., in excess of 100 t annually) are often taken during targeting for other species, particularly silver warehou, arrow squid, and hake. Most ling landings by this fishing method are taken during winter–spring, predominantly in June and September–November (Figure 13). These peaks coincide with fisheries for pre- and post-spawning hoki, and spawning ling. Catch rates in the ling target fishery appear to be consistently higher in the late 1990s than they were early in that decade (Figure 15). There appeared to be a change after 1995–96 to using bottom trawls with a higher net opening. Vessel length and power appears to have generally increased since 1991–92.

A deepwater midwater trawl fishery for hoki has produced a significant, but fluctuating, level of ling landings during the 1990s (Table 10). The fishery occurs almost exclusively from September to November (Figure 13) in statistical areas 28 and 30, when vessels are targeting post-spawning hoki.

3.4.6 Sub-Antarctic

Longline fishing in the Sub-Antarctic area developed in the 1990–91 fishing year and has targeted ling almost exclusively (Table 11). Landings by month have fluctuated markedly between years, but there is a trend apparent of generally higher landings levels from January to June, and negligible landings from August to October (Figure 16). Catch rate and effort per set were at their highest levels in 1990–91, the first year of the fishery, but both dropped markedly in the second year (Figure 17). From 1991–92, catch rates and number of hooks per set have increased steadily, but still only to about half the 1990–91 levels. Vessel size and power have remained relatively constant throughout the duration of the fishery.

Deepwater bottom trawl fisheries targeting ling and hoki account for most of the ling landings taken by this method in the Sub-Antarctic area (Table 11). The target ling fishery is the more productive of the two, with annual landings generally being well over 1000 t. Ling landings when targeting hoki have fluctuated quite widely. The trawl fisheries catch most ling over the months August to December, with generally negligible landings in other months (Figure 16). Catch of ling per trawl shot by vessels targeting ling appears to have increased slightly throughout the 1990s (Figure 18). Trawl and vessel characteristics have fluctuated without trend.

3.4.7 Bounty

Virtually all ling taken from the Bounty Platform are caught in a target longline fishery, which developed in 1991–92 (Table 12). Peak landings generally occur during spring and summer (Figure 19). Catch rate, effort per set, and vessel length and power have all exhibited similar increasing trends over the duration of the fishery (Figure 20).

Other (negligible) landings of ling on the Bounty Platform are taken as a bycatch of the trawl fishery for southern blue whiting.

3.4.8 West South Island

Fisheries returning significant quantities of ling from off the west coast of the South Island are quite diverse, although most landings are a bycatch of trawl fisheries for hoki (Table 13). However, there are two target fisheries for ling in this area; longline and setnet.

The target longline fishery for ling has been increasing in importance throughout the 1990s (Table 13). Landings are concentrated in the south of this area (statistical areas 32–34). Although significant landings are taken in most months, there is a clear landings peak in September and October (Figure 21). Catch rates have increased slightly over the period examined, while hooks per set has almost doubled (Figure 22). Vessel length and power have both increased slightly.

The target setnet fishery for ling has declined in importance throughout the 1990s (Table 13). It is clearly seasonal, with virtually all landings taken from July to September (Figure 21). Most landings are from statistical area 34. Catch rates have been relatively constant, but a slight increasing trend is apparent late in the decade (Figure 23). Length of net per set has increased over time, as have vessel length and power.

Deepwater trawl fisheries (both bottom and midwater) targeting hoki produce significant ling landings (Table 13). These fisheries are strongly seasonal (July to September) to coincide with hoki spawning off the west coast, primarily in statistical areas 34 and 35 (Figure 21). Landings of ling by these methods are negligible from October to May.

Inshore bottom trawling off West SI has consistently produced about 130 t of ling annually, mainly as bycatch of target fisheries for barracouta and hoki in statistical areas 33 and 34 (Table 13). Ling landings are taken throughout the year, but clearly peak from July to September (Figure 21), coinciding with spawning seasons of the two target species.

3.4.9 Cook Strait

A target longline fishery for ling in Cook Strait produces relatively low levels of landings, but does contribute a relatively significant proportion of ling landings from this area (Table 14). The fishery has no strong seasonality, but higher landings in May and June, and negligible landings from December to February are prevalent (Figure 24). Fishing is essentially confined to statistical areas 16 and 17. Catch rates have remained relatively constant throughout the 1990s, although hooks per set have probably doubled (Figure 25). Vessel length and power exhibit slight increasing trends.

A deepwater midwater trawl fishery targeting hoki in statistical areas 16 and 17 has consistently produced more than 100 t of ling bycatch annually (Table 14). The fishery is strongly seasonal (June to September) to coincide with hoki spawning in Cook Strait (Figure 24).

3.5 Analysis of longline methods

Ling are taken by a variety of lining methods, although in the analyses above all landings by this general method have been grouped. Reported lining methods producing catches of ling are bottom longline, dahn line, trot line, and handline. Landings by handline are negligible (less than 1 t per fishing year in all areas combined), so are not considered further here.

Landings by the three other lining methods, by area and fishing year, are presented in Table 15. Landings by bottom longline are clearly dominant in all areas; overall, that method produces 98% of the line catch, with about 1% taken by each of dahn line and trot line. Landings reported by trot line were made generally in the early 1990s, particularly in the 1990–91 fishing year and off West SI. Dahn line landings are negligible in all areas except East SI and Cook Strait where they have been taken consistently throughout the 1990s. Cook Strait is the only area where bottom longline takes less than 95% of the line catch; in that area 27% of landings are attributed to the dahn line method.

4. CONCLUSIONS

Fisheries for ling in New Zealand waters are widespread, diverse, and complicated. Significant landings were recorded from all the fishstock areas examined in this analysis, although 95% of landings are taken in waters to the south of and including Cook Strait. Total landings generally increased throughout the 1990s to peak in 1997–98, and then declined slightly.

Longline (primarily bottom longline) is the method used most often to target ling, and such target fisheries for this species occur in all areas examined. About 39% of all ling landings were taken by longline. Longline was the most productive fishing method in Northland, East NI, Chatham, Bounty, and West SI, and the second most productive method in all other areas. In general, catch per set has increased in all areas throughout the 1990s, although effort (in terms of number of hooks per set) has increased at a greater rate (often about double). Mean catch per hook has declined in all areas, but most notably in East SI and Chatham. In these two major longline fisheries (East SI and Chatham), catch per set has remained static or declined in recent years despite increasing levels of effort. Vessel size and power has generally increased over time in all areas. Longline fisheries for ling are often strongly seasonal, and much of the target fishing may be on spawning aggregations of the species.

Setnet is the other fishing method used to consistently target ling, but it produces less than 3% of the national landings. This method is important only in East SI and West SI. Catch rates in both these areas have remained relatively constant throughout the 1990s, although effort (in terms of mean length of net per set) has increased steadily. Based on total landings per year, these fisheries appear to be declining in importance, particularly in West SI.

The fishing method producing the greatest ling catch is bottom trawl; the inshore and deepwater fisheries combined produce about half of New Zealand's ling landings. Over 80% of the ling taken by this method is a bycatch of target fisheries for hoki. In fact, hoki is one of the top three target species in all bottom trawl fisheries landing ling. Southland and Sub-Antarctic are the only areas with significant bottom trawl target fisheries for ling. But even in these two areas only 40% and 60%, respectively, of the ling catch is taken by target trawling for ling. Consequently, any trends in area or season of bottom trawl landings are primarily influenced by patterns of fishing for species other than ling, and trends in catch rates of ling may not be related to the relative abundance of that species.

Midwater trawling produces about 8% of total ling landings. Of this total, over 95% is taken as a bycatch of target fisheries for hoki. So as for bottom trawl, any trends apparent in area or season are primarily influenced by patterns of fishing for hoki, and trends in catch rates of ling may not be related to the relative abundance of that species.

Landings of ling from fish pots are significant only in the East SI area (and only in statistical area 24), but have been consistently reported from this area throughout the 1990s. This method produces 0.1% of the total ling landings.

Analyses of standardised catch per unit effort (CPUE) are often used to provide indices of relative abundance in fish stocks. CPUE series from target ling longline fisheries in the East SI, Chatham, Southland, Sub-Antarctic, Bounty, and West SI areas are currently being used as inputs into stock assessments (Harley 1999, Horn & Ballara 1999, Horn et al. 2000). CPUE from the target longline

fishery in Cook Strait was also investigated, but was rejected as a useful index of abundance primarily because of insufficient data points (Horn & Ballara 1999). Target longline fisheries in the Northland and, particularly, the East NI areas are more productive than the Cook Strait fishery, so have the potential to produce useful CPUE series. It is recommended that analyses of standardised longline CPUE be conducted for these areas.

There are two significant target setnet fisheries for ling, West SI and Kaikoura coast. However, neither of these is likely to produce useful CPUE series. Fishing activity in the West SI fishery has declined steadily throughout the 1990s, so there would be insufficient data from recent years. The stock affinity of ling off the Kaikoura coast is currently uncertain. These fish could be part of either the Cook Strait or Chatham Rise stocks.

The only trawl fishery yet to be analysed for ling CPUE is the Puysegur bottom trawl fishery in the Southland area (Ballara 1997). Analysis models were run on ling catches from all target species, target ling only, and target ling or hoki. There were insufficient data for the ling target fishery to produce a useful index on its own. Fishing patterns in terms of vessels, nationality, targeting, and timing changed markedly over the years. There were also some doubts as to whether target species was accurately recorded, i.e., was target species recorded as the most abundant species in the catch after the trawl was brought on board? Consequently, it was concluded that the Puysegur trawl series was probably influenced by factors other than fish abundance, and so the results may be meaningless (Ballara 1997). Similar considerations would need to be applied to any CPUE analysis of ling catch from other trawl fisheries. Most of these fisheries target hoki. Before any analysis should be considered, there would need to be an established pattern of targeting that has remained relatively constant in area, season, and fishing method over several years. Areas with potential for such analyses are East SI, Chatham, Sub-Antarctic, and West SI. Relative abundance of ling in the first three of these areas is believed to be satisfactorily monitored by series of research trawl surveys. However, indices of abundance for the West SI ling stock are available only from a CPUE analysis of the longline fishery, which takes less than a third of the catch from that area. Thus, an investigation of ling CPUE in the bottom trawl fishery may be warranted, although owing to the believed under-reporting of ling in the early 1990s, only data collected since 1993–94 could be used.

5. ACKNOWLEDGMENTS

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Table 1: Definitions of geographical areas used in the analysis (based on statistical areas), and the administrative ling stocks they approximate. For a plot of statistical areas, see Figure 1.

Area	Statistical areas	Approximate ling stock
Northland	1–10, 42–48, 101–107	LIN 1
East NI	11–15, 201–206	LIN 2
East SI	18–24, 301–303	LIN 3
Chatham	49–51, 401–412	LIN 4
Southland	25–31, 501–504	LIN 5
Sub-Antarctic	601–606, 610–612, 616–620, 623–625	Part of LIN 6
Bounty	607–609, 613–615, 621, 622	Part of LIN 6
West SI	32–36, 701–706, 801	Part of LIN 7
Cook Strait	16, 17, 37–41	Parts of LIN 2 & 7
Kermadec	91–94	LIN 10
Extra territorial	All area outside NZ EEZ	ET

Table 2: Total ling landings (t) as reported on TCEPR and CELR returns, by fishing year, by area. The percentage of total landings taken over the entire period from each area is also presented (%). In this table, and in all others in this document listing catch, all values have been rounded to the nearest tonne, so "0" represents reported landings of less than 0.5 t, and "–" indicates nil reported landings.

Area	Fishing year										%
	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	
Northland	83	139	180	298	181	221	211	324	278	286	1.4
East NI	268	425	451	512	501	508	509	478	562	423	2.9
East SI	1 220	1 934	1 808	1 615	1 574	1 950	2 352	2 034	2 046	1 983	11.4
Chatham	513	2 157	4 360	3 539	3 755	4 839	4 151	3 814	4 343	3 926	21.8
Southland	2 143	2 105	3 841	2 888	3 258	3 644	4 537	4 445	4 120	3 549	21.3
Sub-Antarctic	1 189	2 673	2 390	5 038	2 270	3 653	3 591	4 951	5 386	4 284	21.8
Bounty	12	32	907	969	1 149	382	387	351	390	563	3.2
West SI	2 322	1 946	1 855	1 864	1 770	2 399	2 595	2 536	2 746	2 977	14.2
Cook Strait	415	528	315	327	257	330	380	392	282	352	2.2
Kermadec	–	–	–	–	–	–	0	–	–	0	0.0
Extra territorial	–	–	–	0	1	0	0	0	1	16	0.0
Total	8 166	11 939	16 107	17 050	14 718	17 926	18 713	19 325	20 153	18 358	

Table 3: Total ling landings (t) from fishing years 1989–90 to 1998–99 combined, by fishing method, by area. The percentage of total landings taken over all areas by each method is also presented (%).

Area	Fishing method						
	longline	setnet	deepwater bottom trawl	inshore bottom trawl	deepwater midwater trawl	inshore midwater trawl	fish pots
Northland	1 238	41	736	178	0	6	0
East NI	3 100	247	1 065	181	41	4	0
East SI	5 621	1 858	8 939	936	908	40	209
Chatham	24 015	0	10 946	17	417	–	0
Southland	5 180	9	27 054	617	1 649	–	16
Sub-Antarctic	11 448	–	23 803	0	179	–	0
Bounty	4 989	–	55	–	94	–	–
West SI	7 578	1 893	4 542	1 543	7 247	210	0
Cook Strait	705	44	540	332	1 646	311	0
Total	63 874	4 092	77 680	3 804	12 182	570	225
%	39.3	2.5	47.8	2.3	7.5	0.4	0.1

Table 4: Catch of ling (t) by area, by fishing year, for various fishing methods: deepwater bottom trawl, inshore bottom trawl, deepwater midwater trawl, inshore midwater trawl.

Area	Fishing year									
	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99
Deepwater bottom trawl										
Northland	32	70	55	30	45	43	73	142	136	109
East NI	59	117	88	75	74	79	126	153	131	163
East SI	599	817	936	802	727	826	1 084	1 019	1 158	972
Chatham	500	1 236	1 344	1 010	443	818	729	771	2 254	1 841
Southland	1 980	2 008	3 376	2 182	2 095	2 506	3 929	3 407	2 921	2 650
Sub-Antarctic	1 148	2 445	2 045	4 104	1 758	2 013	2 297	2 661	2 990	2 344
Bounty	4	7	35	–	4	0	1	–	–	3
West SI	370	260	306	476	385	486	370	518	496	876
Cook Strait	7	13	4	2	48	58	96	126	77	111
Extra territorial	–	–	–	0	1	0	0	0	1	1
Total	4 698	6 972	8 188	8 681	5 580	6 829	8 706	8 796	10 163	9 070
Inshore bottom trawl										
Northland	10	18	28	32	29	19	6	19	9	8
East NI	25	25	21	17	22	18	24	17	7	5
East SI	148	197	145	109	64	64	50	62	46	51
Chatham	4	5	2	–	1	2	3	0	0	0
Southland	47	63	64	94	78	83	50	56	28	64
Sub-Antarctic	–	–	–	0	–	–	–	–	–	–
West SI	148	150	192	218	111	107	190	166	105	157
Cook Strait	4	9	3	10	22	78	83	72	25	25
Total	386	469	447	479	326	374	406	393	220	310
Deepwater midwater trawl										
Northland	–	–	–	0	–	0	0	–	–	0
East NI	0	12	1	4	1	0	2	2	12	7
East SI	72	57	62	35	39	34	87	111	198	213
Chatham	–	69	11	44	39	54	59	52	44	45
Southland	116	29	121	173	271	398	274	133	79	57
Sub-Antarctic	42	11	19	48	11	11	22	5	5	6
Bounty	8	19	38	4	3	3	2	–	7	11
West SI	1 261	740	402	340	353	803	857	725	997	770
Cook Strait	260	326	200	179	107	117	119	141	105	91
Total	1 759	1 261	854	828	824	1 421	1 421	1 168	1 447	1 199
Inshore midwater trawl										
Northland	1	–	0	–	0	1	–	4	0	–
East NI	1	0	1	2	0	0	0	–	0	–
East SI	3	9	6	0	1	0	2	7	4	8
West SI	2	–	2	4	3	10	24	25	57	83
Cook Strait	42	125	37	30	11	6	16	22	13	9
Total	49	134	45	35	14	17	43	58	74	100

Table 5: Catch of ling (t) by area, by fishing year, for various fishing methods: longline, setnet, fish pots.

Area	Fishing year									
	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99
Longline										
Northland	39	50	95	231	104	131	130	158	131	169
East NI	135	186	300	389	401	409	353	278	401	248
East SI	185	613	475	490	552	816	944	593	397	556
Chatham	8	846	3 003	2 485	3 272	3 966	3 360	2 991	2 045	2 039
Southland	0	2	288	437	813	653	280	845	1 087	775
Sub-Antarctic	–	217	326	886	501	1 630	1 273	2 289	2 392	1 934
Bounty	–	7	834	965	1 142	378	384	347	383	549
West SI	197	428	687	698	766	891	983	975	963	990
Cook Strait	66	56	71	103	67	70	64	31	62	115
Kermadec	–	–	–	–	–	–	–	–	–	0
Extra territorial	–	–	–	0	0	–	0	0	0	15
Total	630	2 407	6 079	6 683	7 619	8 942	7 771	8 506	7 860	7 390
Set net										
Northland	2	0	1	5	3	27	1	1	1	0
East NI	48	85	40	25	4	1	4	27	12	1
East SI	210	227	145	164	180	199	180	205	201	147
Chatham	0	–	0	–	–	–	–	–	–	–
Southland	0	2	1	1	0	1	0	2	2	0
West SI	345	368	266	129	154	103	170	126	129	103
Cook Strait	36	0	1	3	1	1	1	1	0	0
Total	641	682	453	327	342	332	357	363	344	252
Fish pots										
Northland	0	0	0	0	–	–	–	–	–	–
East NI	–	–	–	–	0	–	0	–	–	–
East SI	2	14	39	15	12	8	4	38	41	36
Chatham	0	0	0	0	0	–	–	–	–	–
Southland	1	1	1	1	1	2	4	2	3	0
Sub-Antarctic	–	0	–	–	–	–	–	–	–	0
West SI	–	–	0	–	–	–	0	0	0	–
Cook Strait	–	0	0	0	–	–	0	–	–	–
Total	3	16	40	16	13	10	8	40	44	36

Table 6: Northland — reported landings (t) of ling by stated target species, by fishing year, for significant fishing methods. The listed target species account for at least 99% of ling landings in each fishery over the period examined.

Target species	Fishing year									
	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99
Longline										
ling	23	40	74	212	76	94	94	133	111	147
bluenose	14	8	6	5	8	12	7	13	11	8
ribaldo	0	0	13	7	6	2	16	6	–	6
hapuku & bass	1	2	3	6	6	4	6	5	8	7
rig	–	–	–	–	8	17	6	–	–	–
total	38	50	95	230	104	130	129	157	131	168
Deepwater bottom trawl										
scampi	31	70	54	26	43	26	17	13	15	25
gemfish	0	0	1	2	2	12	42	74	78	36
hoki	0	–	–	1	0	1	4	45	30	27
tarakihi	–	–	0	0	1	3	6	7	8	5
ling	–	–	–	–	–	–	1	0	2	14
snapper	–	–	–	–	0	0	3	1	1	0
total	32	70	55	30	45	42	72	140	134	107

Table 7: East NI — reported landings (t) of ling by stated target species, by fishing year, for significant fishing methods. The listed target species account for at least 99% of ling landings in each fishery over the period examined.

Target species	Fishing year									
	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99
Longline										
ling	121	160	290	369	377	378	339	269	390	242
bluenose	1	8	8	14	14	19	10	5	9	5
hapuku & bass	13	13	0	2	4	9	2	3	2	0
gemfish	–	0	2	3	5	1	2	1	0	0
total	135	182	299	388	400	406	352	278	401	247
Deepwater bottom trawl										
scampi	58	114	86	70	56	51	70	73	63	119
hoki	–	0	1	2	11	14	31	68	56	34
gemfish	0	0	1	2	3	3	8	7	9	7
tarakihi	–	0	1	0	1	8	8	2	2	2
alfonsino	–	2	–	0	2	1	3	0	0	–
total	59	116	88	73	73	76	121	151	130	162

Table 8: East SI — reported landings (t) of ling by stated target species, by fishing year, for significant fishing methods. The listed target species account for at least 99% of ling landings in each fishery over the period examined.

Target species	Fishing year									
	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99
Longline										
ling	183	608	471	486	544	801	934	580	396	547
bluenose	2	0	0	2	2	12	9	12	1	5
hapuku & bass	0	3	4	2	5	1	0	0	1	2
total	185	612	475	489	552	815	943	593	397	555
Deepwater bottom trawl										
hoki	356	330	715	449	485	554	926	902	1 025	872
ling	46	350	57	25	24	16	3	–	24	–
scampi	1	0	4	150	89	82	57	28	14	22
arrow squid	60	8	41	34	58	57	33	32	30	27
silver warehou	69	55	39	60	29	48	25	1	13	15
red cod	16	23	53	43	24	27	29	37	23	17
barracouta	24	18	19	36	7	8	8	13	20	14
spiny dogfish	4	21	1	0	–	15	1	0	2	–
hake	1	–	0	2	1	9	0	2	3	3
total	578	804	928	799	716	816	1 082	1 015	1 154	969
Deepwater midwater trawl										
hoki	55	54	62	32	36	32	86	110	198	213
ling	17	–	–	–	–	–	–	–	–	–
arrow squid	–	0	–	1	2	1	0	0	–	–
total	72	54	62	33	38	33	86	110	198	213
Setnet										
ling	169	167	97	121	110	104	115	154	161	104
hapuku & bass	19	11	10	19	12	16	9	6	8	28
bluenose	3	4	1	7	9	32	35	19	15	5
tarakihi	12	12	13	3	7	19	6	7	5	2
spiny dogfish	3	5	3	5	19	10	7	6	5	5
rig	2	6	6	4	6	14	3	4	2	1
school shark	1	0	1	3	5	3	2	7	3	2
red cod	–	11	12	0	3	0	0	–	–	–
blue warehou	1	9	0	0	1	1	0	0	–	0
total	209	225	143	162	172	198	178	203	198	147

Table 9: Chatham — reported landings (t) of ling by stated target species, by fishing year, for significant fishing methods. The listed target species account for at least 99% of ling landings in each fishery over the period examined.

Target species	Fishing year									
	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99
Longline										
ling	7	846	2 999	2 479	3 267	3 966	3 359	2 983	2 038	2 038
hapuku & bass	1	0	4	6	5	0	0	0	1	1
bluenose	–	–	–	–	–	–	0	8	0	0
total	8	846	3 003	2 485	3 272	3 966	3 360	2 991	2 038	2 039
Deepwater bottom trawl										
hoki	161	759	653	431	188	520	436	482	1 159	1 190
ling	250	159	273	95	3	29	39	48	704	246
hake	21	9	65	229	84	137	170	165	306	321
scampi	–	17	270	221	138	94	40	66	45	58
silver warehou	26	163	60	22	18	37	26	2	15	11
barracouta	36	54	16	11	10	1	11	2	8	–
arrow squid	3	36	5	–	1	–	4	3	12	7
total	496	1 195	1 341	1 010	443	818	727	766	2 248	1 833

Table 10: Southland — reported landings (t) of ling by stated target species, by fishing year, for significant fishing methods. The listed target species account for at least 99% of ling landings in each fishery over the period examined.

Target species	Fishing year									
	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99
Longline										
ling	–	1	287	431	795	646	278	842	1 087	774
hapuku & bass	–	0	1	6	18	6	2	1	0	1
total	0	2	288	437	813	652	280	843	1 087	775
Deepwater bottom trawl										
ling	1 137	924	714	726	868	1 409	2 300	1 699	1 081	1 051
hoki	502	720	2 268	1 017	779	645	1 137	1 310	1 460	1 168
silver warehou	210	176	220	266	299	209	170	118	77	53
arrow squid	25	73	50	83	140	67	50	173	128	131
red cod	1	16	50	29	3	115	106	60	37	56
hake	21	0	4	4	2	51	115	22	108	107
barracouta	24	77	22	25	3	8	20	7	12	1
white warehou	37	19	25	–	–	1	–	–	12	70
stargazer	0	0	12	18	0	–	–	9	–	–
scampi	–	–	–	12	–	–	–	0	5	11
total	1 957	2 006	3 365	2 181	2 094	2 504	3 898	3 399	2 921	2 649
Deepwater midwater trawl										
hoki	115	28	120	170	261	398	272	127	78	55
arrow squid	0	1	0	2	–	0	1	6	0	1
hake	–	–	–	–	10	–	–	–	–	–
total	116	29	120	172	271	398	274	133	79	56

Table 11: Sub-Antarctic — reported landings (t) of ling by stated target species, by fishing year, for significant fishing methods. The listed target species account for at least 99% of ling landings in each fishery over the period examined.

Target species	Fishing year									
	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99
Longline										
ling	–	217	326	886	501	1 630	1 273	2 285	2 388	1 934
Deepwater bottom trawl										
ling	845	1 729	1 242	2 685	1 297	1 458	1 970	1 536	1 811	1 326
hoki	103	485	444	1 292	231	453	216	1 027	1 099	915
scampi	–	0	83	37	96	56	73	89	61	74
hake	164	77	136	45	74	3	–	0	11	9
arrow squid	21	53	5	33	47	21	36	4	6	0
southern blue whiting	2	0	111	6	14	13	–	0	2	10
white warehou	13	83	–	–	–	–	–	–	–	10
silver warehou	–	17	25	7	–	–	0	0	–	–
total	1 148	2 445	2 045	4 104	1 758	2 005	2 296	2 657	2 989	2 344

Table 12: Bounty — reported landings (t) of ling by stated target species, by fishing year, for significant fishing methods. The listed target species account for at least 99% of ling landings in each fishery over the period examined.

Target species	Fishing year									
	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99
Longline										
ling	–	7	834	965	1 142	378	384	351	386	549

Table 13: West SI — reported landings (t) of ling by stated target species, by fishing year, for significant fishing methods. The listed target species account for at least 99% of ling landings in each fishery over the period examined.

Target species	Fishing year									
	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99
Longline										
ling	195	422	661	652	726	824	970	947	928	928
hapuku & bass	0	4	19	11	26	10	6	12	24	48
bluenose	1	1	5	19	2	49	6	14	9	13
total	197	428	686	682	754	883	982	973	960	989
Deepwater bottom trawl										
hoki	270	230	235	327	348	419	354	458	468	818
gemfish	9	3	33	64	0	10	–	23	–	–
ling	38	6	1	46	7	2	3	26	–	4
hake	1	–	23	20	15	0	10	7	16	37
barracouta	35	16	5	13	4	17	1	–	5	2
silver warehou	8	1	4	3	2	25	1	–	1	3
jack mackerel	4	5	2	1	2	7	1	–	0	0
total	365	260	304	473	379	480	369	514	489	864
Deepwater midwater trawl										
hoki	1 260	739	398	315	327	774	851	713	986	760
hake	0	–	1	23	20	19	1	9	8	5
jack mackerel	–	0	2	1	1	6	3	2	0	1
silver warehou	–	–	1	2	5	–	1	1	3	–
barracouta	0	–	0	0	0	4	1	–	–	–
total	1 260	739	402	340	353	803	857	724	997	766
Inshore bottom trawl										
barracouta	6	23	35	17	11	25	61	125	65	134
hoki	99	60	24	87	33	12	55	27	30	18
ling	20	53	93	76	9	19	13	5	7	0
tarakihi	6	5	8	21	17	5	25	4	0	1
red cod	0	2	25	6	16	26	11	1	0	0
stargazer	4	1	0	1	8	19	11	1	2	0
flatfish	0	0	1	6	15	2	10	2	2	2
lookdown dory	12	2	2	1	0	–	–	–	–	–
total	344	368	266	129	154	103	170	126	129	101
Setnet										
ling	337	367	263	128	138	88	160	124	128	97
school shark	7	1	2	1	15	10	5	2	0	0
stargazer	–	–	–	–	–	6	4	–	1	0
hapuku & bass	0	0	0	0	0	0	1	0	0	3
total	148	146	188	215	109	106	186	164	104	156

Table 14: Cook Strait — reported landings (t) of ling by stated target species, by fishing year, for significant fishing methods. The listed target species account for at least 99% of ling landings in each fishery over the period examined.

Target species	Fishing year									
	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99
Longline										
ling	60	47	64	91	49	50	44	16	49	101
hapuku & bass	3	4	5	5	14	6	11	12	4	10
bluenose	0	2	0	4	3	13	7	2	9	2
school shark	1	3	1	3	1	1	2	1	0	1
total	65	56	71	103	67	70	64	31	62	114
Deepwater midwater trawl										
hoki	260	326	200	179	107	117	119	141	105	91
hake	–	–	–	–	–	–	–	–	1	–
total	260	326	200	179	107	117	119	141	106	91

Table 15: Landings of ling (t) by area, by fishing year, from the three main lining methods: bottom longline (BLL), dahn line (DL), trot line (TL).

Method	Fishing year									
	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99
Northland										
BLL	21	29	94	230	103	131	128	155	128	166
DL	0	0	0	0	0	0	0	1	1	2
TL	18	21	1	1	0	1	2	1	2	1
East NI										
BLL	126	134	289	385	383	400	351	277	400	247
DL	–	1	1	2	3	2	1	1	1	–
TL	9	52	10	2	15	6	1	0	–	1
East SI										
BLL	159	463	460	483	533	806	911	500	341	520
DL	17	47	5	4	19	9	34	77	57	36
TL	9	104	10	3	0	1	–	16	–	–
Chatham										
BLL	7	766	2 997	2 485	3 272	3 960	3 358	2 991	2 045	2 039
DL	0	0	–	–	–	0	0	–	–	–
TL	1	80	6	–	–	6	2	–	–	–
Southland										
BLL	0	2	288	437	813	652	279	845	1 087	775
DL	–	0	0	0	0	0	0	0	–	0
TL	–	–	–	1	0	0	0	–	–	–
Sub-Antarctic										
BLL	–	217	326	872	501	1 630	1 273	2 285	2 388	1 934
DL	–	–	–	0	–	–	–	–	–	–
TL	–	–	–	14	–	–	–	–	–	–
Bounty										
BLL	–	7	834	965	1 142	378	384	351	386	549
West SI										
BLL	151	353	629	666	705	871	982	971	961	989
DL	–	0	0	–	3	1	0	3	2	1
TL	46	75	58	32	58	19	–	1	–	–
Cook Strait										
BLL	18	16	44	75	46	52	51	21	52	105
DL	40	19	25	26	21	15	12	10	9	10
TL	8	21	1	1	1	3	0	1	–	–
Kermadec										
BLL	–	–	–	–	–	–	–	–	–	0
Extra territorial										
BLL	–	–	–	0	–	–	–	–	–	15
DL	–	–	–	0	0	–	0	0	0	–
TL	–	–	–	–	0	–	0	–	–	–

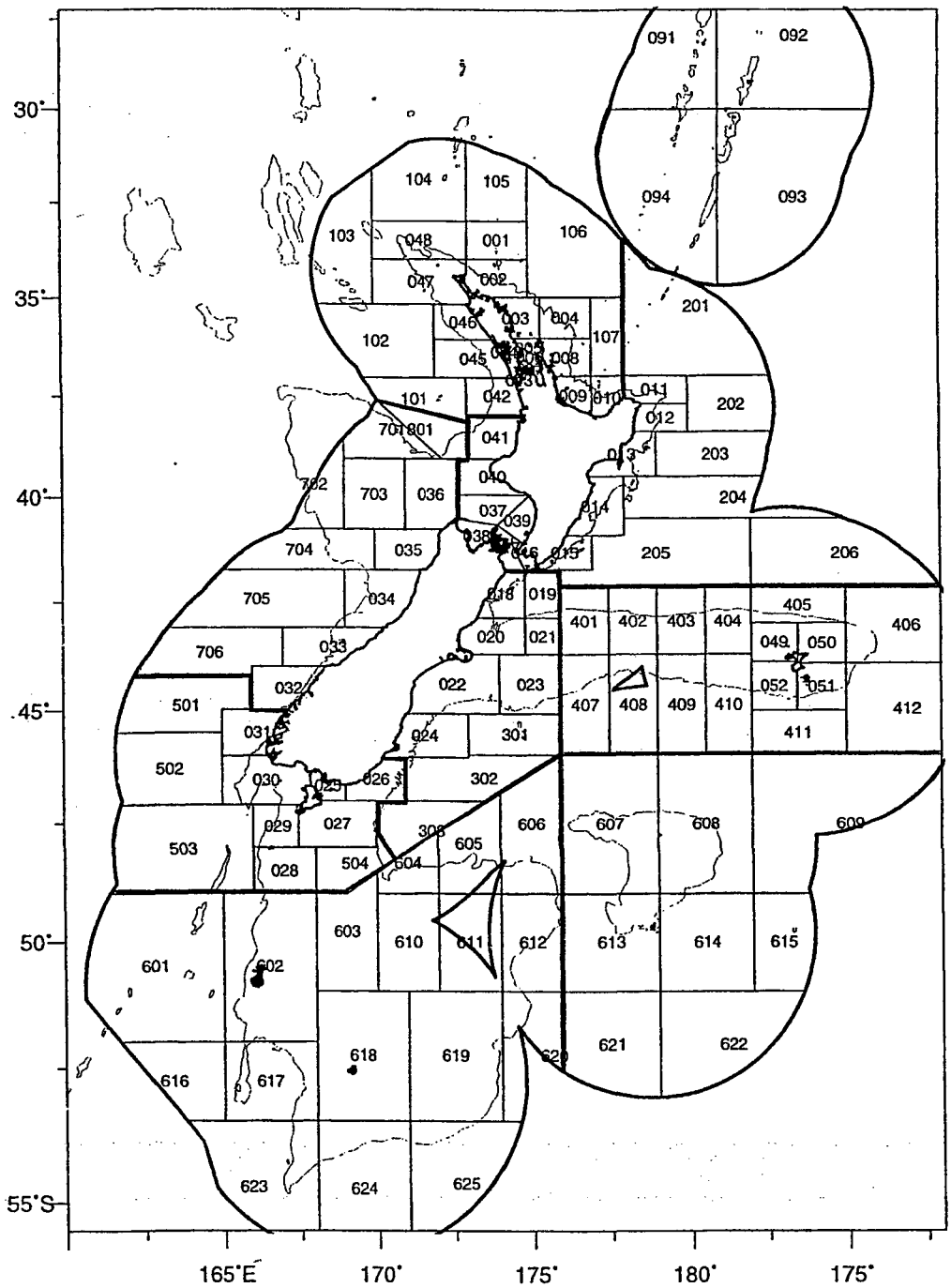

Figure 1: Map of the New Zealand EEZ with statistical areas (numbers from 001 to 801), showing how they were grouped (thick lines) to construct the 10 areas used in this analysis. The 1000 m isobath is also plotted.

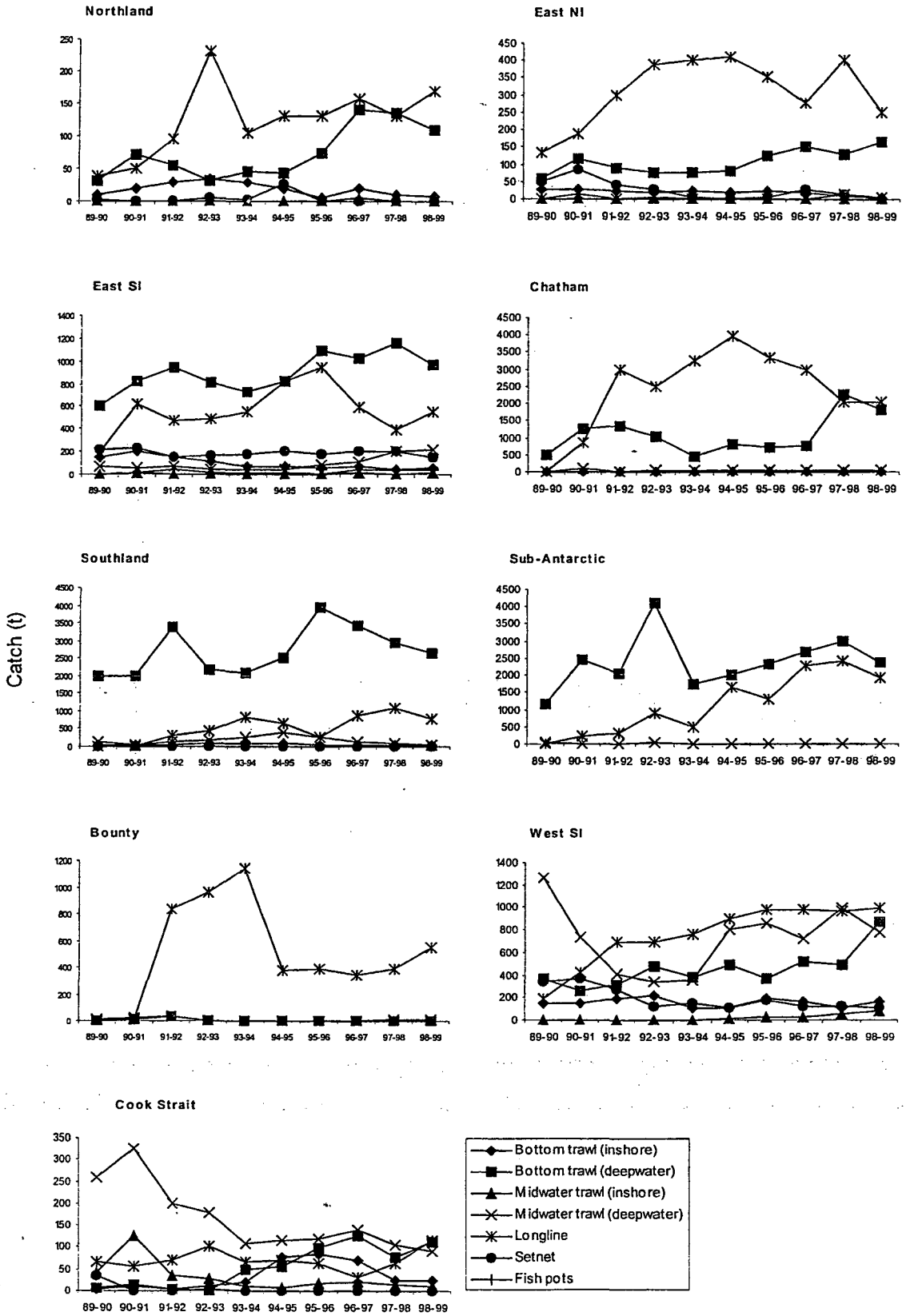

Figure 2: Catch (t) by fishing method, by fishing year, from the various areas defined for this analysis.

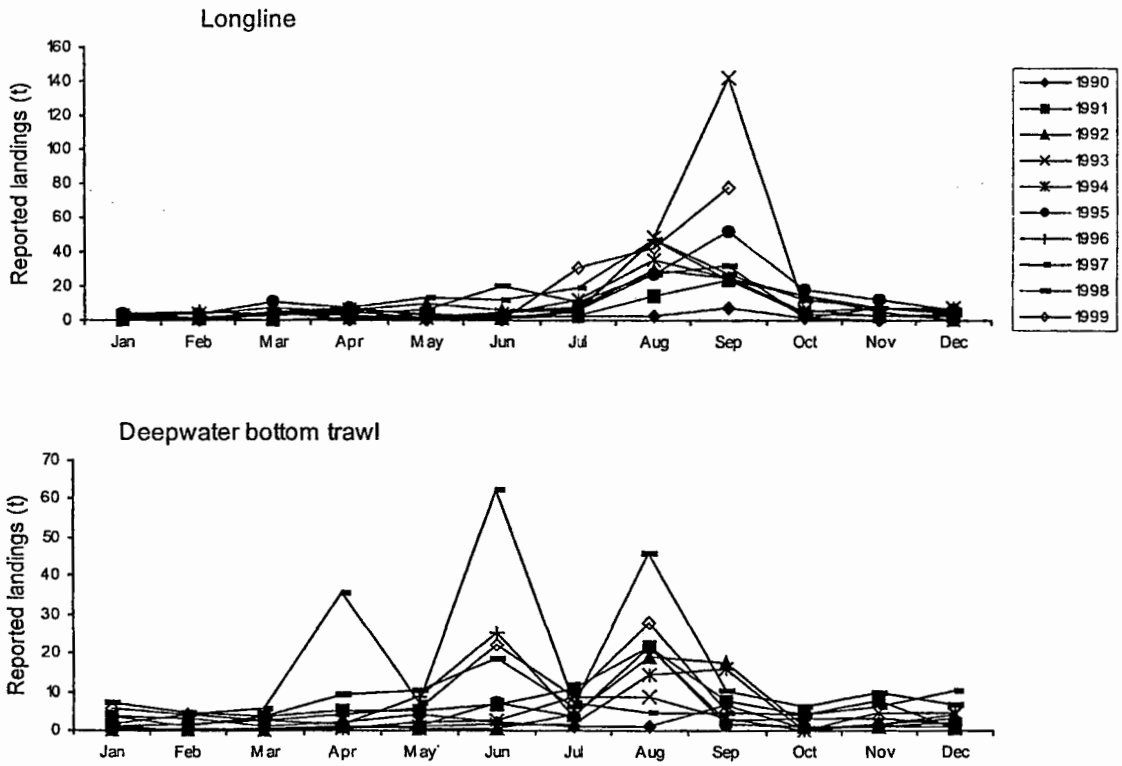

Figure 3: Northland — landings by month, by fishing year, for all significant ling fisheries in the area.

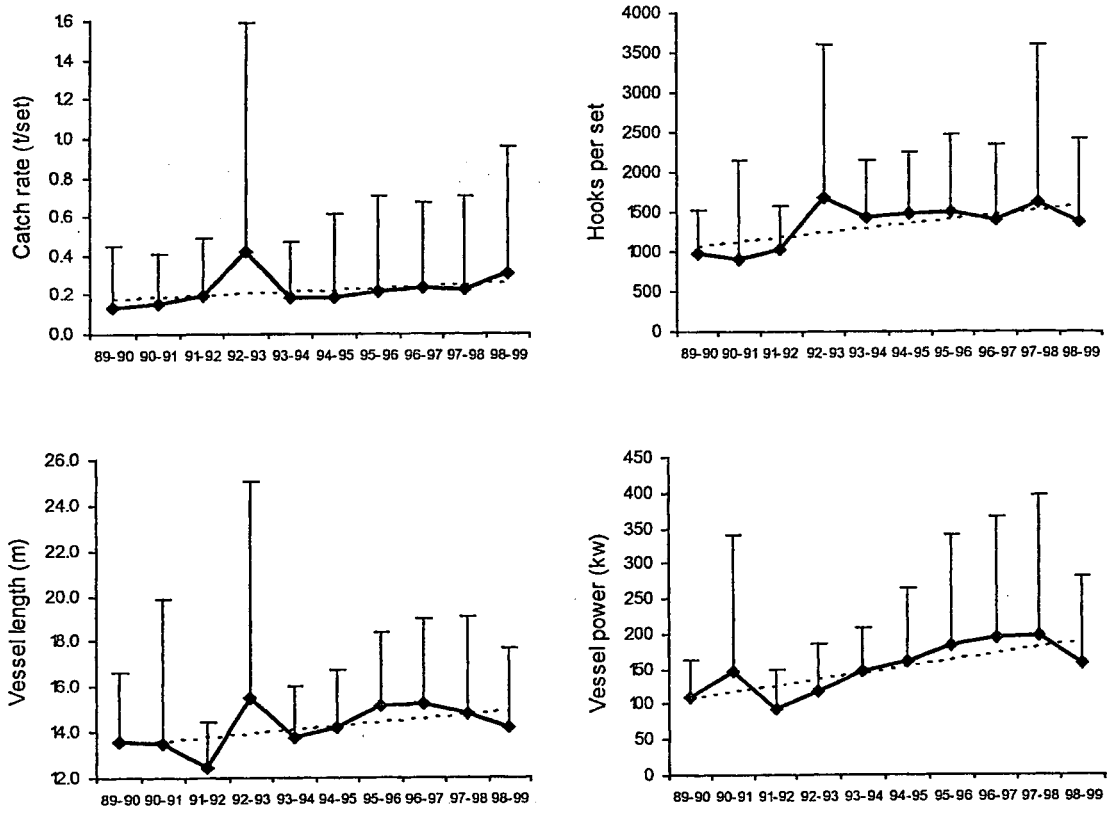

Figure 4: Northland — mean catch rate (t per set), effort (hooks per set), vessel length, and vessel power for the target ling longline fishery. Bars indicate one standard deviation, and the broken line is the linear regression to the averages.

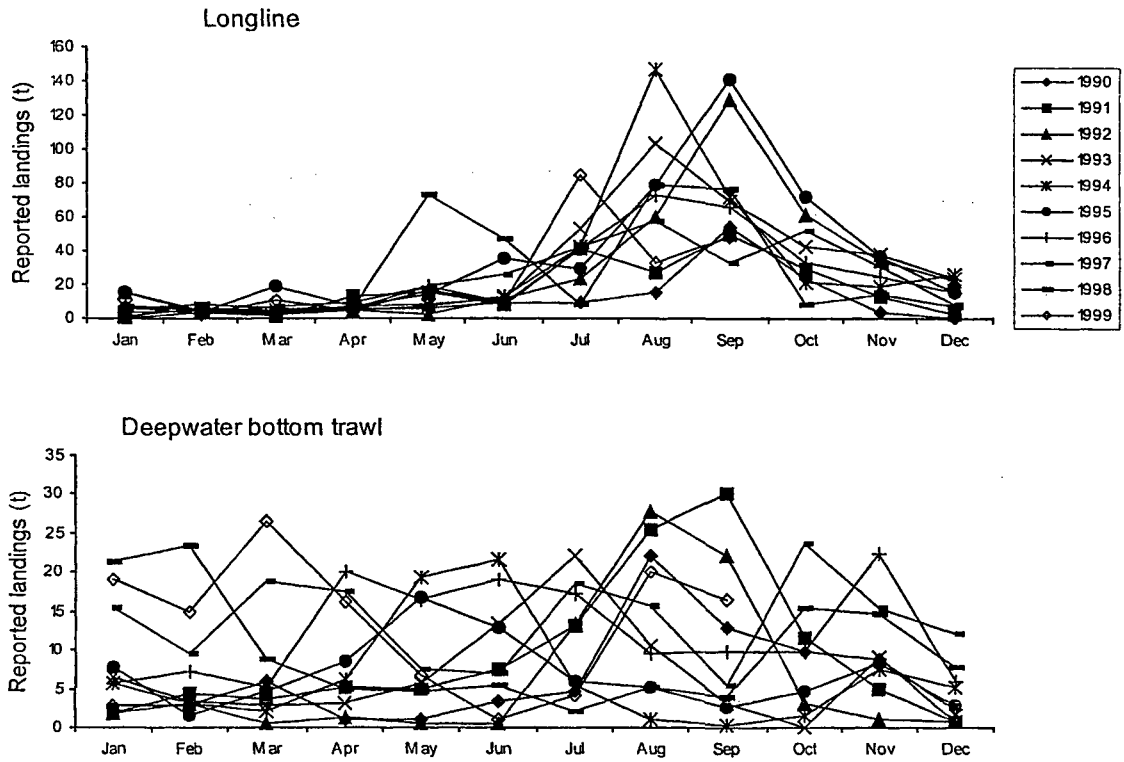

Figure 5: East NI — landings by month, by fishing year, for all significant ling fisheries in the area.

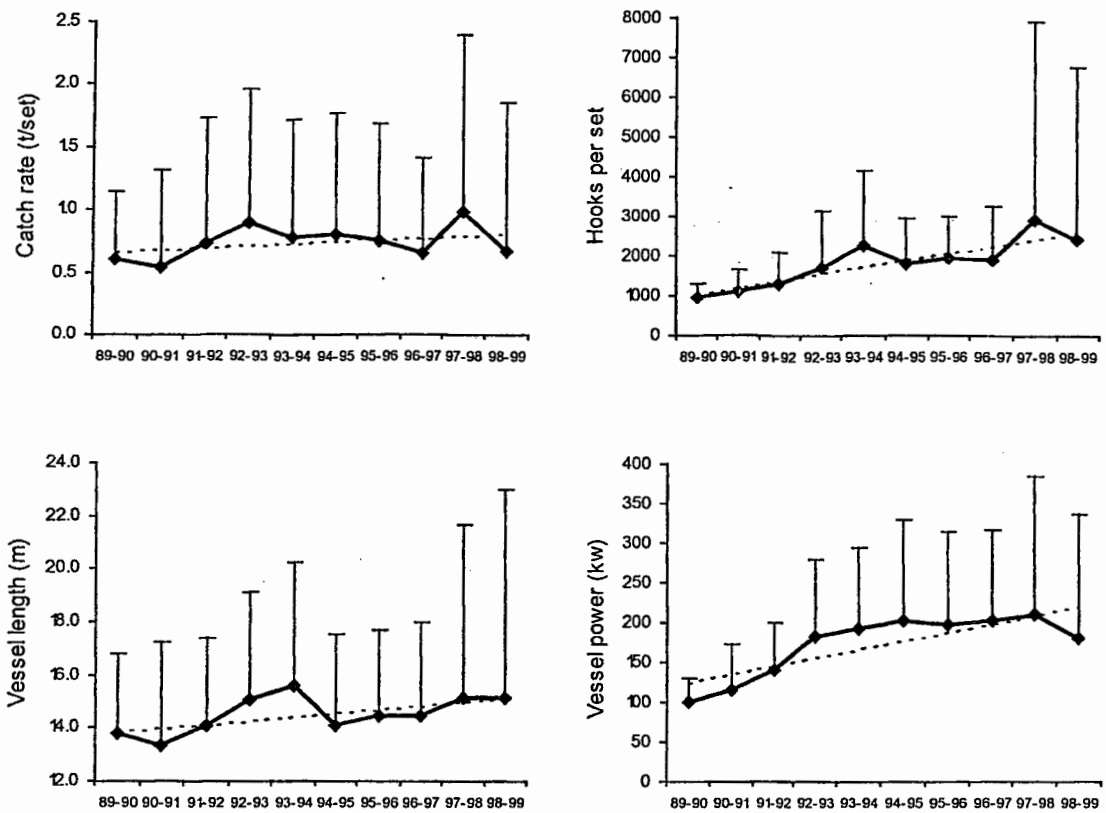

Figure 6: East NI — mean catch rate (t per set), effort (hooks per set), vessel length, and vessel power for the target ling longline fishery. Bars indicate one standard deviation, and the broken line is the linear regression to the averages.

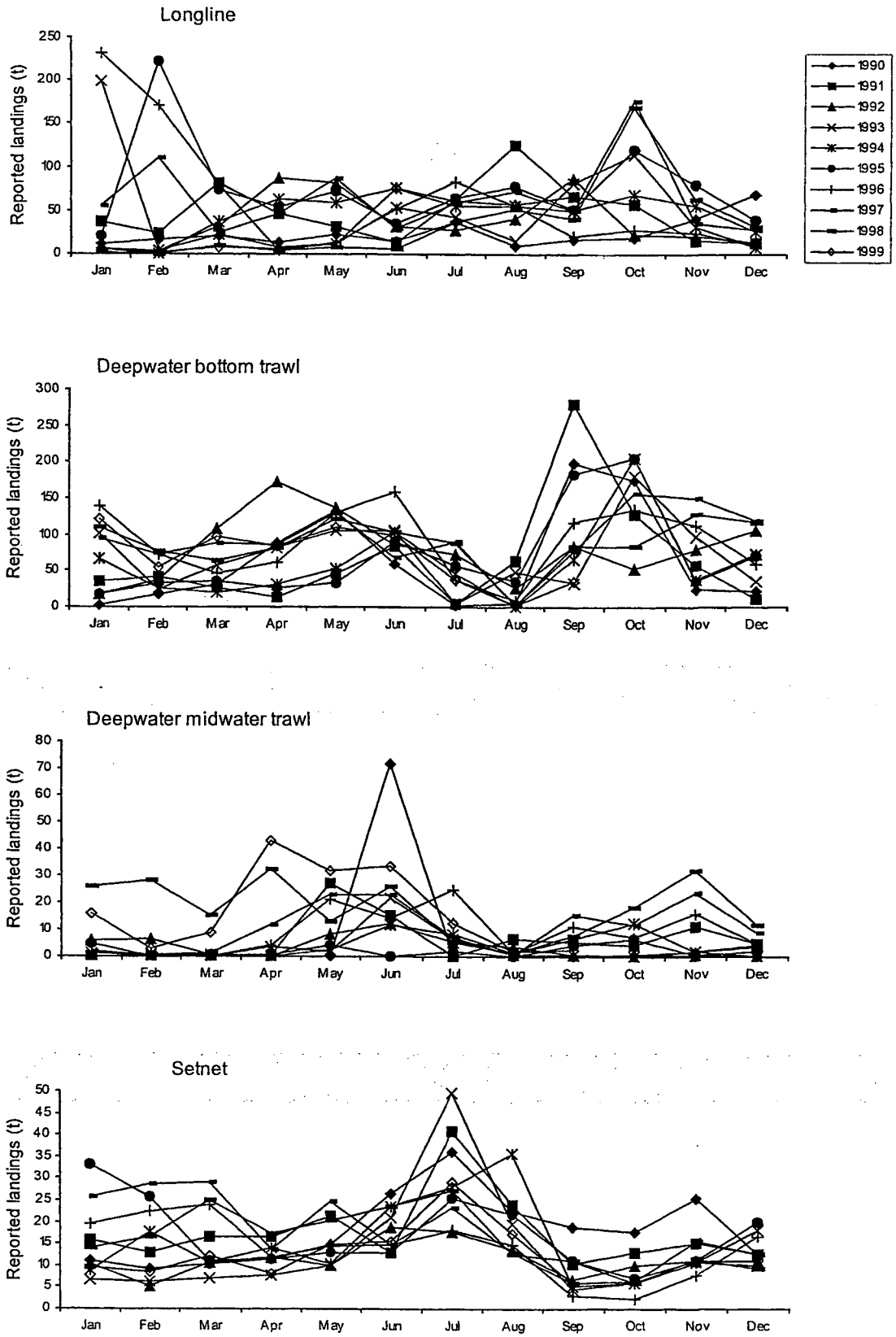

Figure 7: East SI — landings by month, by fishing year, for all significant ling fisheries in the area.

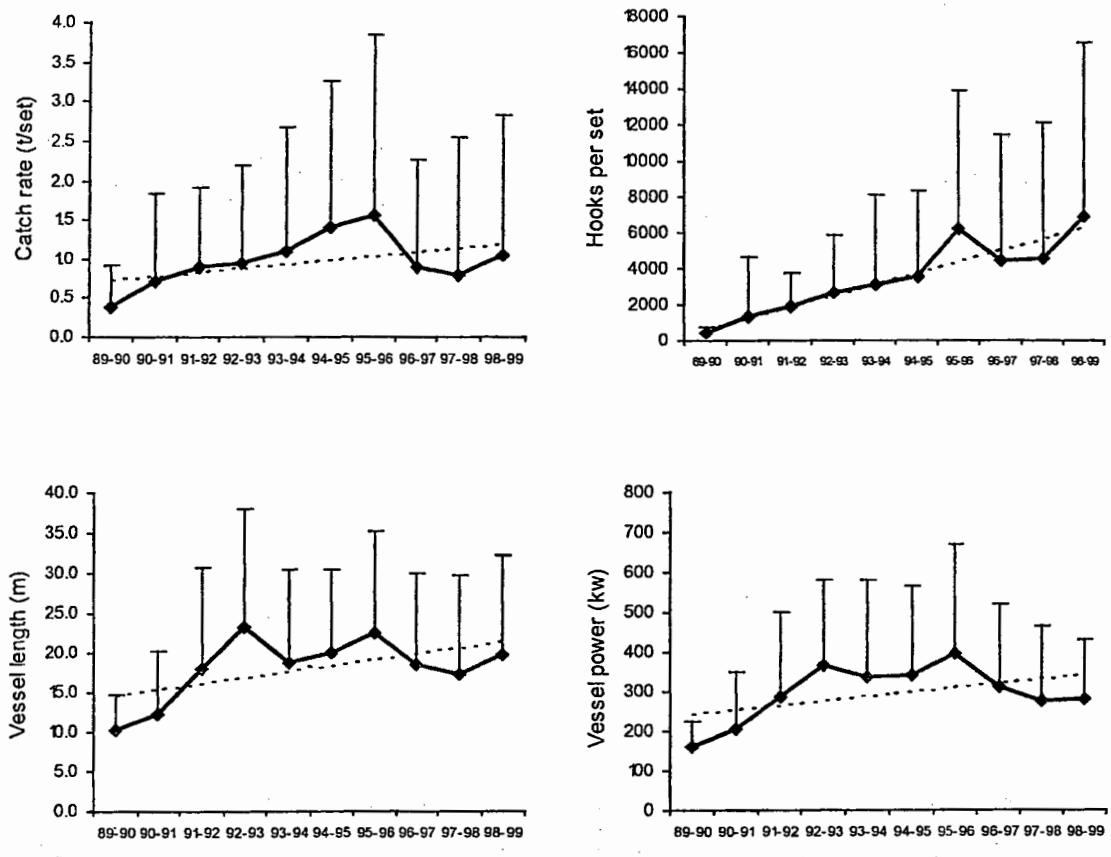

Figure 8: East SI — mean catch rate (t per set), effort (hooks per set), vessel length, and vessel power for the target ling longline fishery. Bars indicate one standard deviation, and the broken line is the linear regression to the averages.

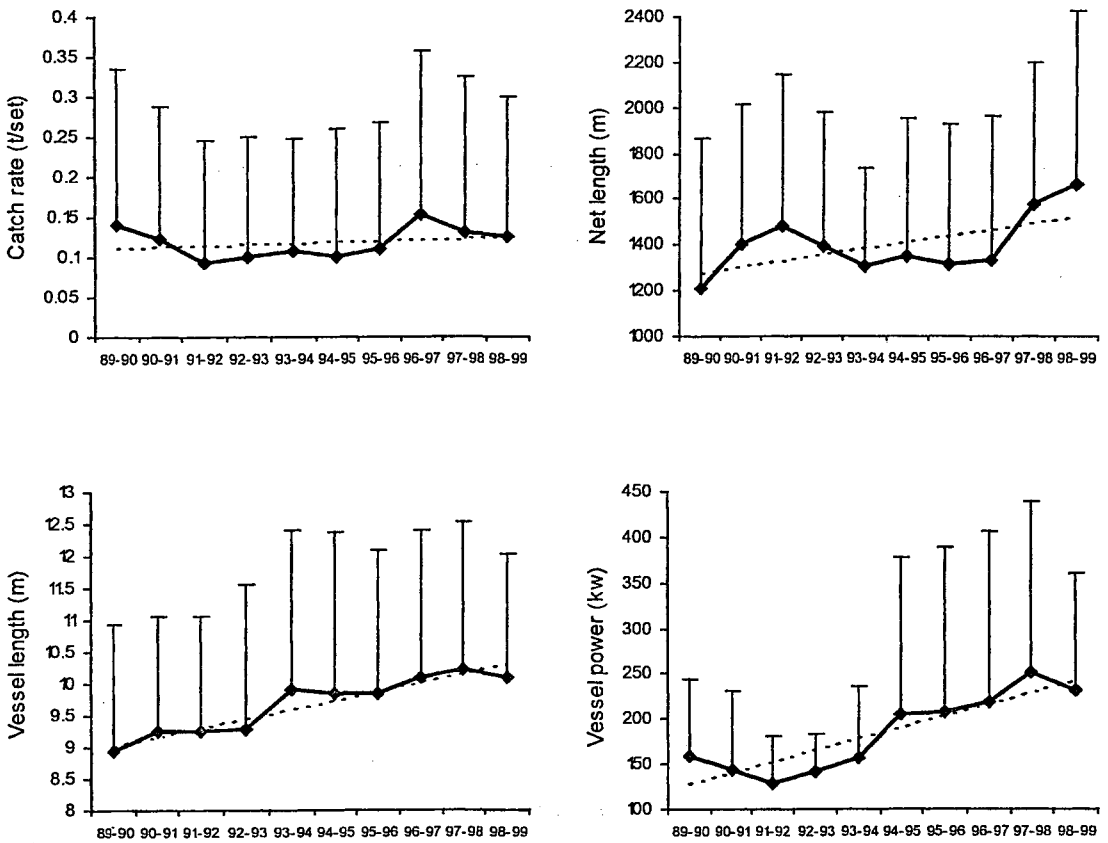

Figure 9: East SI — mean catch rate (t per set), effort (net length per set), vessel length, and vessel power for the target ling setnet fishery. Bars indicate one standard deviation, and the broken line is the linear regression to the averages.

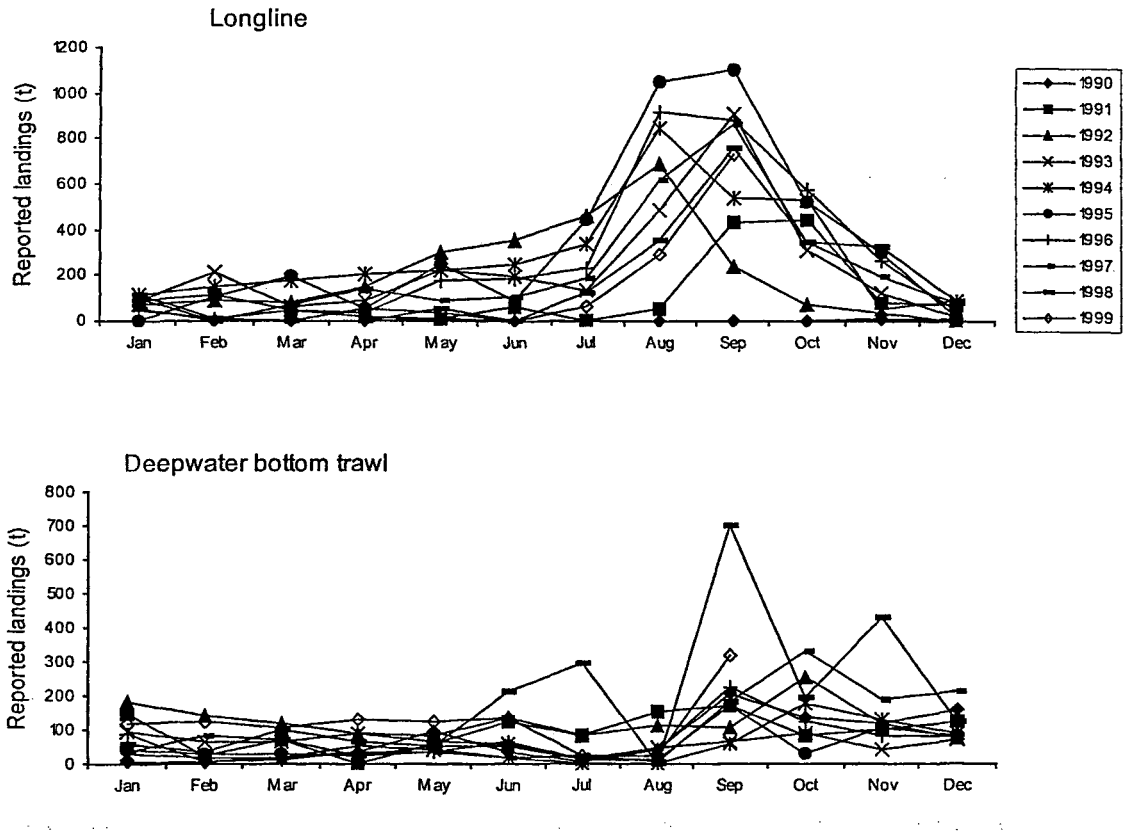

Figure 10: Chatham — landings by month, by fishing year, for all significant ling fisheries in the area.

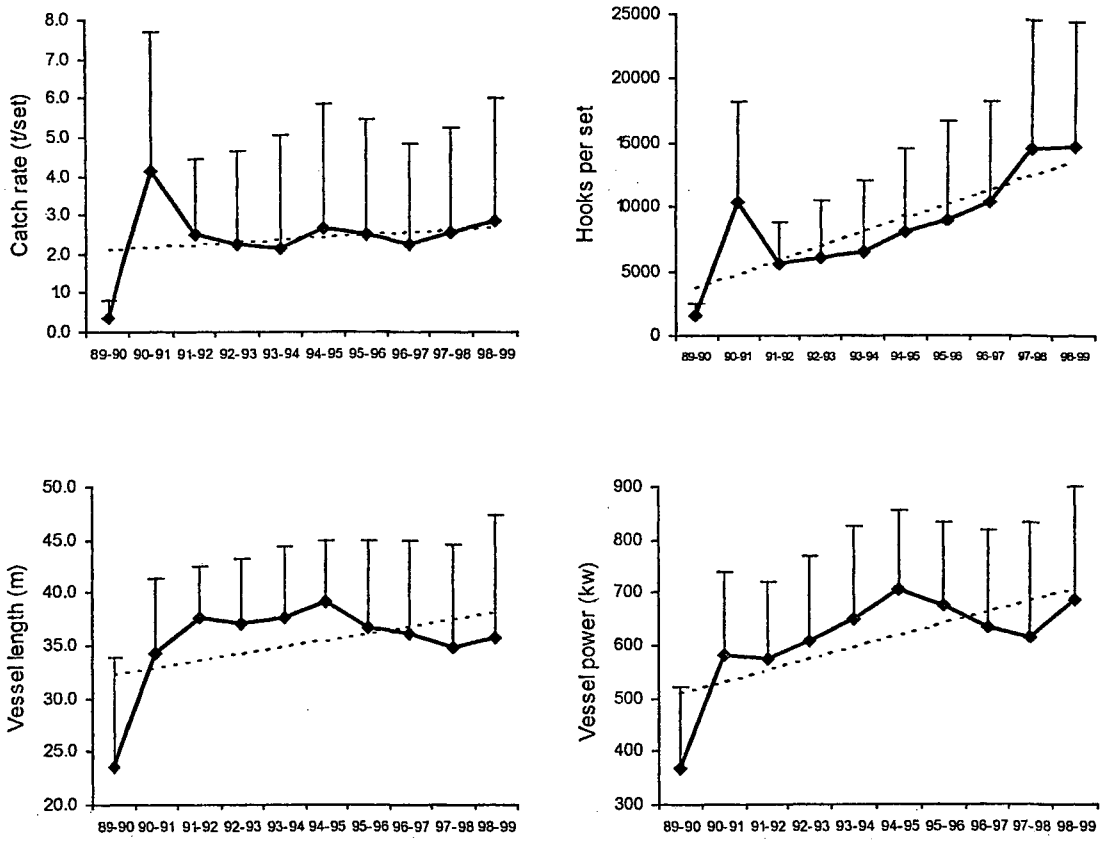

Figure 11: Chatham — mean catch rate (t per set), effort (hooks per set), vessel length, and vessel power for the target ling longline fishery. Bars indicate one standard deviation, and the broken line is the linear regression to the averages.

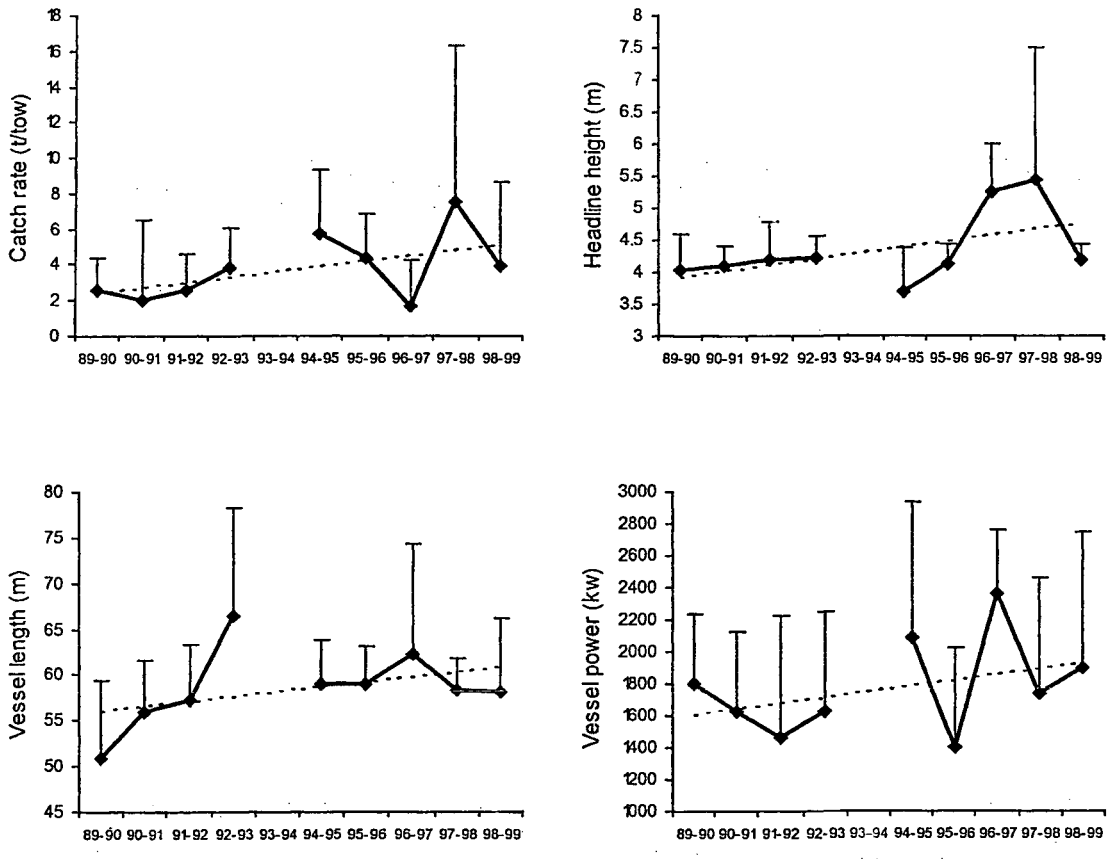

Figure 12: Chatham — mean catch rate (t per tow), trawl headline height, vessel length, and vessel power for the deepwater bottom trawl fishery when ling were reported as the target species. Bars indicate one standard deviation, and the broken line is the linear regression to the averages.

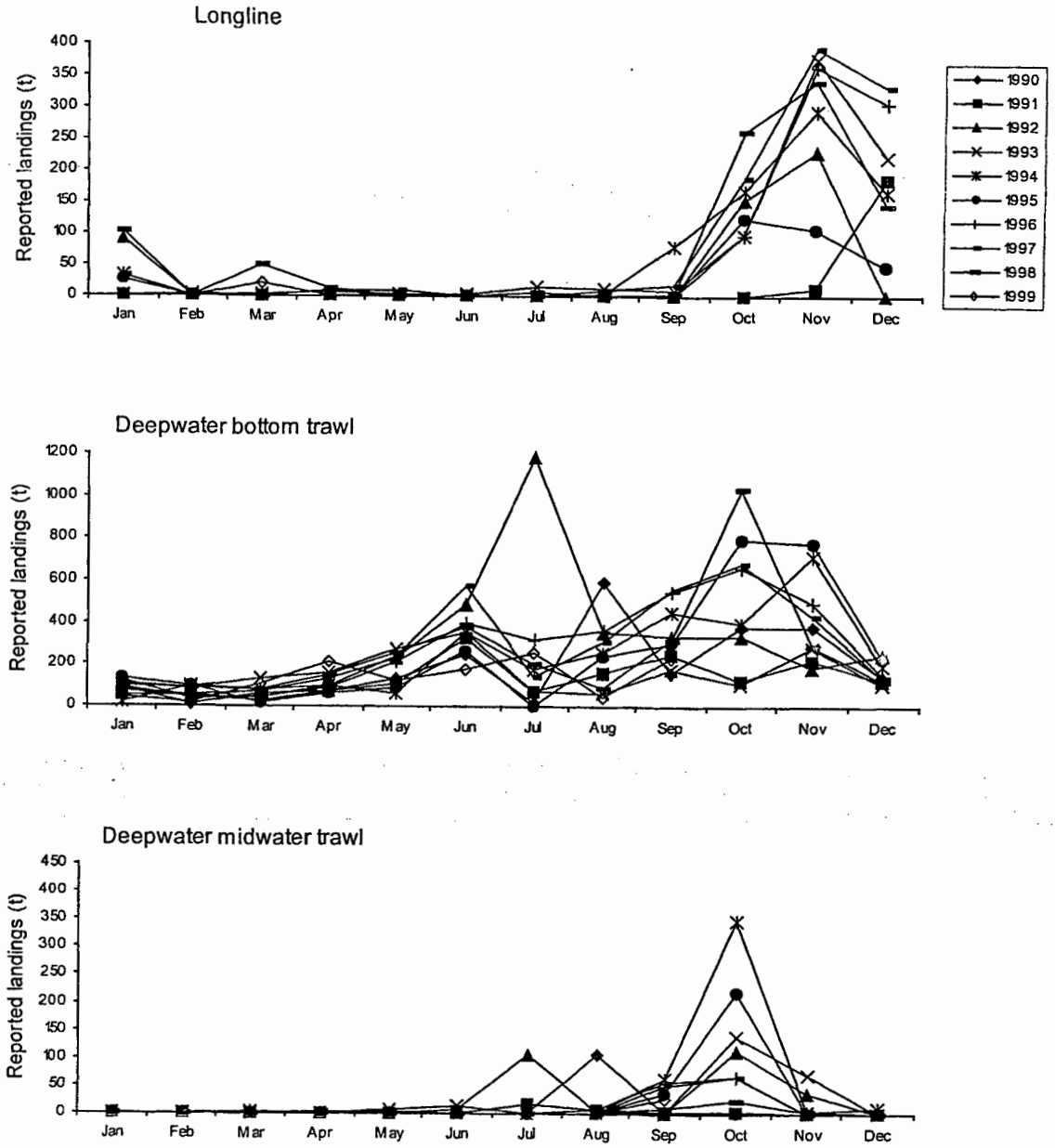

Figure 13: Southland — landings by month, by fishing year, for all significant ling fisheries in the area.

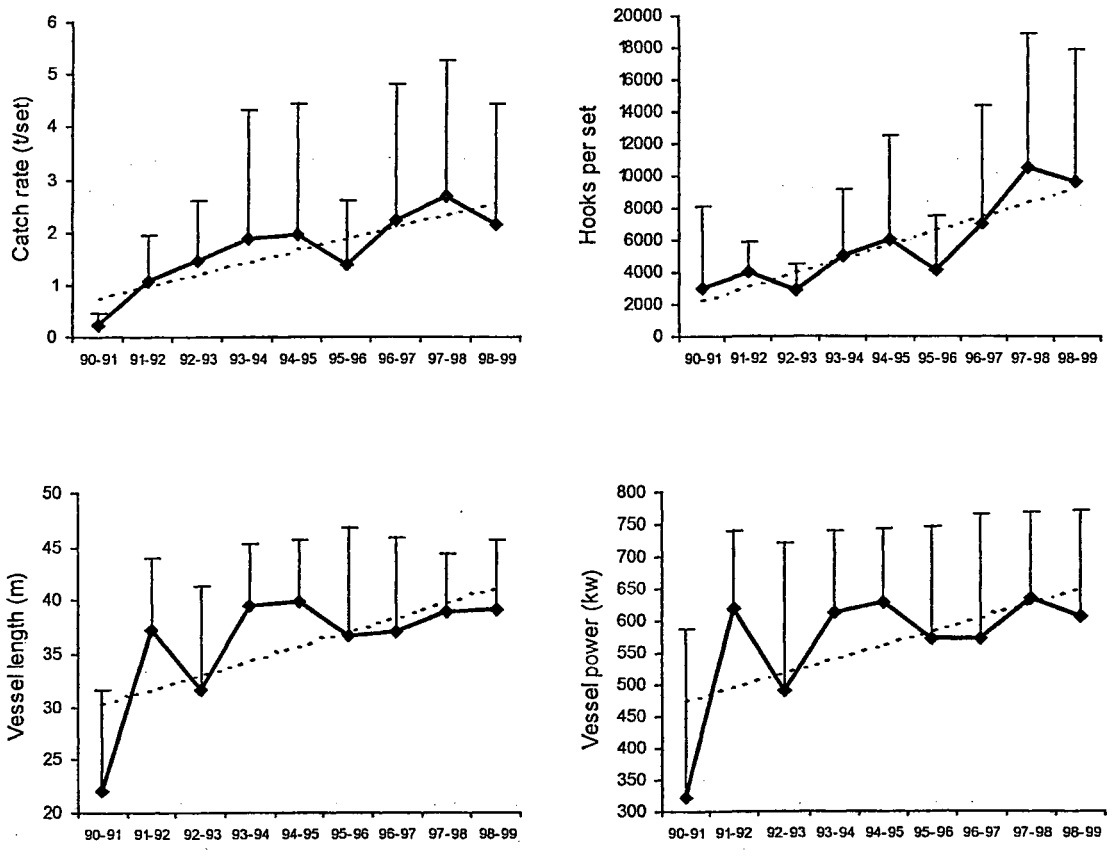

Figure 14: Southland — mean catch rate (t per set), effort (hooks per set), vessel length, and vessel power for the target ling longline fishery. Bars indicate one standard deviation, and the broken line is the linear regression to the averages.

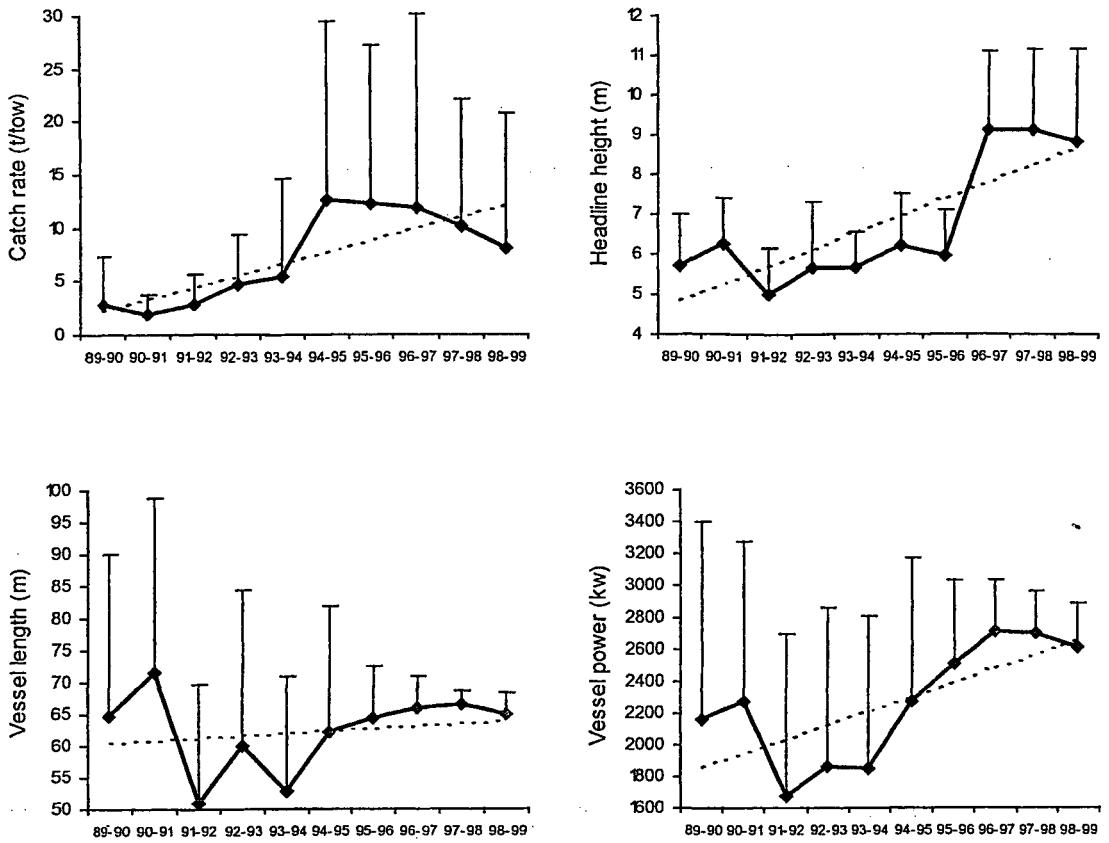

Figure 15: Southland — mean catch rate (t per tow), trawl headline height, vessel length, and vessel power for the deepwater bottom trawl fishery when ling were reported as the target species. Bars indicate one standard deviation, and the broken line is the linear regression to the averages.

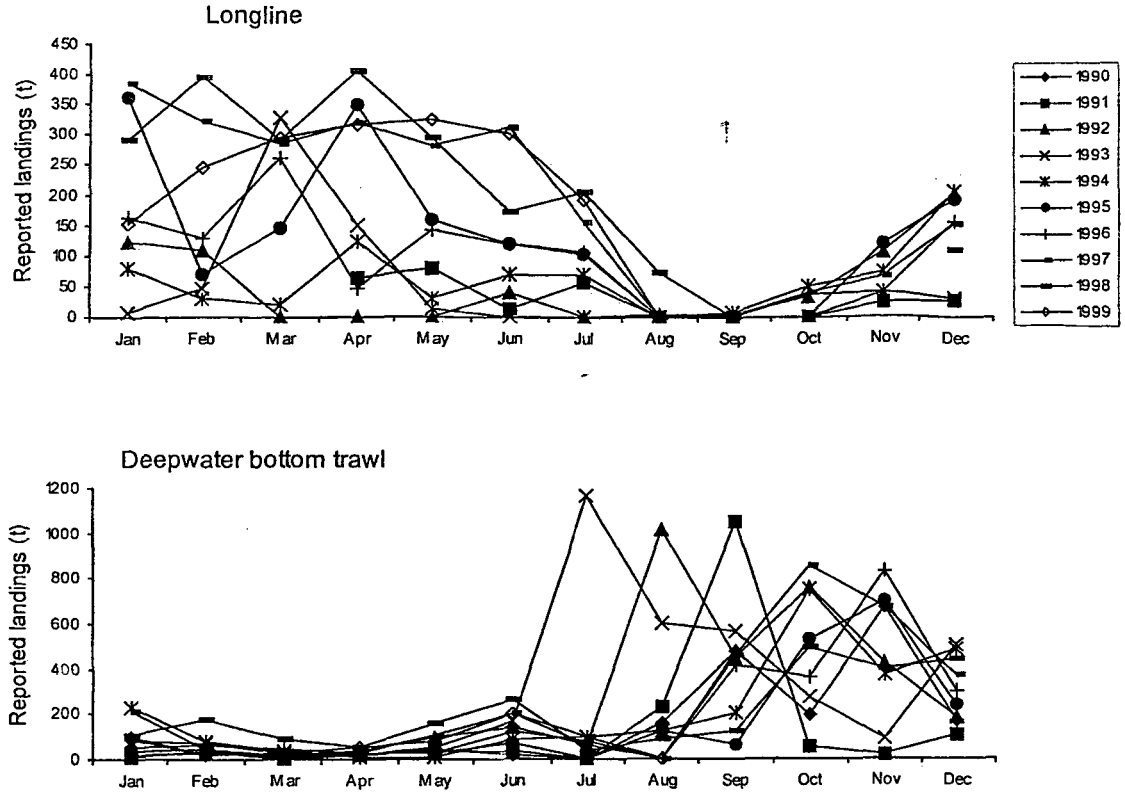

Figure 16: Sub-Antarctic — landings by month, by fishing year, for all significant ling fisheries in the area.

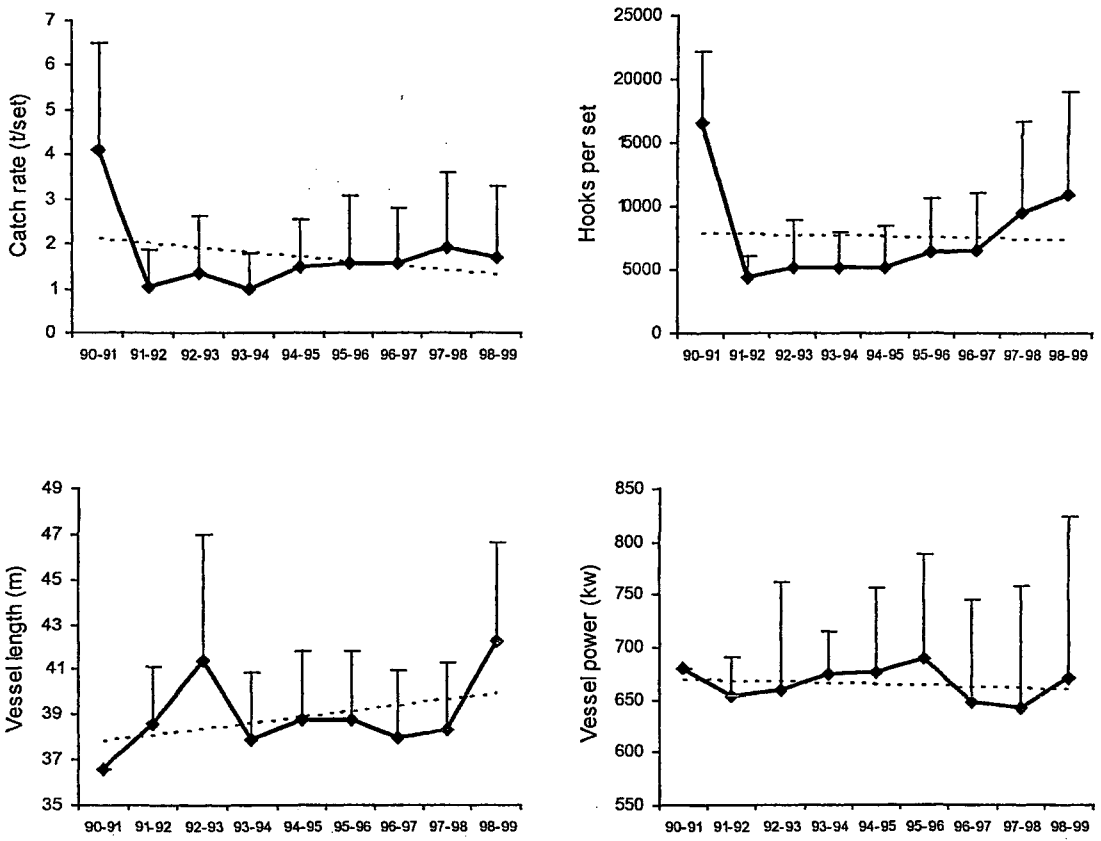

Figure 17: Sub-Antarctic — mean catch rate (t per set), effort (hooks per set), vessel length, and vessel power for the target ling longline fishery. Bars indicate one standard deviation, and the broken line is the linear regression to the averages.

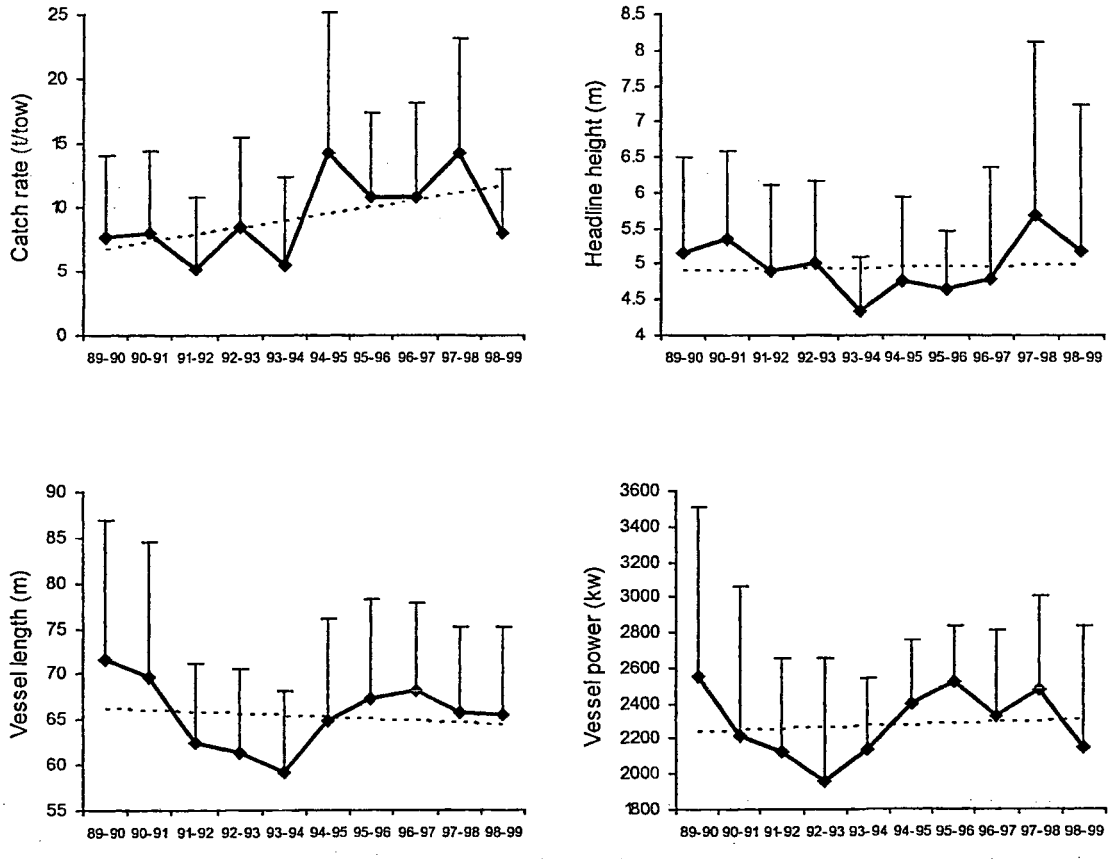

Figure 18: Sub-Antarctic — mean catch rate (t per tow), trawl headline height, vessel length, and vessel power for the deepwater bottom trawl fishery when ling were reported as the target species. Bars indicate one standard deviation, and the broken line is the linear regression to the averages.

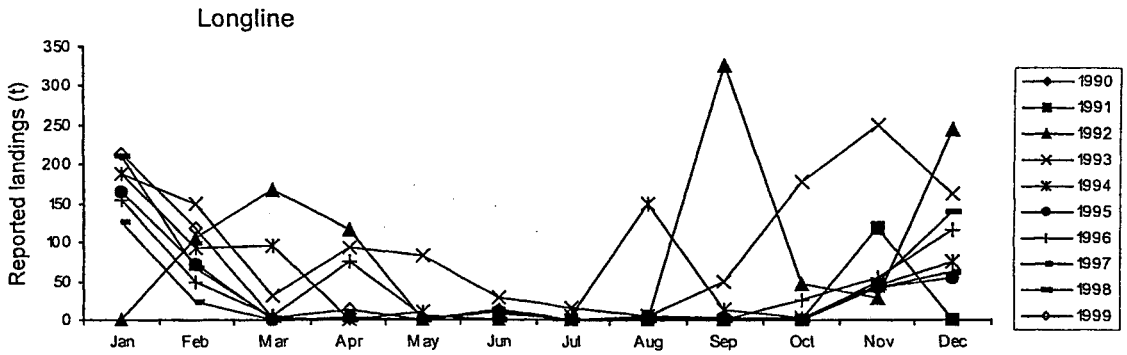

Figure 19: Bounty — landings by month, by fishing year, for all significant ling fisheries in the area.

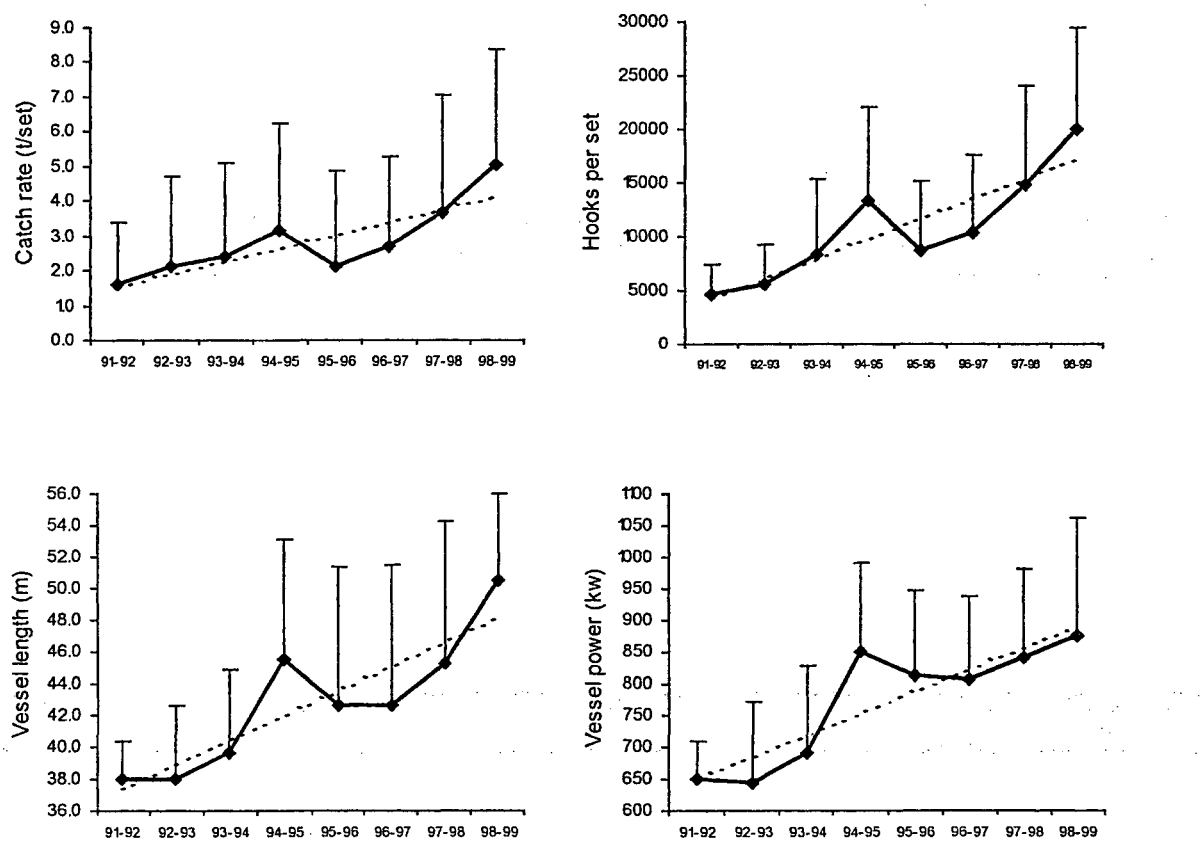

Figure 20: Bounty — mean catch rate (t per set), effort (hooks per set), vessel length, and vessel power for the target ling longline fishery. Bars indicate one standard deviation, and the broken line is the linear regression to the averages.

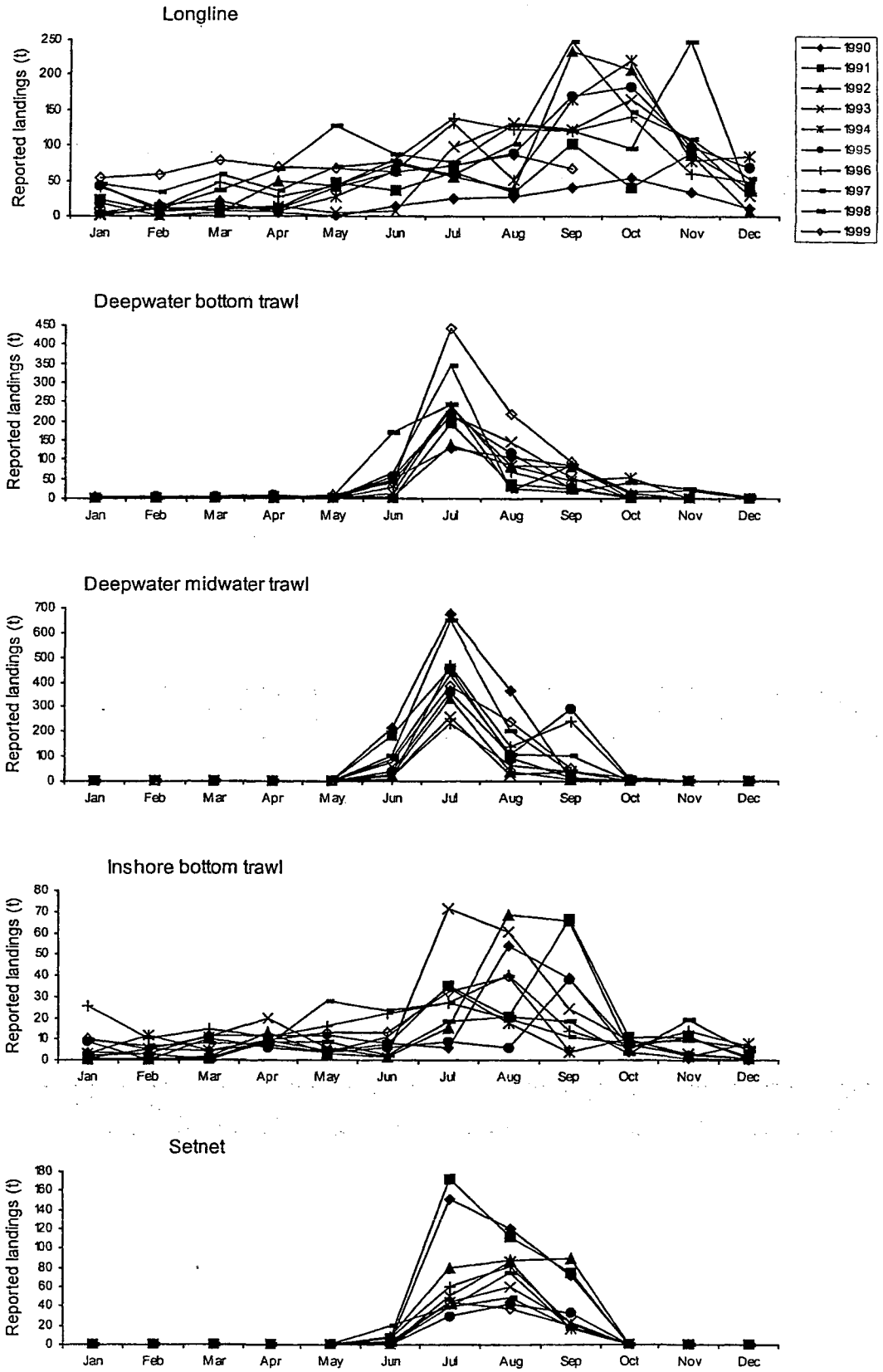

Figure 21: West SI — landings by month, by fishing year, for all significant ling fisheries in the area.

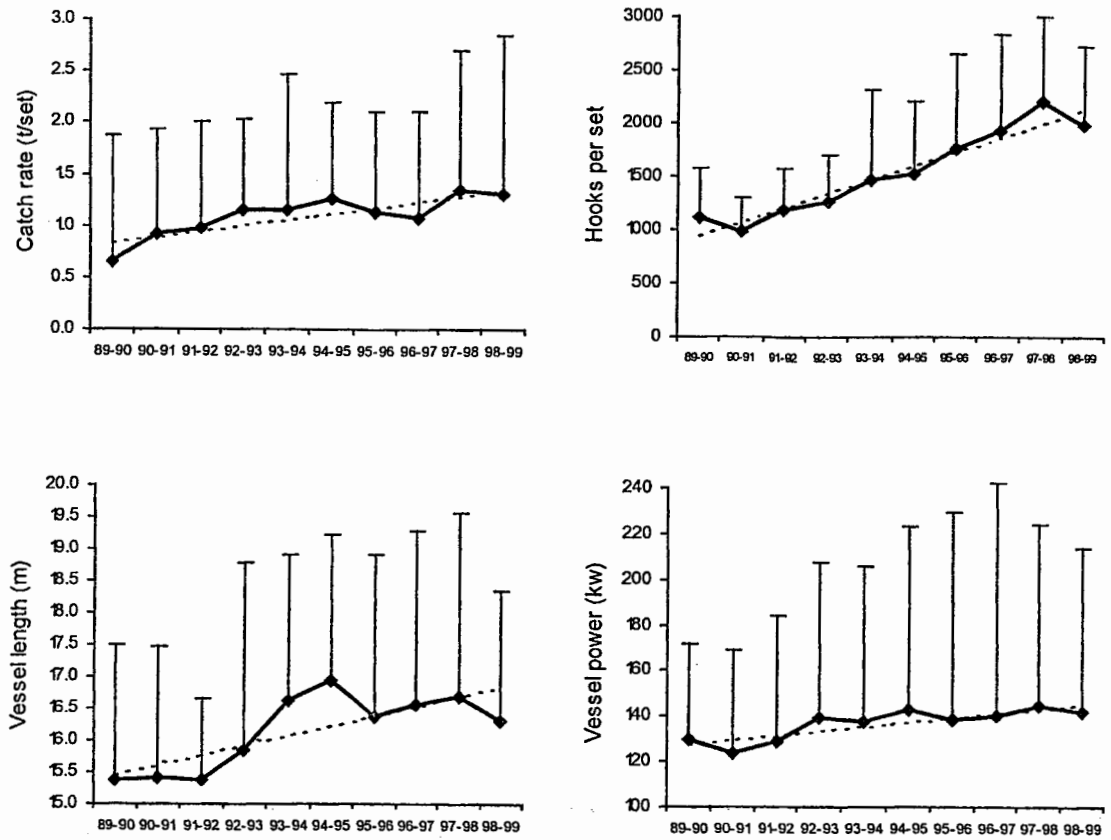

Figure 22: West SI — mean catch rate (t per set), effort (hooks per set), vessel length, and vessel power for the target ling longline fishery. Bars indicate one standard deviation, and the broken line is the linear regression to the averages.

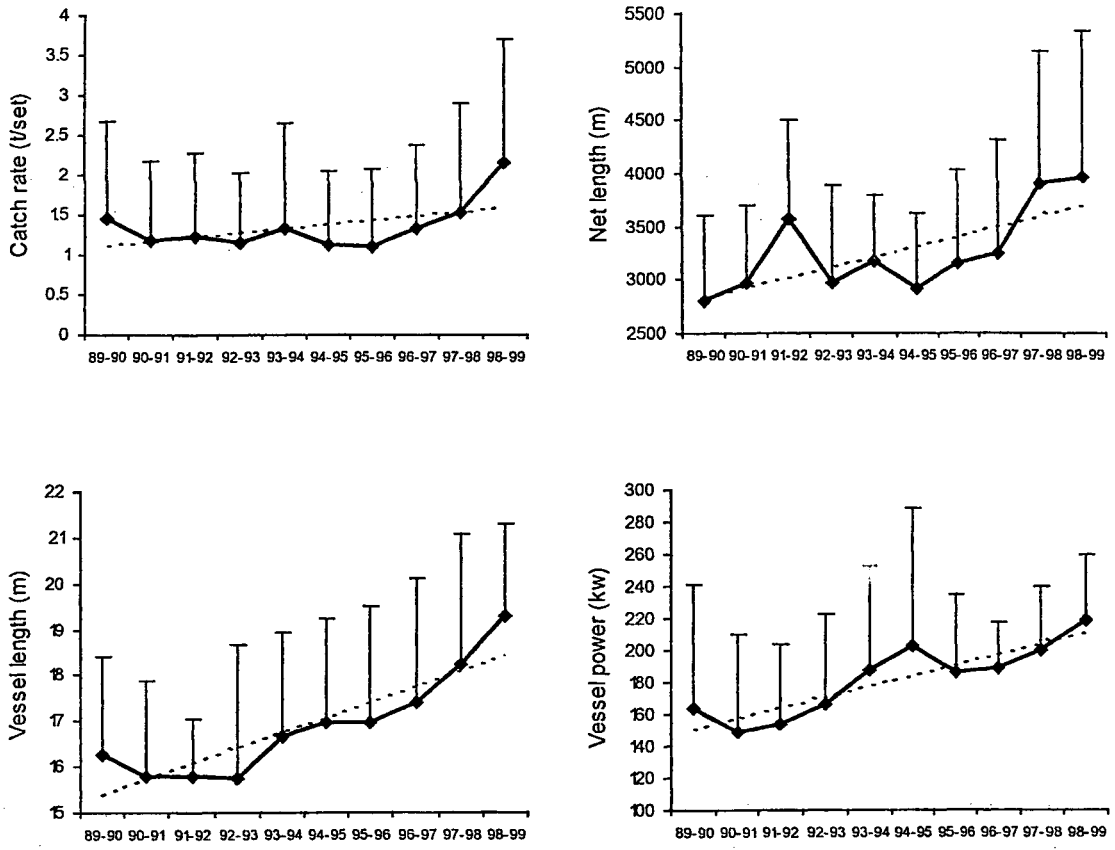

Figure 23: West SI — mean catch rate (t per set), effort (net length per set), vessel length, and vessel power for the target ling setnet fishery. Bars indicate one standard deviation, and the broken line is the linear regression to the averages.

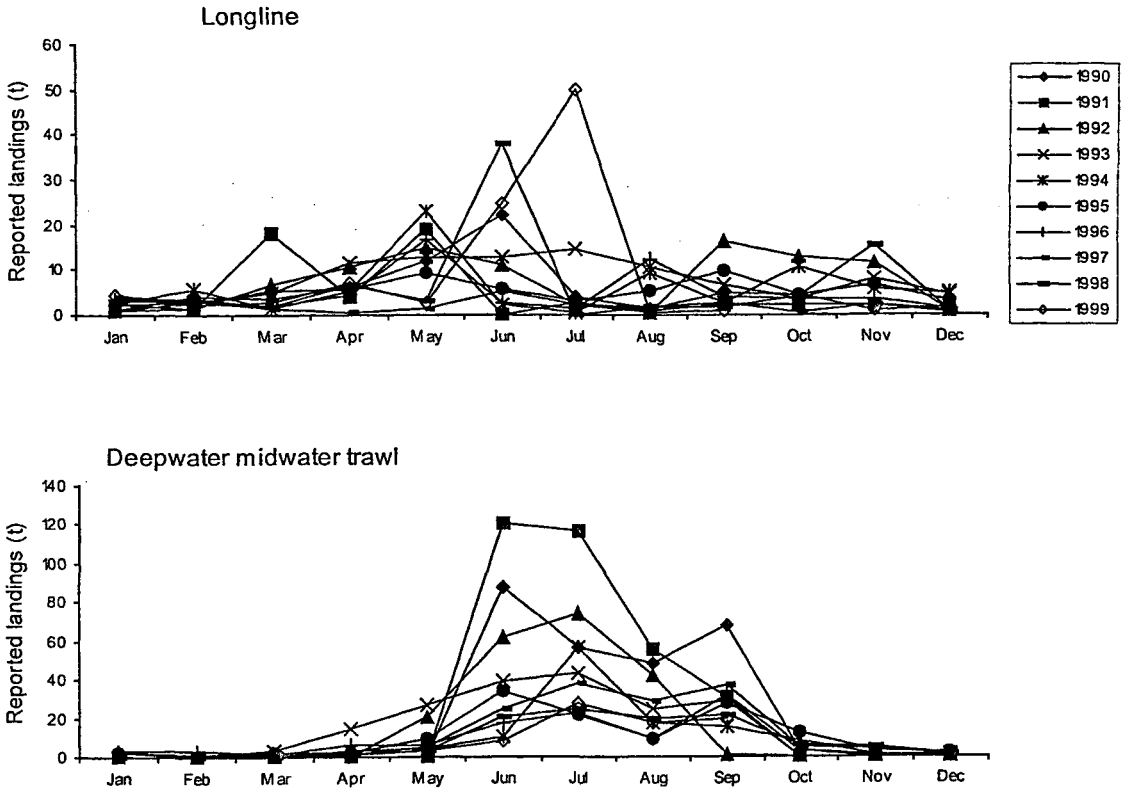

Figure 24: Cook Strait — landings by month, by fishing year, for all significant ling fisheries in the area.

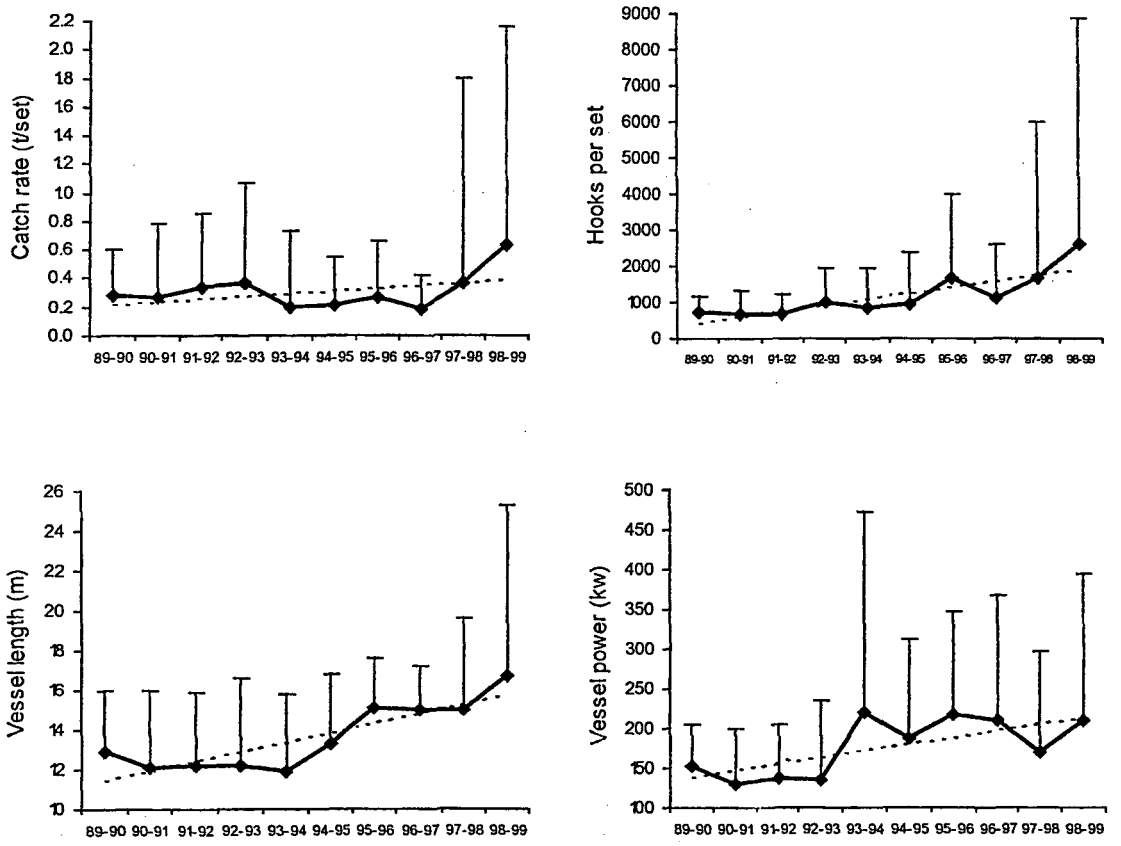

Figure 25: Cook Strait — mean catch rate (t per set), effort (hooks per set), vessel length, and vessel power for the target ling longline fishery. Bars indicate one standard deviation, and the broken line is the linear regression to the averages.

Appendix A

Table A1: Reported landings (t) by statistical area, by fishing year. Statistical areas (Statarea) have been grouped into the fish stock areas as defined in the Methods section. For positions of particular statistical areas, see Figure 1. All values have been rounded to the nearest tonne, so "0" represents reported landings of less than 0.5 t, and "–" indicates nil reported landings. Statareas 300, 400, 500, 600, and 700 are not actual statistical areas, but are used to report landings records with uncertain statistical area data but confidently believed to derive from a particular stock area.

Statarea	Fishing year									
	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99
Northland										
1	0	2	0	23	13	21	11	22	26	13
2	1	6	3	17	7	15	46	55	61	120
3	19	5	2	0	0	3	8	29	14	9
4	1	2	1	111	0	6	1	24	6	9
5	3	1	0	15	5	0	0	0	0	0
6	–	0	–	–	0	0	–	0	–	0
7	6	0	0	10	0	2	0	7	0	0
8	8	38	31	16	22	8	11	43	30	27
9	34	43	69	54	71	72	62	45	45	52
10	10	37	57	47	52	47	27	28	33	18
42	0	–	–	–	–	0	–	0	0	0
45	–	0	0	1	0	26	1	6	2	1
46	0	0	1	1	3	7	10	40	32	19
47	0	1	14	2	5	15	33	26	28	18
48	0	0	–	0	0	0	1	0	0	–
101	0	–	–	–	–	–	–	–	–	–
102	0	–	–	–	0	–	–	–	–	–
103	–	1	–	–	–	–	–	–	–	–
104	–	0	–	–	–	–	–	–	–	–
106	–	1	–	–	–	–	–	0	0	–
107	–	0	–	–	–	0	0	–	–	–
East NI										
11	8	13	24	21	32	41	44	34	24	12
12	3	17	18	15	35	42	76	84	40	20
13	37	68	146	150	125	196	119	105	175	81
14	208	246	211	244	172	119	154	158	177	148
15	13	79	50	76	134	105	115	88	146	155
201	–	0	–	–	–	–	–	–	–	1
203	0	–	–	–	–	–	–	–	–	
204	0	0	0	0	0	0	0	0	0	0
205	0	2	1	6	3	4	1	8	1	5
East SI										
18	279	410	179	242	218	208	263	379	244	297
19	18	58	14	15	44	61	37	14	6	10
20	331	408	618	427	364	746	955	653	709	634
21	113	519	229	430	367	386	379	320	280	308
22	234	246	344	247	221	158	145	247	265	171
23	137	126	248	166	247	282	460	226	378	421
24	107	167	175	86	104	108	81	196	148	99
300	–	–	–	–	2	–	32	–	12	44
301	–	–	0	–	6	–	0	–	–	–
302	–	–	1	0	–	1	–	–	–	–
303	–	–	–	2	1	–	–	–	3	–

Table A1 ctd.

Statarea	Fishing year									
	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99
Chatham										
49	14	19	46	74	75	267	268	272	124	128
50	19	26	91	44	62	15	27	31	3	10
51	0	22	21	41	19	3	11	9	3	10
52	1	9	623	150	130	357	297	190	269	210
400	–	–	–	–	54	419	18	31	98	15
401	324	848	919	734	493	585	633	720	1 561	1 203
402	78	518	557	384	479	437	275	362	577	410
403	3	36	300	89	117	213	100	273	120	174
404	23	196	396	591	528	1 177	1 062	658	712	890
405	0	0	–	88	34	23	26	14	–	3
406	0	–	–	7	–	36	0	0	8	–
407	47	197	209	77	199	160	126	210	139	184
408	1	118	192	146	144	210	302	348	217	163
409	1	43	67	23	48	193	324	163	144	126
410	0	123	938	1 092	1 374	740	682	532	367	400
411	–	–	–	–	–	–	–	2	–	–
412	–	–	–	–	0	2	–	0	1	0
Southland										
25	4	6	6	15	10	12	19	16	14	6
26	191	129	270	251	232	134	125	159	191	130
27	305	365	529	483	449	397	495	374	320	287
28	163	207	210	590	1 178	1 686	2 460	2 047	1 880	1 586
29	37	24	34	33	3	20	72	35	12	14
30	1 307	1 230	2 538	1 350	1 157	1 210	1 192	1 633	1 499	1 353
31	3	1	1	2	18	16	7	29	5	6
500	–	–	–	–	–	–	–	8	–	–
502	–	–	2	–	–	2	–	–	6	–
503	–	0	–	–	–	–	–	–	–	–
504	135	143	250	165	211	169	166	145	194	167
Sub-Antarctic										
600	–	1	–	–	52	49	20	–	–	–
601	–	–	–	–	–	2	0	2	0	–
602	1 023	1 303	1 195	3 492	1 046	1 131	1 654	2 258	2 614	2 099
603	109	1 130	684	761	707	948	864	863	701	493
604	3	131	96	302	41	76	74	80	91	84
605	1	32	16	84	7	87	98	55	30	163
606	0	0	3	6	4	5	–	2	0	14
610	19	57	192	294	212	153	66	393	441	165
611	0	5	119	69	17	15	46	47	40	33
612	0	0	25	–	–	–	0	0	7	41
616	–	–	–	–	–	1	–	–	–	–
617	–	–	–	–	0	–	0	0	–	–
618	31	12	32	31	61	537	398	966	1 081	268
619	2	1	28	–	124	610	348	276	331	890
620	0	–	–	–	–	–	–	–	–	–
624	0	0	–	–	–	1	–	–	41	0
625	–	0	–	–	–	41	22	8	4	33

Table A1 ctd.

Statarea	Fishing year									
	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99
Bounty										
607	10	26	430	572	688	108	112	236	89	93
608	2	6	477	397	461	272	274	111	301	470
609	–	–	–	–	–	–	–	4	–	–
613	–	–	–	–	0	0	–	0	–	–
614	–	–	–	0	–	2	–	–	–	–
621	–	–	–	–	–	–	–	–	4	–
West SI										
32	13	69	85	10	72	105	273	245	294	265
33	233	295	432	404	350	384	411	278	256	229
34	1 791	1 318	1 096	1 063	1 025	1 508	1 633	1 584	1 779	1 870
35	259	252	177	301	276	333	256	348	341	567
36	9	8	59	75	33	56	18	61	62	24
700	–	–	–	–	–	–	–	12	3	0
701	–	–	–	0	–	–	0	0	1	1
702	0	–	–	0	–	–	–	0	0	1
703	18	3	4	9	6	13	4	7	8	19
704	–	–	1	0	–	–	–	–	–	–
705	–	–	0	0	2	1	–	0	–	–
801	–	–	1	–	5	–	–	–	1	–
Cook Strait										
16	255	348	206	211	115	172	224	194	162	230
17	118	173	101	105	114	143	122	180	108	110
37	3	1	1	0	1	1	4	0	0	
38	33	4	0	2	2	2	12	3	0	0
39	2	2	0	0	14	0	1	1	2	0
40	4	1	5	6	6	2	6	3	3	3
41	0	0	1	3	4	10	11	11	7	8
Kermadec										
91	–	–	–	–	–	–	–	–	–	0
92	–	–	–	–	–	–	0	–	–	–
Extra territorial										
ET	–	–	–	0	1	0	0	0	1	16
Total	8 166	11 939	16 107	17 050	14 718	17 926	18 743	19 325	20 153	18 370

Appendix B

Reported landings of ling by bottom trawl, midwater trawl, and bottom longline, where landings were associated with latitude and longitude. Latitudes and longitudes were rounded to the nearest 0.1 degree, and all landings at a particular point were summed. Data were plotted only when the summed catch at a particular point was greater than 100 kg. Plots by fishing year, and by month with all years combined are presented. Note that these plots do not represent a complete picture of all ling landings by the three fishing methods; many inshore trawl vessels and longline vessels do not report shot position.

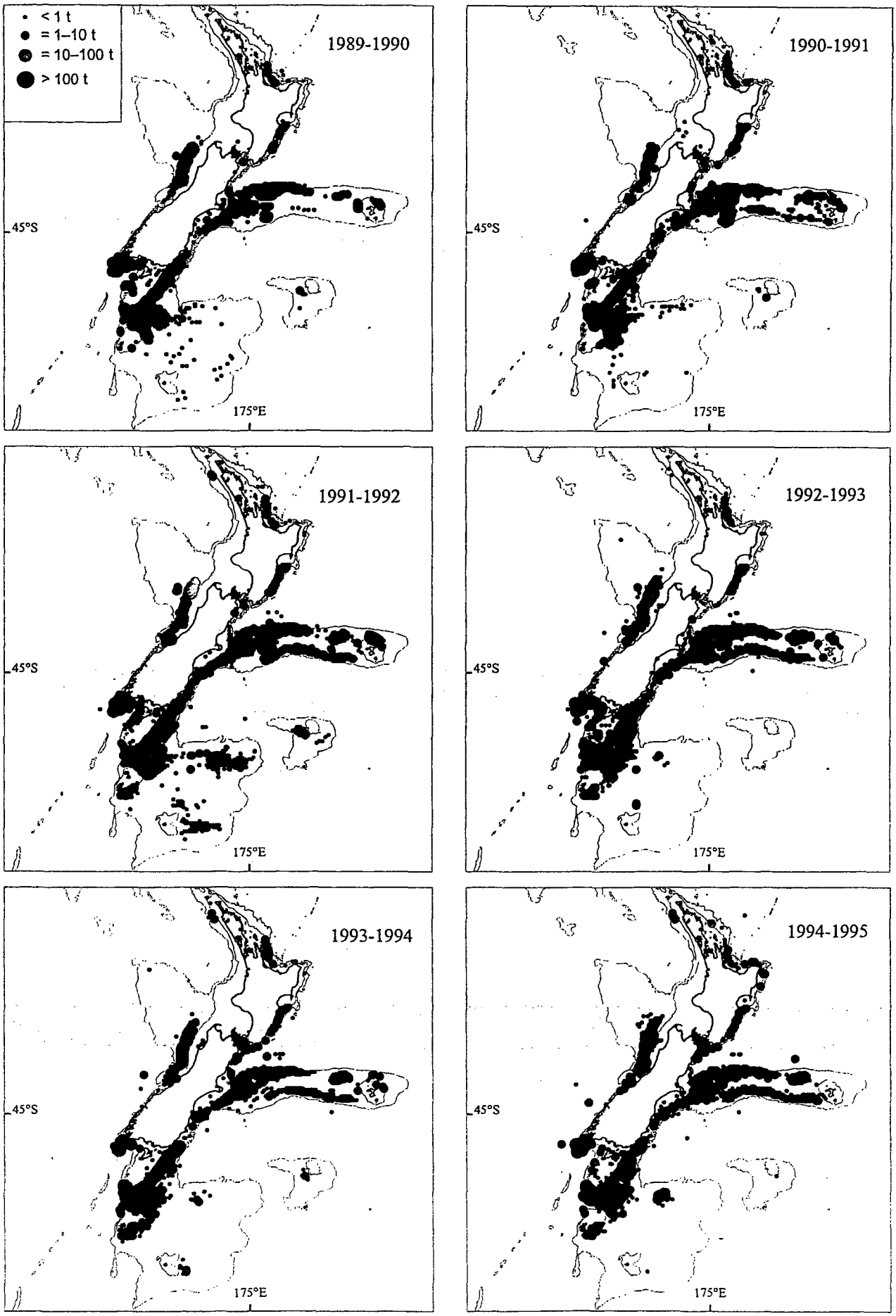

Figure B1: Bottom trawl landings, by fishing year.

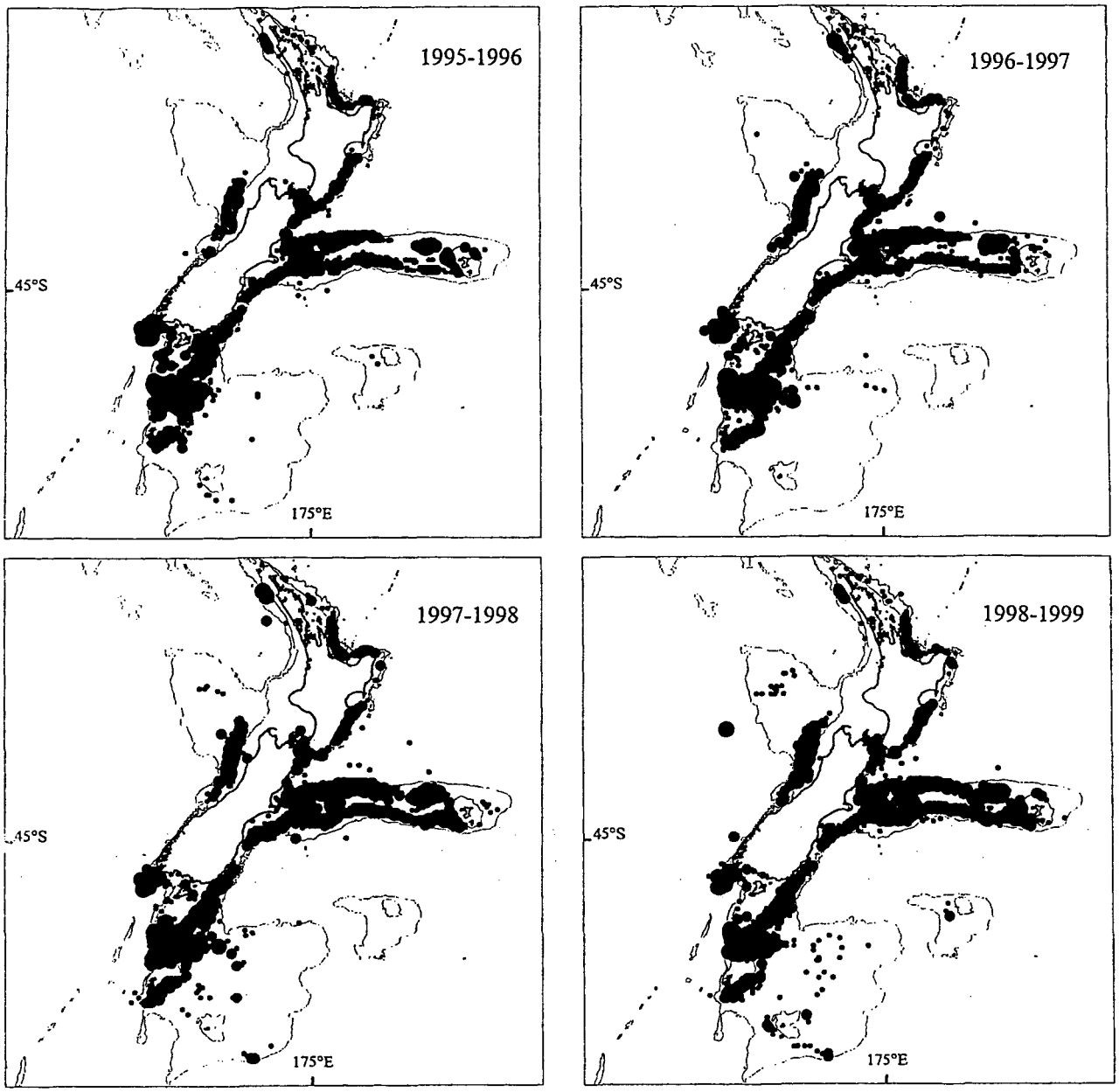

Figure B1 ctd.

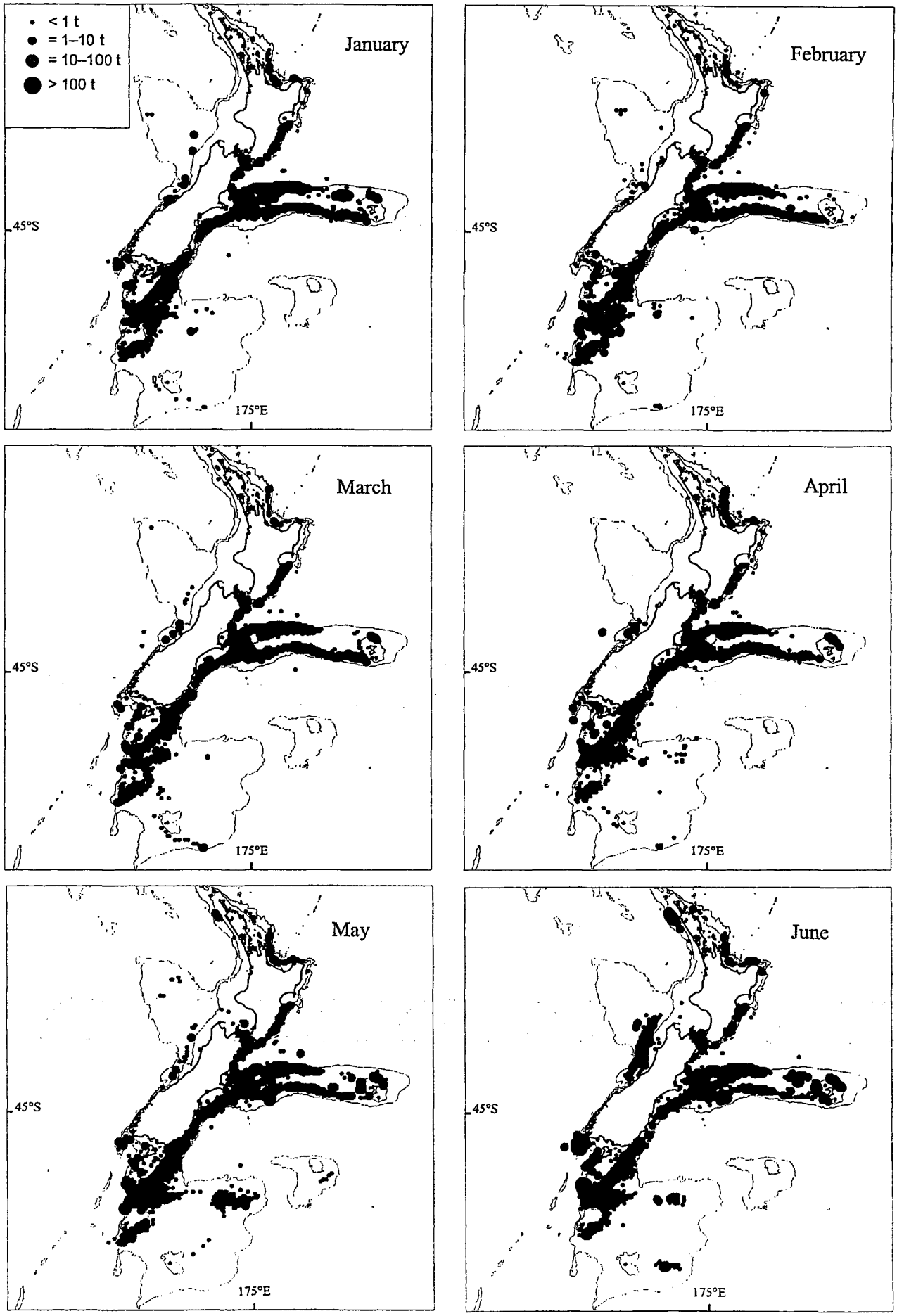

Figure B2 : Bottom trawl landings, by month.

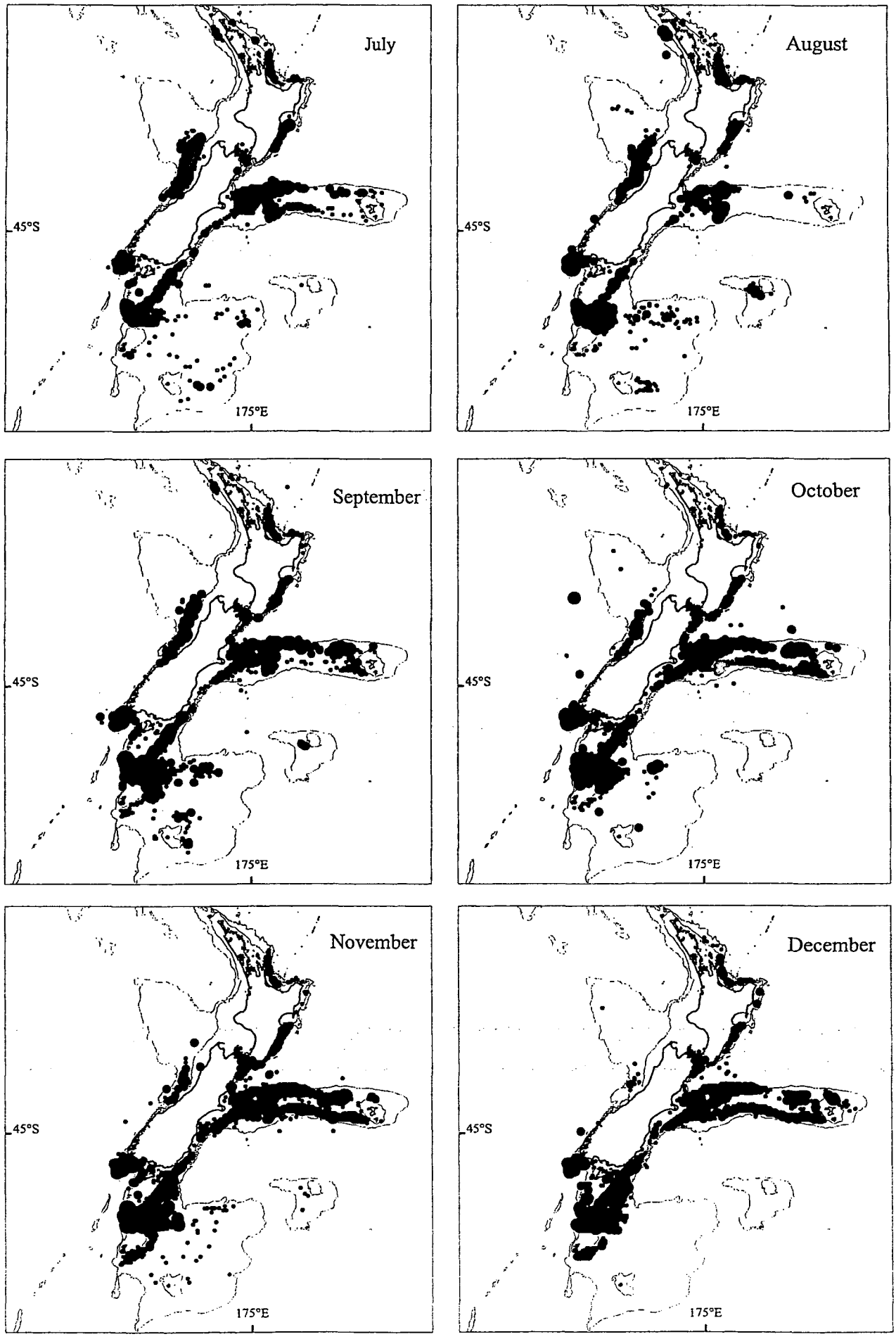

Figure B2 ctd.

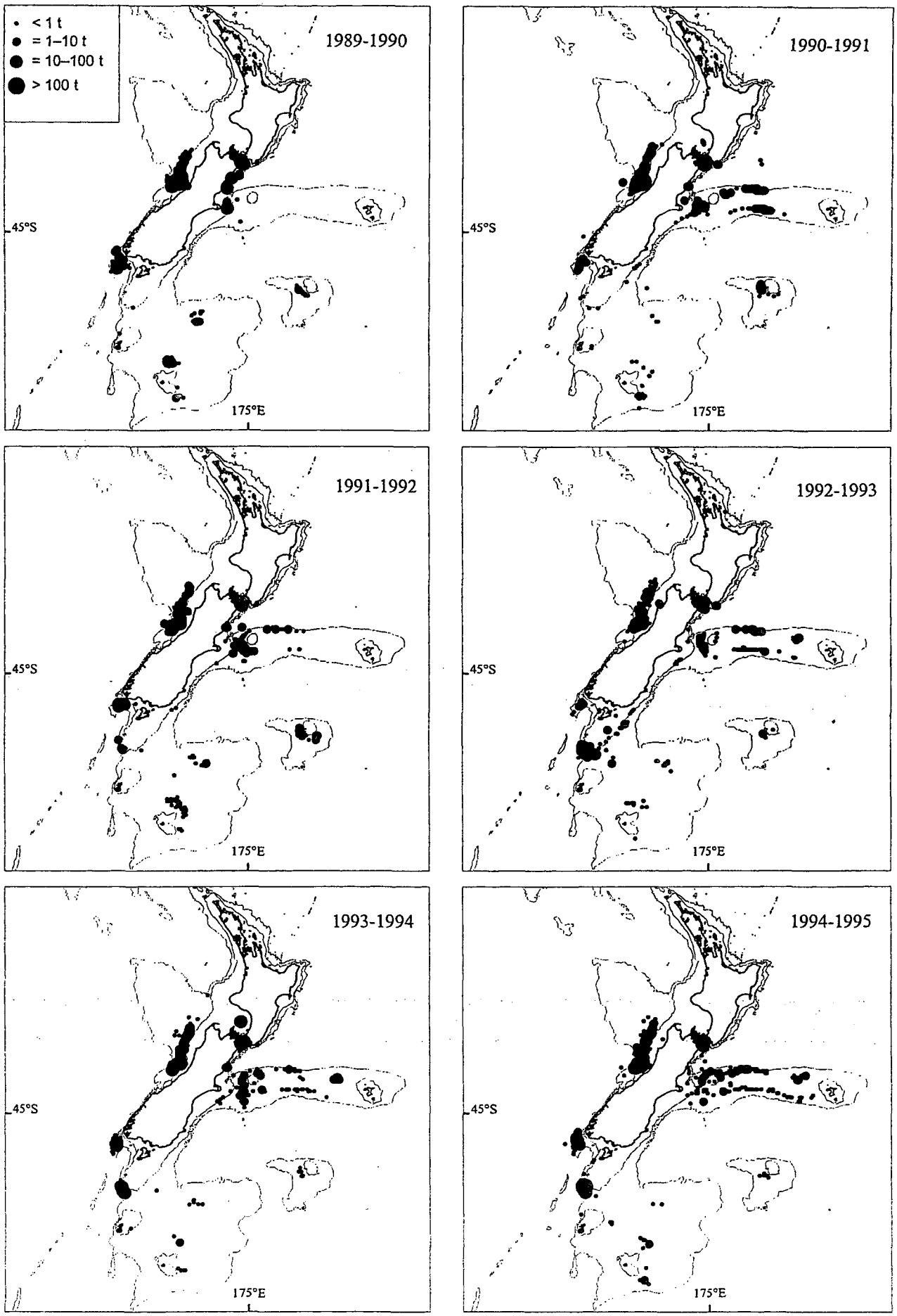

Figure B3: Midwater trawl landings, by fishing year.

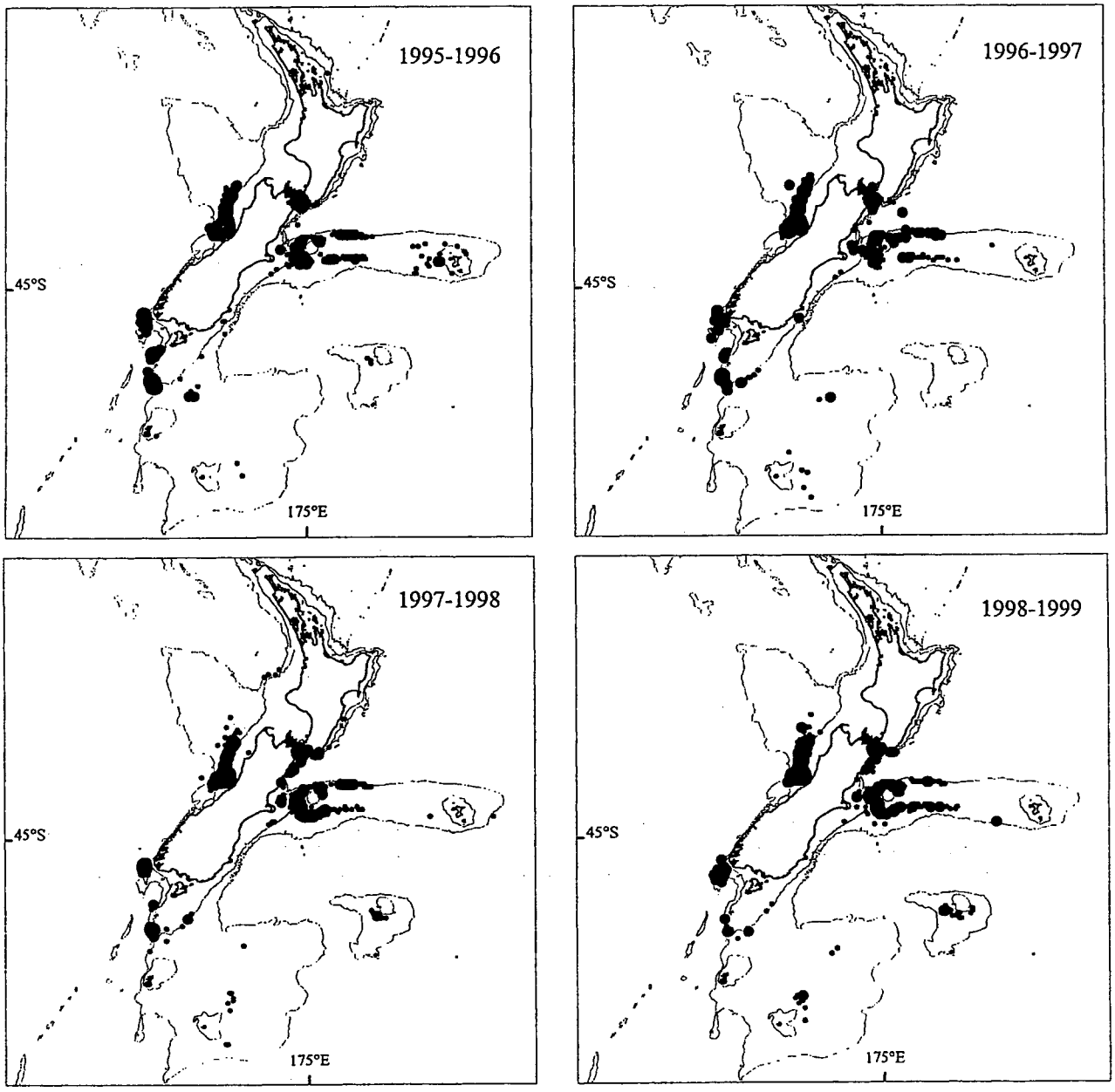

Figure B3 ctd.

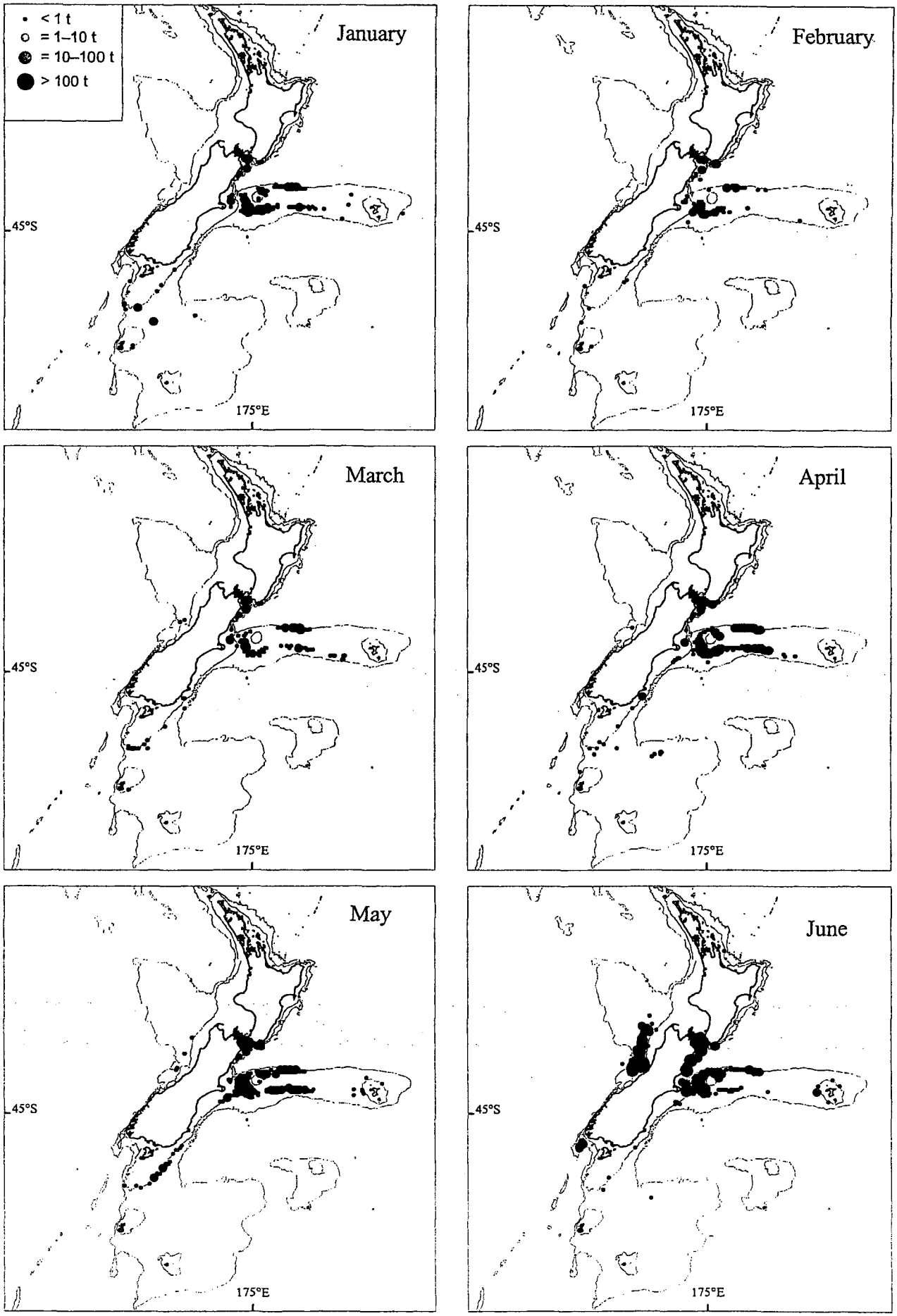

Figure B4: Midwater trawl landings, by month.

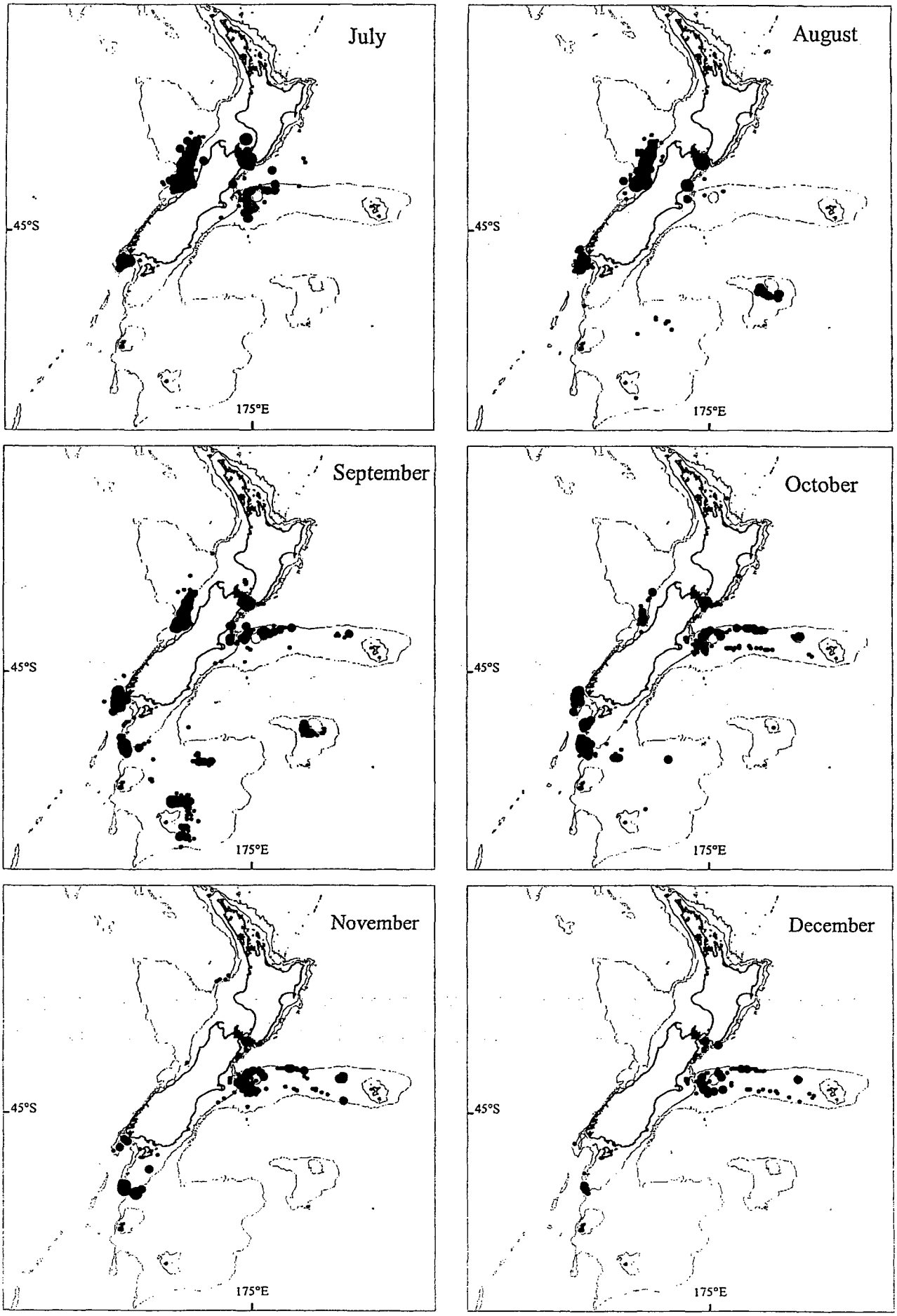

Figure B4 ctd.

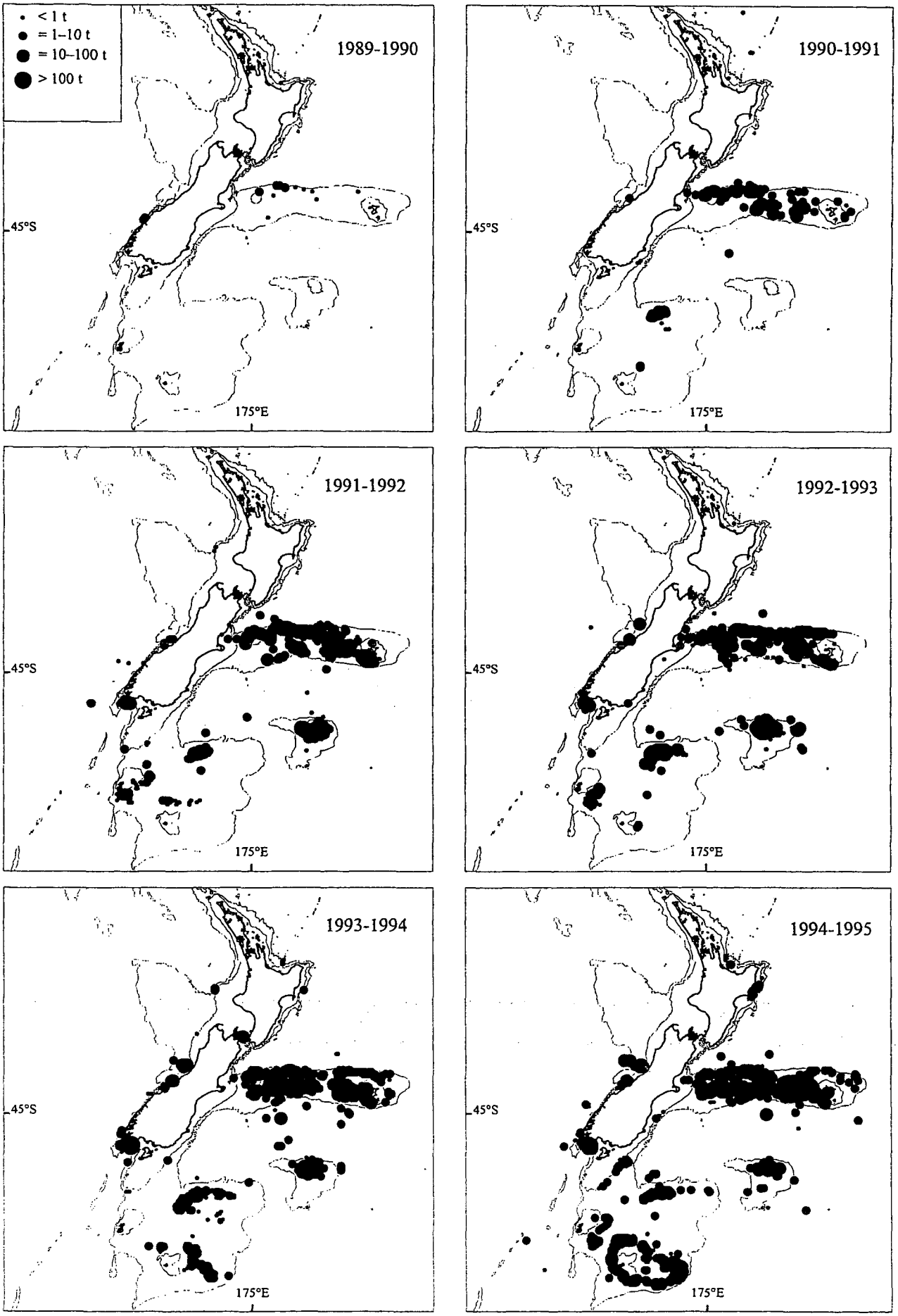

Figure B5: Longline landings, by fishing year.

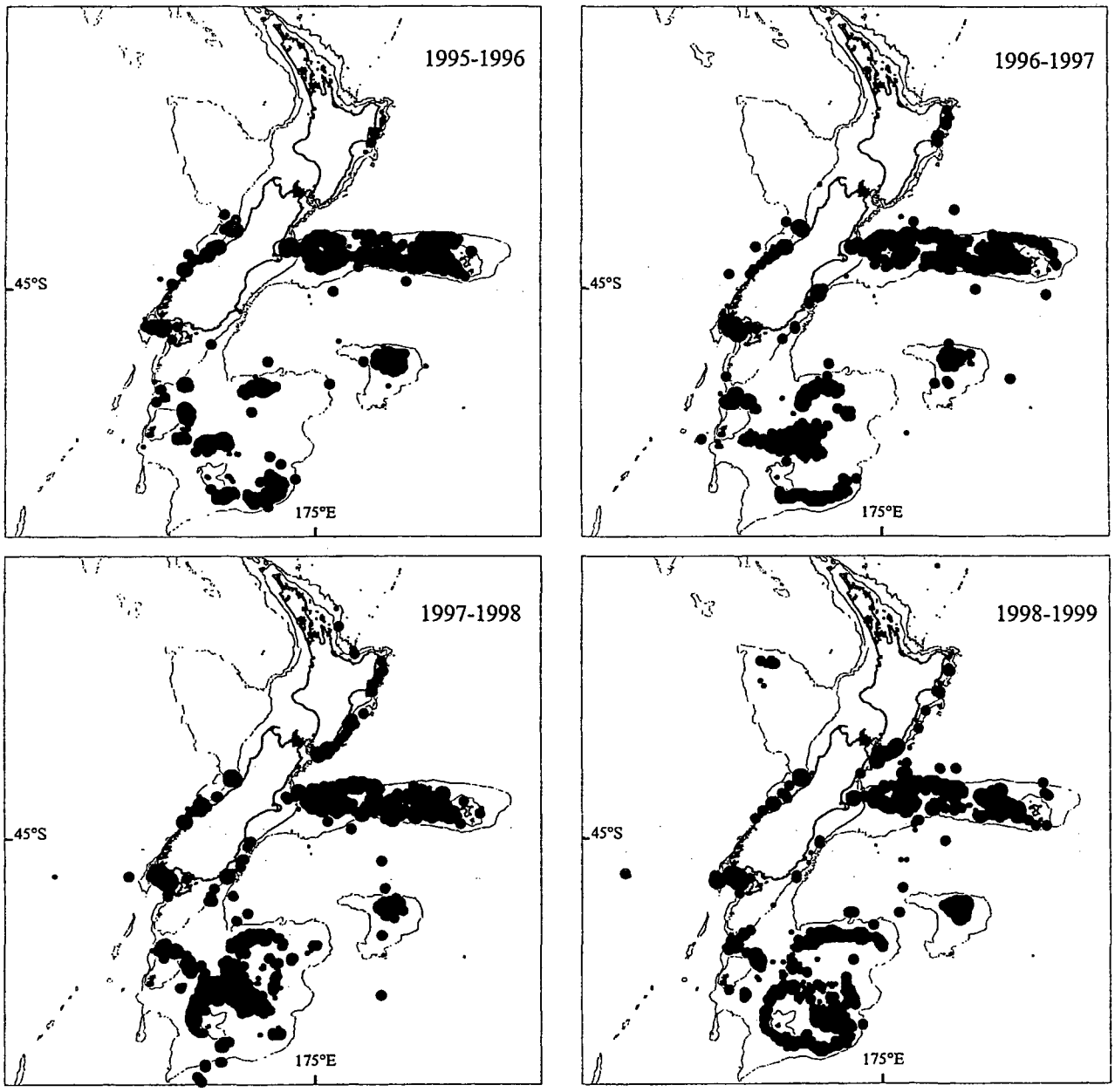

Figure B5 ctd.

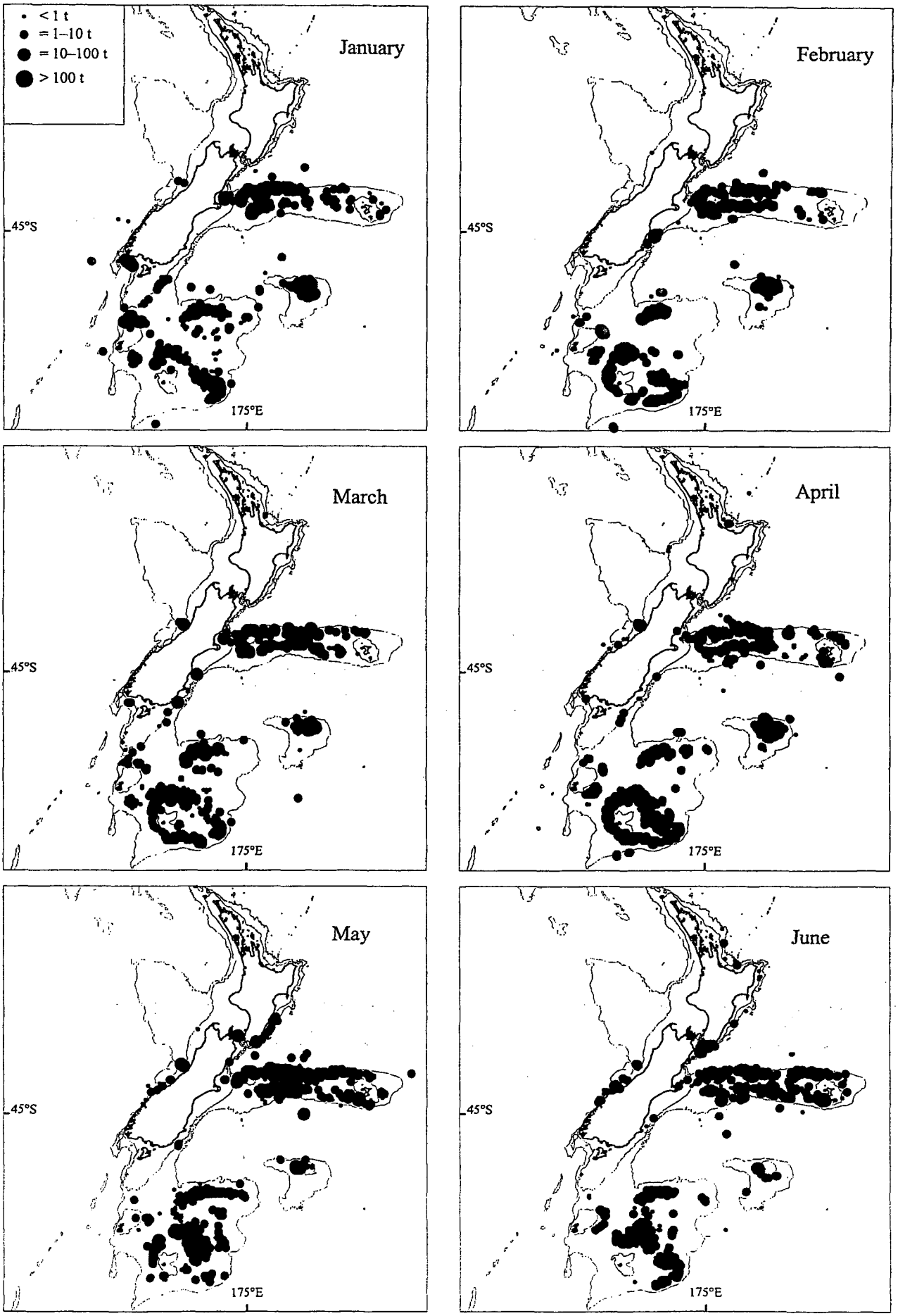

Figure B6: Longline landings by month.

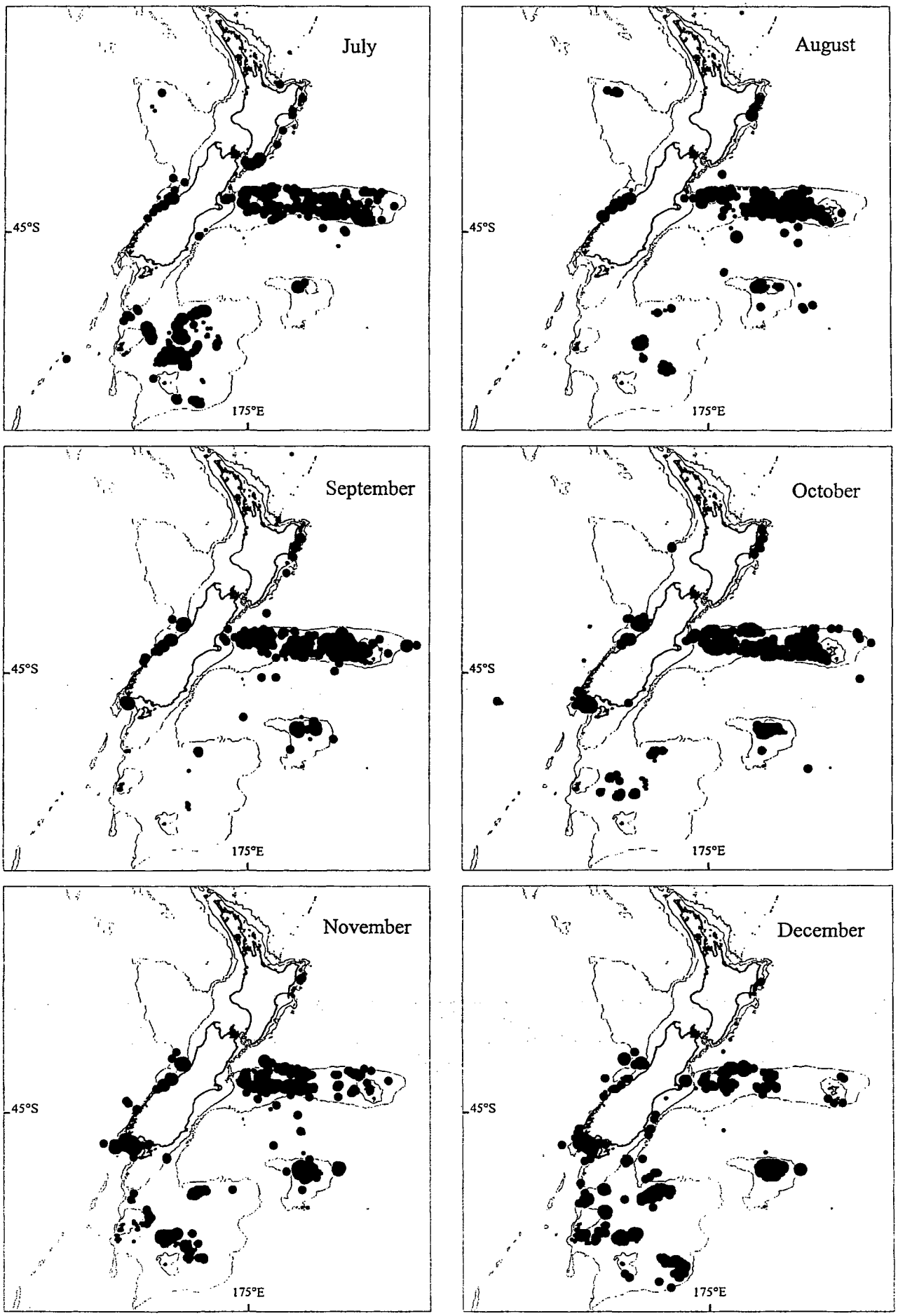

Figure B6 ctd.