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Characterisation of the alfonsino (*Beryx splendens*) fishery in BYX 3

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EXECUTIVE SUMMARY

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Alfonsino, *Beryx splendens,* are distributed worldwide in temperate and tropical waters with the exception of the northeastern Pacific. The commercial fishery in New Zealand fishes seamounts and underwater ridges at depths ranging from 200 to 1000 m. In BYX 3, the alfonsino fishery off the east coast of the south island of New Zealand, a target trawl fishery has developed recently, particularly to the southeast of the Chatham Islands, which has resulted in a large increase in catches and a concomitant increase in bycatch of bluenose, *Hyperoglyphe antarctica.* These developments prompted concerns regarding the status of the stocks and the Ministry of Fisheries commissioned a review of the fishery. The objective of this study was to characterise the BYX 3 fishery by analysis of existing literature, commercial catch and effort data, and data from other sources, and make recommendations on methods to monitor or assess the status of the BYX 3 fishery.

Reviews of the literature found limited development of stock assessment methods for alfonsino outside New Zealand. Within BYX 3, fishing was seasonally and spatially segregated with most of the increase in catch between 1996 and 2000 coming from underwater 'hill' features to the southeast of the Chatham Islands during the summer (November–February). The most common fishing method was the bottom trawl (over 80% of catch), with the remainder being caught by midwater trawls. Bycatch of other commercial species in BYX3 has been 150–200 t per annum, dominated by bluenose (over 60%). Commercial catch size-frequency data is limited to a sample of 930 fish from 1994–95 that showed two strong modes at 20–21 cm FL and 25–28 cm FL. A larger time series of length compositions from the trawl survey data (1991–2000) shows a declining proportion of fish in the larger length classes; however, the survey biomass estimates from this data are highly variable. Furthermore, a GLM analysis of CPUE in the fishery revealed no strong trends in catch rates from this fishery, although the analysis was limited by changes in effort distribution, high variability, and short time-series of appropriate CPUE data (5 years).

Our finding is that insufficient data are currently available for the BYX 3 fishery to undertake a formal stock assessment and this is unlikely to be practicable within 3–5 years. Our first recommendation is to establish an estimate of growth parameters for the BYX 3 by collection of age and length data. The age composition of the catch would reveal the age at recruitment to the fishery, the number of age classes supporting the commercial catch, the maximum age of fish in the catch, and the variability in recruitment strength. These data would also enable comparison with the BYX 2 fishery and throw light over questions of stock relationships. CPUE should be continued to be monitored and methods for its analysis refined.

1. INTRODUCTION

Alfonsino, *Beryx splendens*, has been caught in BYX 3 off the Kaikoura Coast, the northern side of the Mernoo Bank, along the northern side of the Chatham Rise, and to the southeast of the Chatham Islands. The annual catch from the BYX 3 fishery was below 300 t before the 199495 fishing year. After this the annual catch increased dramatically with the development of the target trawl fishery, principally in the area to the southeast of the Chatham Islands. Between 1995–96 and 1998–99, the total catch from the BYX 3 fishery was around the level of the TACC of 1010 t, although the annual catch declined to 743 t in 1999–2000 (Annala et al. 2000).

The development of this alfonsino target fishery has also caused an increase in the amount of bycatch caught. Bluenose, *Hyperoglyphe antarctica,* was caught in considerable amounts in the alfonsino target fishery in BYX 3. The bluenose quota has been overcaught in all fishing years from 1994-95. This project was initiated due to concerns regarding the large increase in the annual catches of alfonsino and, subsequently, bluenose.

The work described in this report was conducted for specific project objective 1 of Ministry of Fisheries research project BYX2000/01, Characterisation of the alfonsino fishery in BYX 3. The objective was "To characterise the BYX 3 fishery by analysis of existing commercial catch and effort data and data from other sources; and make recommendations on appropriate methods to monitor or assess the status of this Fishstock."

This document provides a review of the literature available (especially in regard to the stock assessment methods used for alfonsino) and an analysis of available catch and research data, and concludes with recommendations for the monitoring and assessment of this fishstock.

2. LITERATURE REVIEW

2.1 General review

Alfonsino are found worldwide in temperate and tropical waters with the exception of the northeastern Pacific (Busakhin 1982, Paulin 2000) and have been recorded in the Mediterranean Sea (Relini et al. 1995). Between 1989 and 1999, alfonsino fisheries existed in 11 of the 18 FAO statistical areas (Table 1).

Globally, the annual catch of alfonsino has increased in recent years with the discovery of new fishing grounds, particularly in the southeastern Indian Ocean. A new fishery for alfonsino has recently developed to the southeast of Madagascar in association with the orange roughy fishery in the area (Darby 2000). In New Zealand waters, alfonsino was virtually unfished before 1983 (Horn 1988). Annual catches increased to 1 500 t in the mid 1980s and early 1990s and further increased to 2500–3000 t in the late 1990s (Annala et al. 2000). Between 1996 and 1998, the reported annual worldwide catch of alfonsino was about 8–10 000 t, of which 20–40% was taken within the New Zealand EEZ.

2.2 Biology

Alfonsino spawn from August to October in Japanese waters, northwest of Hawaii and in the northeast Atlantic (Masuzawa et al. 1975, Uchida & Uchiyama 1986) and from November to February in New Caledonian waters (Lehoday & Grandperrin 1994, Lehoday et al. 1997). In the southeast Atlantic, alfonsino spawn between January and March (Alekseev et al. 1986). It has been suggested that the spawning season for alfonsino in New Zealand waters is in winter, from July to August (Horn & Massey 1989).

There have been several studies on alfonsino ageing and growth. Visible rings on alfonsino otoliths have allowed otolith ageing techniques to be used. But some investigators have questioned whether these are annuli. Kotlyar (1987) found that to calculate growth rates for alfonsino, two rings per year were required to calculate growth for the Indian Ocean alfonsino, as compared to one for alfonsino in other parts of the world.

Female alfonsino grow slightly faster than males (Lehoday & Grandperrin 1994, Lehoday & Grandperrin 1996, Massey & Horn 1990) (Table 2). Growth rates around the world are reasonably similar, although those of Japanese alfonsino (Masusawa et al. 1975) were slightly higher than those from the Atlantic Ocean (Kotlyar 1987), which in turn were higher than those from New Caledonia (Lehoday & Grandperrin 1996) and New Zealand alfonsino (Massey & Horn 1990). Lehoday & Grandperrin (1996) found that alfonsino growth varies with the El Niño Southern Oscillation; El Niño events increase growth; La Niña events depress it.

There have been suggestions that alfonsino migrate between seamounts and that there are separate populations within oceanic eddies rather than on individual seamounts (Alekseev et al. 1986, Lehoday & Grandperrin 1994): spawning occurs in reproductive zones, currents carry the larvae away, and the juvenile fish migrate back to the reproductive zone (Alekseev et al. 1986).

The depth distribution of alfonsino is between 25 m and 1200 m (Busakhin 1982). In New Zealand, alfonsino are usually found over seamounts and underwater ridges at depths ranging from 200 to 1000 m (Horn 1988, Horn & Massey 1989).

Alfonsino undergo strong diurnal migrations in the water column. During the day they occupy a demersal habitat and during the evening they rise and disperse in the water column to feed and aggregate, to descend again to the seafloor in the morning (Galaktionov 1984, Uchida & Tagami 1984). In New Zealand, Horn & Massey (1989) observed the opposite pattern, whereby dense schools of fish were present on the bottom during the night. However, their conclusions were based on only a few observations.

2.3 Stock assessment methods

Internationally, limited information is available concerning monitoring and assessment of alfonsino stocks. Most of the relevant information relates to the alfonsino fishery off the east coast of the North Island of New Zealand (BYX 2). For this fishery, initial investigations attempted to assess the abundance of alfonsino using trawl-acoustic, video and tagging surveys (Horn & Massey 1989). Since then, CPUE indices have been used to monitor trends in relative abundance (Horn 1988, Horn & Massey 1989, Stocker & Blackwell 1991, Langley 1995, Blackwell 2000).

Acoustic and trawl survey methods for assessing the abundance of alfonsino were investigated by Horn (1998) and Horn & Massey (1989). They found that the volume of fish schools could be easily estimated; however, trawling was inadequate for verifying the density of the schools as the performance of the trawling was unknown. Video and tagging surveys were unsuccessful because no alfonsino were successfully videoed and identified, and it appeared that very few alfonsino were successfully tagged (Horn & Massey 1989).

Studies aimed at using CPUE to estimate alfonsino abundance in BYX 2 derived non-standardised CPUE indices (Horn & Massey 1989, Stocker & Blackwell 1991). Horn & Massey (1989) used CPUE data (catch per day) that were approximately normalised using a log transformation and analysed using one-way ANOVA and the Student-Newman-Keuls' test for comparing the means. There were few statistically significant differences in CPUE between years for each fishing ground, attributed to the high variability of the CPUE dataset. This may have been due to several factors, such as vessel size and power, skipper experience, and fish behaviour. Despite the data variability, it was concluded that these factors could not be responsible for such a large change in CPUE, and therefore the observed

decline in CPUE was interpreted as a reduction in the abundance of alfonsino (Horn 1998, Horn & Massey 1989).

Stocker & Blackwell (1991), using the same catch per day CPUE estimator as Horn & Massey (1989), concluded that the observed decline was not as steep as suggested by Horn and Massey (1989). Stocker & Blackwell (1991) suggested that this may have been due to them aggregating data from all fishing grounds rather than calculating annual CPUE indices for each fishing ground and then calculating the average, as was done by Horn & Massey (1989).

Stocker & Blackwell (1991) also incorporated the CPUE indices in an age and sex structured model to estimate the virgin biomass and current biomass of alfonsino in BYX 2: virgin biomass was between 15 500 and 21 000 t and the biomass in 1990 was about 60% of the virgin biomass.

Langley (1995) used a stepwise multiple regression method of standardising CPUE to assess trends in alfonsino and bluenose fisheries in BYX 2. Catch per tow was used to produce the CPUE index, because it was said to be a more reliable estimator than catch per hour because the trawl duration may be restricted due to the topography, and as midwater trawls tend to be short, any error on the reporting times will have large effects on the analysis. This type of analysis might have underestimated the total effort as it did not include search time, so the CPUE indices may not be directly linked to the relative abundance of alfonsino. However, this study was aimed at highlighting the reasons for the increasing bycatch of bluenose in the alfonsino fishery. It was found that the areal distribution of the alfonsino fishery had changed to grounds which had higher catch rates of bluenose and the proportion of tows conducted in the morning and evening, when higher catch rates of bluenose are evident had increased (Langley 1995).

Blackwell (2000) compared loglinear and gamma log link models, for producing standardised CPUE indices for alfonsino. Two CPUE estimators were also compared, catch per day from CELR and TCEPR data and catch per tow from TCEPR data. Both models showed a similar trend of CPUE indices with the catch per day estimator, the CPUE dropped from 1989–90 until 1991–92 and had stabilised from 1993–94 to 1997–98. The catch per day estimator had similar trends to catch per tow, but explained more variation and produced a better fit to the data. Blackwell (2000) concluded that the standardised CPUE index using the catch per day estimator for the main vessels in the BYX 2 fishery best indicated the changes in the relative abundance of alfonsino.

Several other methods have been used to assess the abundance of species from the Berycidae family. In Australia, the length dependent offshore distribution of redfish, *Centroberyx affinis,* has been modelled. Trawl surveys used three depth strata. This illustrated a strong length dependent offshore distribution with the larger redfish being found in deeper waters. Two logistic functions were used to model this movement, which can provide an estimate of the number of redfish that move into the commercial fishing grounds (in offshore deeper waters). The model proposed will be useful in further stock assessments of this fishstock (Chen et al. 1997).

In New Caledonia, where *Beryx splendens* was fished using bottom longlines (FAO Yearbook, Table 1, records no catch since 1991), a study has been carried out to model their distribution over seamounts to the southeast of the country. This study aimed to estimate the abundance of alfonsino by modeling the species distribution of size and depth. Lehoday et al. (1994) concluded that a recursive model could be used to predict the most economic depth to be fished on a newly discovered seamount, whereas a bivariate-normal model could be used to help define stock management parameters for each of the seamounts fished.

The main limitation of this model is that it did not account for the large variation in alfonsino abundance over time. This temporal variation may have been due to some sampling being performed close to the reproductive season or due to effects of fluctuations in the El Niño Southern Oscillation. Lehoday et al. (1994) concluded that this modelling should be performed only over a short period.

3. CATCH AND EFFORT SUMMARY

3.1 Dataset

Catch and effort data from the BYX 3 fishery for the 1989–90 and 1999–2000 fishing years were provided by the Information Management Group of the Ministry of Fisheries (Extracts 3312 and 3407). Data were provided for all records where alfonsino was caught and/or targeted within all statistical areas, which were entirely or partly contained within BYX 3. The dataset included data recorded in two formats; Trawl Catch Effort and Processing Return (TCEPR) and Catch Effort Landings Return (CELR) data. The TCEPR format records details of individual trawls, while CELR data are aggregated by statistical area and fishing day.

The initial dataset included data from several statistical areas, including 018 and 019, only partially within BYX 3. Records of trawls conducted north of the boundary between BYX 2 and BYX 3 (42°10'S, Figure 1) were excluded from the TCEPR dataset.

The TCEPR and CELR data were separately checked for errors as these different data formats required different constraints. Where possible, corrections to records that were identified as erroneous were based on the adjacent records for the particular vessel. Otherwise, the record was assigned an error code and excluded from the subsequent analysis.

For the TCEPR dataset, the following errors were identified (variable names are in *italics*):

- The *duration* of the trawl equalled zero or was null.
- The *effort_speed* equalled zero or was null.
- The *effort_depth* was less than 200 m, greater than 900 m, or null.
- The *bottom_depth* was less than 200 m, greater than 900 m, or null.
- The *effort_height*, where the *primary_method* was MW (mid-water trawl), was less than 15 m, greater than 50 m, or null.
- The *effort_height*, where the *primary_method* was BT (bottom trawl), was less than 3 m, greater than 15 m, or null.
- The *catch_weight* from the related record in the table estimated_subcatch, where species_code was BYX was null.
- The *catch_weight* from the related record in the table estimated_subcatch, where species_code was BNS was null.

For the CELR data, the following errors were identified (variable names are in *italics*):

- The *trawl_duration* was null, less than 0.25, or greater than 10 hours.
- The *effort_height* was null, less than 1 m, or greater than 7 m.
- The *effort_num* was null, less than 1, or greater than 7.

3.2 Catch summary for the entire BYX 3

Annual reported catches from the BYX 3 fishery were 100200 t from 1986–87 to 1992–93. During this period, the level of catch was considerably less than the TACC for the fishery, which was established at 220 t in 1986–87 and subsequently increased to 1000 t in 1987–88 (Figure 2). The TACC increase was apparently based on yield estimates derived from the results of trawl surveys of the Chatham Rise by *Shinkai Maru* in March 1983 and July 1986 (Baird & McKoy 1988).

Annual catches from BYX 3 increased rapidly between 1992–93 and 1995–96 to approach the level of the TACC and were maintained at this level between 1995–96 and 1998–99. The catch from the

fishery exceeded the TACC by 15% in 1997–98, although annual catches declined slightly during the two subsequent years and were only 74% of the TACC in 1999–2000.

Estimated catches recorded in the TCEPR and CELR (effort section) formats accounted for 7095% of the total annual reported landed catch from BYX 3 between 1989–90 and 1999–2000 (Table 3). However, the percentage of the reported catch recorded in these formats was higher (9095%) in the later years following the increase in both the total catch and the catch from the target alfonsino fishery (see below). Given the relatively high proportion of the catch accounted for in the catch and effort dataset, trends in the distribution of catch from these data were considered representative of the entire BYX 3 fishery.

In 1989–90, CELR data provided nearly 90% of the total estimated catch from the BYX 3 fishery, while the proportion of TCEPR increased rapidly and accounted for 95100% of the total estimated catch since 1991–92 (Table 3).

3.2.1 Fishery location

TCEPR data were used to define the location of the main fishing grounds for alfonsino within BYX 3. Most of the alfonsino catch from BYX 3 was taken from along the Kaikoura shelf, along the northern edge of the Mernoo Bank and the Chatham Rise, and southeast of the Chatham Islands (Figure 3, top map). The distribution of larger catches (over 1 t) followed a similar pattern, but had fewer trawls along the Chatham Rise and relatively more dense aggregations of trawls along the Kaikoura shelf and to the southeast of the Chatham Islands (Figure 3, bottom map).

3.2.2 Target species

The BYX 3 alfonsino catch is primarily taken by the target fishery (Table 4). The target fishery expanded rapidly between 1993–94 and 1995–96 with catches increasing from less than 50 t to about 600700 t (Figure 4). Catches from the target fishery remained at or above this level until 1998–99 and declined slightly in 1999–2000. Most of the alfonsino target trawls were conducted along the Kaikoura shelf, along the northern boundary of the Mernoo Bank and to the southeast of the Chatham Islands (Figure 5).

Alfonsino was also caught as a bycatch in other fisheries within BYX 3, primarily hoki and orange roughy and, to a lesser extent, hake (Table 4). The BYX 3 bycatch from the hoki fishery varied from 1989–90 to 1999–2000, generally accounting for 50150 t, although the catch increased to about 250 t in 1996–97. Hoki target trawls where more than 50 kg of alfonsino caught were mainly along the northern margin of the Chatham Rise and the Mernoo Bank, in lower numbers along the Kaikoura shelf, and in very low numbers around the Chatham Islands (Figure 6).

The orange roughy fishery accounted for a BYX 3 bycatch of about 150 t in 1993–94 and 1997–98, although annual catches were generally less than 50 t during the remainder of the period studied. Most orange roughy target trawls with a bycatch of alfonsino were made to the south and east of the Chatham Islands (see Figure 5).

The alfonsino bycatch from the hake target fishery generally accounted for less than 15 t annually between 1989–90 and 1999–2000. Hake target trawls where more than 50 kg of alfonsino was caught, were located in a dense patch on the northern Chatham Rise and to the northwest of the Chatham Islands where there is a fishery targeting spawning hake (Figure 6).

3.2.3 Fishing method

Most of the BYX 3 catch was caught by bottom trawl: this method accounted for at least 75% of the total estimated catch in 6 of the 11 fishing years between 1989–90 and 1999–2000. Midwater trawling took most of the rest of the catch. A small proportion of the total BYX 3 catch was taken by the set net and longline methods (Table 5).

3.2.4 Fishing season

Most (5090%) of the BYX 3 annual catch was taken between November and March period, particularly since 1995–96. Overall, there was a general increase in the level of catch taken from November, reaching a seasonal peak in January and declining over the subsequent months. Catches were low between April and October (Table 6).

3.2.5 Areal distribution

Statistical areas 018 and 019 accounted for most of the BYX 3 catch between 1989–90 and 1990–91. Subsequently, an increasing proportion of the catch has been taken from statistical areas 406, 412, and 51 and these areas have accounted for 6580% of the BYX 3 catch since 1995–96 (Table 7).

Within BYX 3, three discrete areas account for a high proportion of the total alfonsino catch and fishing effort; Kaikoura, Mernoo, and East Chathams (Figure 5). Similarly to the trends shown for the statistical areas, the Kaikoura area accounted for most of the BYX 3 catch during 1989–90 to 1990–91 and the East Chatham area has accounted for most of the catch since 1995–96 (Table 8). Catches from the Mernoo sub-area were generally low.

3.3 BYX 3 alfonsino target fishery

Between 1989–90 and 1991–92, the alfonsino target fishery was dominated by the midwater trawl method, although catches were low. Bottom trawling became more prevalent after 1995–96, when annual catches exceeded 600 t (Table 9).

From 1995–96 there was a more defined fishing season, with most of the catch taken between November and March (Table 10). Before 1993–94, most of the catch from the target fishery was taken from statistical area 018, but statistical areas 412, 406 and 051 accounted for most of the catch in subsequent years (Table 11).

Midwater trawling was the principal method in the Mernoo area, although annual catches were generally low. In the East Chatham area bottom trawling was used extensively from 1995–96 when high catches of alfonsino were taken (Tables 12 and 13).

3.4 East Chatham target alfonsino fishery

The recent increase in catch from the BYX 3 fishery is largely attributable to the development of the target alfonsino trawl fishery in the East Chatham area. The fishery is dominated by the bottom trawl method, with up to eight vessels participating in any one year. The midwater trawl method is less prevalent, with only one vessel using this method exclusively over the seven year period (Table 14).

Since 1995–96, most of the alfonsino catch has been taken during summer (from November to March) (Table 15). Within the East Chatham area, there are seven main hills fished and few trawls are made elsewhere (Figure 7). In 1993–94, only one of these seven sub-areas was fished but, by 1997–98, each of the sub-areas was being fished. Four sub-areas (Areas 2, 3, 5, and 7) have consistently provided a high proportion of the total catch from the East Chatham area (Table 16).

Between 1993–94 and 1999–2000, 13 vessels operated in the East Chatham target alfonsino fishery, with 5 vessels taking most of the catch. Each of these five vessels has made at least 100 trawls in the

area in at least three of the seven fishing years. These vessels accounted for a high proportion of the total catch and effort from the fishery from 1995–96 onwards (Tables 17 and 18) and caught almost all of their alfonsino catch by bottom trawl (Table 19).

3.4.1 Processing state

About two-thirds of the target BYX 3 fishery was landed in the unprocessed (green) state and the balance has been processed on board to the dressed state (Table 20). Vessels involved in the target fishery consistently landed alfonsino in either state between 199596 and 19992000.

3.4.2 Bycatch

The bycatch of commercial finfish species reported from the target BYX 3 fishery has ranged from 24 to 31% of the BYX catch since 1994–95 (Table 21). Since the level of target fishing increased in 1995–96, the bycatch of other commercial fish species was about 150200 t per annum. Bluenose dominated the mix of bycatch species, with small quantities of orange roughy and white warehou also consistently taken. The remainder of the bycatch consisted of other species, including hoki, smooth oreo, and silver warehou.

3.5 Summary

Annual catches from the BYX 3 fishery increased rapidly from 1993–94 to about the level of the TACC and have remained at the higher level from 1995–96 to 1999–2000. The increase in catch was largely attributable to the development of the target alfonsino fishery associated with seven undersea "hill" features located in a relatively small area to the southeast of the Chatham Islands. This fishery typically operates during the summer period (November–March) and is dominated by five medium sized trawlers using bottom trawl gear.

4. SCIENTIFIC OBSERVER DATA

A limited amount of data have been collected from the BYX 3 fishery by the Ministry of Fisheries Scientific Observer Programme (SOP). Only 55 trawls targeting alfonsino in BYX 3 have been monitored by the SOP, 51 in 1994–95 and 4 in 1997–98. Data were collected from six separate fishing trips, although most of the trawls were observed during a single trip (48 records). Virtually all observed BYX 3 target trawls were along the southeastern edge of the Chatham Rise (Figure 8).

Length frequency samples of the target alfonsino catch were collected by the SOP from only 14 target trawls from a single fishing trip in 1994–95 (Table 22). Each sample represented the measurement of 50–100 fish from the catch, The sex of the fish sampled was also determined.

In addition, a few length frequency samples were collected from alfonsino caught as a bycatch of the hake, hoki, and orange roughy trawl fisheries within BYX 3. Three large catches of alfonsino were sampled from the hake fishery, but alfonsino catches sampled from the hoki fishery were small (less than 100 kg). Five samples were taken from the alfonsino bycatch of the orange roughy fishery (Table 22).

Only data from the target alfonsino fishery were considered in detail as this fishery accounted for the largest number of sampled trawls and number of fish measured. The sampling data were also all collected from the East Chatham Rise, the area that supports the largest proportion of the total alfonsino catch.

The combined length composition of the sampled BYX 3 target catch was determined, with individual samples weighted by the total estimated alfonsino catch from the trawl. This length composition applies only to the single sampled trip in 1994–95. The coefficients of variation associated with the estimates of proportion at length were determined following Southward (1976).

The length composition is dominated by fish in the 20–30 cm fork length (F.L.) range comprising two strong modes at 20–21 cm (F.L.) and 25–28 cm (F.L.) (Figure 9). The length frequency distribution also includes a broad tail of larger fish occupying the 30–50 cm F.L. range.

The length composition is dominated by samples from three large catches exceeding 2500 kg. These catches comprised largely of fish within the 2329 cm length range and hence the estimates of proportion at length for these length classes have a lower coefficient of variation (15–30%) than the remainder of the length range of the sampled catch. The estimates of proportion at length for the length classes greater than 30 cm F.L. are highly uncertain. Larger fish were caught in small numbers from trawls with a relatively small total catch of alfonsino.

5. TRAWL SURVEY DATA

Within BYX 3, the most frequent occurence of alfonsino in the trawl survey data set has been from the time series of Chatham Rise trawl surveys conducted annually since 1992. This trawl survey encompasses the area of the Chatham Rise within the 200–800 m depth range and principally targets juvenile hoki, with secondary objectives to monitor the relative abundance of ling and hake. In addition, alfonsino were caught in a few trawls from trawl surveys targeting orange roughy and oreo species along the eastern Chatham Rise in the 800–1000 m depth range (Anderson et al. 1998). However, these deepwater surveys included only the fringe of the distribution of alfonsino and, consequently, are not considered relevant to the monitoring of the BYX 3 fishery.

The Chatham Rise hoki survey is of a stratified random design with the survey area divided into 20–27 area and depth strata depending on the year of the survey. Details of the individual surveys were presented by Horn (1994a, 1994b), Schofield & Horn (1994), and Schofield & Livingston (1995, 1996).

Alfonsino has been caught from 30 to 60 trawl stations in each survey conducted between 1992 and 2000 (Table 23). Catches of alfonsino from these stations were small, generally less than 20 kg, although 11 catches have exceeded 500 kg. For many of the surveys, the total survey catch of alfonsino has been dominated by the catch from a single trawl station. About 1000–1500 fish have been sampled from the catch of alfonsino from each survey.

Most catches of alfonsino during the trawl survey series were taken from trawl stations along the central and northern margin of the Chatham Rise (Figure 10), with highest catch rates from trawls in the 300–500 m depth range (Anderson et al. 1998). The small number of trawl catches exceeding 500 kg of alfonsino were distributed throughout this area.

Trawl survey biomass estimates and coefficients of variation were calculated for alfonsino following the method of Vignaux (1994). The series of biomass estimates is characterised by high inter-annual variability and low precision, with coefficients of variation around 50–60% (Table 24). The very high survey biomass in 1994 (TAN9401) and high coefficient of variation is attributable to a large catch of alfonsino from one trawl. The biomass estimates from other surveys are also strongly influenced by the catch from a small number of stations, although not to the extent of the 1994 survey.

Most of the trawl survey biomass was derived from strata encompassing the central and northeastern Chatham Rise within the 200–400 m depth range. However, the relative distribution of survey biomass between individual strata varied between years largely due to the location of the few large catches taken during each survey.

Biomass estimates from the first three surveys of the series are higher than for the remainder of the survey period (Table 24). The change in relative abundance between the two periods of the survey is not significant, given the high coefficients of variations associated with all survey biomass indices. The difference in biomass may be attributable to a change in the survey design, including a reduction in the number of trawl stations, after survey TAN9401. Given the apparent patchy distribution of

alfonsino, the reduction in the number of stations is likely to reduce the probability of encountering a large catch of alfonsino, thereb, reducing the likelihood of achieving a higher survey biomass estimate.

Length frequency distributions were calculated for alfonsino for each trawl survey in the Chatham Rise time series. Length compositions were determined by scaling the individual length samples by the weight of the alfonsino catch from the trawl. This approach differs from the standard procedure for calculating trawl survey length frequency distributions in which individual stratum length compositions are scaled by the stratum area (Vignaux 1994). However, it was considered that the survey length frequency data were inadequate to determine the length compositions of the individual survey strata. Separate length frequencies were not determined for each sex as a high proportion of the smaller (less than 25 cm F.L.) fish sampled were unsexed for some surveys.

For most surveys, the length composition of the alfonsino catch was dominated by fish in the 20–30 cm F.L. range (Figure 11). One or two strong modes were apparent within this length range in most surveys, with modal lengths around 20–22 cm (F.L.) and 24–25 cm (F.L.). A third mode is present in the length composition of some surveys at around 27–28 cm (F.L.). The relative strength of each of these three modes is variable between surveys, although in many years the survey length composition is dominated by the smallest length mode.

The length compositions also generally consist of a declining proportion of fish in the larger length classes (over 30 cm F.L.), although fish in this length range account for a variable proportion of the survey catches. For example, alfonsino in the 30–40 cm F.L. range accounted for a significant proportion of the catch from the 1993 survey (TAN9212), but were virtually absent from the catch in 1998 (TAN9801) (Figure 11).

6. OPERATOR INTERVIEWS

Operators in the BYX 3 fishery were interviewed in order to gain an understanding of their perceptions of the extent of the resource and factors influencing the performance of the fishery. Three interviews were conducted with skippers and/or company representatives from three companies that together own or lease nearly 70% of the BYX 3 quota. The data summaries in this document and the CPUE analysis in Langley & Walker (2002) provided the basis for these discussions.

6.1 Steve Donker and Matthew Hardyment, skipper of *Tasman Viking*, Donker Marine (1988) Limited, 18 June 2001

Donker Marine (1988) Limited held the largest amount of BYX 3 quota for the 2000–01 fishing year and has a long involvement in both the BYX 2 and BYX 3 alfonsino fisheries. Matthew Hardyment has a long history with the alfonsino fishery in both BYX 2 from the early 1980's and the *Tasman Viking* was one of the few vessels that developed the BYX 3 target fishery to the southeast of the Chatham Islands.

Tasman Viking is an ice boat: fish are stored on ice and are landed 'fresh' (unprocessed). The vessel has a limited time on the fishing grounds (seven days fishing) in order to maintain the quality of the fish. They fish the southeast Chatham grounds from late December to March when the sea conditions are the calmest. While the fishing is better in winter, rough sea conditions can make trips risky as the vessel may not make it back to port before the fish is unsellable.

Tasman Viking fishes hill features S1 and S2, the closest areas, to reduce steaming time. There are some new grounds to the west of S1, which they have experimentally trawled with variable results. The main problem with these new grounds is that the terrain is very rough and they need to develop gear that will cope with the ground.

The net used, called a "rock hopper", is similar to nets used for fishing orange roughy. Tows are less than 10 minutes, mainly to prevent coming fast on the bottom after trawling down the pinnacle. These tows were initially done at 4 knots, but they are modifying their nets to get more speed (up to 4.5 knots), which is necessary as the alfonsino are becoming more flighty and increasingly able to avoid the trawl gear.

The size of alfonsino is much larger in the southeast Chatham grounds than in BYX 2, with an average weight of 0.9 kg: the larger alfonsino weighing about 1.5 kg. The large alfonsino come off the sea bottom in the evening, spend the night on the sides on the pinnacles, and then descend to the sea floor again around dawn. *Tasman Viking* targets alfonsino from 2200 until 0400 or 0500 the next morning.

It is difficult to distinguish the species composition of fish marks on the echosounder. The skipper can predict bluenose, but catch alfonsino, therefore large amounts of bluenose have been caught as bycatch from the alfonsino fishery. Donker Marine's bluenose catch has reduced, but they consider this to be related to the measures they have taken to reduce bluenose bycatch rather than a reduction in the abundance of bluenose. They have reduced the headline height of their nets to increase the escapement of bluenose. Bluenose will try to escape through the top of the net, while the alfonsino will try to dive under it. Also they actively move to avoid areas of high bluenose abundance and don't fish in the daytime when bluenose are more aggregated.

White warehou and silver warehou are also taken as bycatch: both species have increased in abundance in the bycatch in the last few years.

Donker Marine leases as much bluenose quota as possible to cover their bycatch but they still need to use the bycatch trade provision a lot, trading off the alfonsino quota to cover the bluenose caught. The tradeoff ratios between bluenose and alfonsino were:
1998–99; 1.4 t BNS to 1 t of BYX
1999–2000; 1.5 t BNS to 1 t of BYX.
They consider that the bycatch trade provision does a good job as the full quota of alfonsino will not be caught because the remainder will be traded for bycatch quota and further reduce the bluenose catch. They are very concerned about the bycatch trade provision being abolished.

6.2 Geoff Williams, skipper of *Amaltal Atlantis*, Amaltal Corporation Limited, 18 June 2001

Amaltal Corporation Limited is currently one of the main quota holders within the BYX 3 fishery with a quota holding of about 75 t for the 2000–01 fishing year. This quota is mainly fished by Geoff Williams on *Amaltal Atlantis* to the southeast of the Chatham Islands. Alfonsino is processed to a dressed state and sold to the Asian markets, where the best prices are received for large alfonsino in good condition (no scale loss).

Amaltal Atlantis fishes for hoki throughout the year and for alfonsino in the spring and early summer when they are fishing to the south and east of the Chatham Islands. Previously they had caught alfonsino while midwater trawling for hoki. They have since begun targeting alfonsino on hill features S1, S3, and S5 (see hill features in Figure 7). They have found that they can catch large alfonsino at depths greater than 700 m. These hill features have names, but it was difficult to match names to hill features exactly without Geoff's charts. It is likely that S1, S3, and S5 are known as "270", "DCS" and "Mount Lizzy", respectively.

Marks (from the depth sounder) are targeted on S3 and S5, but as alfonsino are relatively mobile it is common for the mark to be on the other side on the hill by the time the vessel has turned and shot the trawl gear. When targeting hoki or when initially approaching a hill, established tow lines will be used rather than targeting a mark. Zero catches result from trawls targeting a mark that misses, or from the trawls that use towlines but yield a nil catch.

The features fished are quite rough and a bottom trawl net rigged in a similar fashion to an orange roughy trawl is used. The net has a groundrope with 21-inch rubber bobbins and weighs 23 t. Tows are kept relatively short, less than 20 minutes, to maintain the condition of the fish.

Hoki are targeted during the day and alfonsino during the night. However, during a period where *Amaltal Atlantis* fished for alfonsino throughout the day, it was found that better catches were achieved during the afternoon to early evening and in the early morning. The fish caught were generally larger during the early morning.

Geoff does not consider bycatch to be much of a problem as they catch a maximum of 300400 kg of bluenose and rarely 100200 kg of white warehou per trawl. Bluenose tend to be more abundant in shallower depths. Schools of bluenose and alfonsino can be distinguished between on the net monitor, as long as the school isn't mixed, but it is not possible to distinguish these marks on the depth sounder. However the tows with catches under 0.5 t tend to have higher percentages of bluenose. The white warehou caught is relatively small but Geoff has noticed an increase in the amount of small white warehou over the Chatham Rise area over the last 12 months.

Geoff thought that the apparent decrease in catch rates for alfonsino in the 1999–2000 fishing year might have been caused by several vessels fishing in close together. This did not allow the fish to regroup before another vessel trawled the same hill feature.

6.3 Tony Muollo, Director, Cook Strait Seafoods Limited, 14 June 2001

Cook Strait Seafoods Ltd are one of the main operators in the target BYX 3 fishery. The company has been involved in the fishery for the last 34 years using FV *Baldur*. The company leases BYX 3 quota and has caught about 250 t annually since 1997–98. The vessel lands the alfonsino catch in an unprocessed (green) state. Onshore, the catch is processed to the dressed state for export to Japan. The market requires a high quality product, including minimal scale loss.

During the first two years in the fishery (1997–98 and 1998–99), almost all the alfonsino catch was taken from one main hill and catches were dominated by large fish. The bycatch of bluenose from this area was low. However, alfonsino catches subsequently declined and the hill was considered "fished out" after a few years. The reason for this decline was that this stock of fish was residential and never moved from this hill feature. These residential alfonsino were the largest Tony had ever seen.

In recent years, the vessel shifted fishing effort to other areas to maintain catches. However, the size of the alfonsino caught has been more variable, with an increase in the proportion of smaller fish, as these alfonsino are thought to be more migratory, and there has been a higher level of bluenose bycatch.

There has been an increased emphasis on the quality of the product and, consequently, large catches of alfonsino (over 5 t) are discouraged. Larger catch sizes result in increased damage, including scale loss, to the catch.

Most of the features fished are volcanic hills although, in the absence of the vessel skipper, Tony was unable to provide detailed information concerning the topography of the individual features fished. The vessel uses bottom trawl gear, similar to an orange roughy trawl. There is no specific reason why bottom trawl gear is used in preference to midwater gear.

Alfonsino are generally more aggregated during the summer (NovemberFebruary) and the company catches its entire BYX 3 quota during that period. Catch rates are relatively poor from March to October.

The distribution of alfonsino associated with an individual feature is highly variable. Alfonsino are relatively mobile, with the fish aggregating and dispersing around the feature. The distribution of fish

also varies with respect to the time of the day. Night fishing is generally better than day fishing, but this is not always the case.

The variation in the distribution of alfonsino on individual hill features means that during a fishing trip the vessel must move between the fishing areas to locate marks that can be targeted. The relationship between fish on different hills is unknown.

Tony considers the fishery to be very healthy with a large area of potential alfonsino habitat to the east of the Chatham Islands. The company has explored some of this area, although many of the features also have a high abundance of bluenose. There is limited potential for the fishery to develop along the Chatham Rise (west of the Chatham Islands) as catches of alfonsino in this area are dominated by smaller fish that are of lower economic value.

The main problem in the fishery is the lack of sufficient BNS 3 quota to cover the level of bluenose bycatch. The company attempts to lease BNS 3 quota to cover the bycatch, but the lease price is high, approaching the deemed value price for bluenose, and often requires a trade of other high value species. A TACC increase in BNS 3 will only slightly alleviate the problem, as Cook Strait Seafoods do not own BNS 3 quota and any increase would accrue to existing quota owners. White warehou is also caught as a significant bycatch of alfonsino in most of the areas fished, although the company has sufficient access to WWA 4 quota to cover the current level of bycatch.

7. SUMMARY AND RECOMMENDATIONS

Current information concerning the BYX 3 fishery is limited. Recent trends in the commercial fishery have been summarised in detail. However, there is currently no reliable index of abundance for the stock and very limited information is available concerning the size composition of the catch from the fishery. While the important biological parameters have been established for BYX 2 (e.g. growth and age structure, Horn & Massey 1989, Massey & Horn 1990), it is not known whether these parameters are appropriate to the BYX 3 fishery. The issues of stock boundaries of alfonsino over the Chatham Rise and between BYX 2 and BYX 3 remain unresolved (Smith & Paul 2000).

Currently, there is insufficient information available to undertake a formal stock assessment of the BYX 3 fishery and this is unlikely to be practicable in the medium term (3 to 5 years). This section of the report considers various options for monitoring future trends in the abundance of BYX 3 and other research requirements for the management of the fishery. While alfonsino are widely distributed (Busakhin 1982, Paulin 2000), few published accounts are available concerning the application of fishery independent survey techniques to monitor the abundance of alfonsino stocks globally.

7.1 Trawl surveys

The time-series of Chatham Rise trawl surveys by *Tangaroa* has covered the main depth range for alfonsino (300500 m). However, the resulting survey biomass estimates are poorly determined (high c.v.) and are highly variable between surveys. This is partly due to the aggregated distribution of alfonsino resulting in high variation in catch rates from adjacent stations.

Modifications to the current design of the Chatham Rise survey, in terms of the areal stratification and station allocation, are unlikely to substantially improve the precision of the biomass estimates for alfonsino. The location of trawls yielding high catch rates of alfonsino was not consistent between surveys and the alteration to the stratum boundaries of the survey area may compromise the results of the survey for the main target species (hoki, hake, and ling). The likely increase in station density required to achieve a reasonable level of precision (c.v. about 30%) on the alfonsino biomass estimates would substantially increase the duration and cost of the survey.

The survey encompasses the area of the southeast Chatham Rise that supports the main BYX 3 target fishery. However, due to the spatial extent of the survey strata and the relatively discrete location of the fishery, there is only a small probability of allocating a random trawl station within the main area of the commercial fishery. During the 19922000 period, no random trawl stations were occupied on the seven features that support virtually the entire BYX 3 target fishery. In future, there may be potential to sub-divide this area and undertake a targeted phase of the survey to monitor the relative abundance of alfonsino in the core area of the fishery. However, any targeted survey would require very careful consideration of the main factors influencing the variation of catch rates in the area. The recent analysis of CPUE data from the BYX 3 fishery revealed catch rates of alfonsino were inherently variable, although some of the variation was accounted for by the time of day, location, and season. These factors would influence the design of any such survey, while the high variation in catch rates would require intense sampling to achieve abundance indices of sufficient precision.

The utility of any targeted survey would need to be considered in the context of the wider distribution and abundance of alfonsino within BYX 3. A targeted survey may enable trends in local abundance to be monitored. However, this would be of limited utility in an assessment of the entire BYX 3 stock unless there was a high degree of mixing within the fishstock.

Discussions with operators in the BYX 3 fishery revealed that there is potential for the current fishery to develop beyond the known grounds on the southeast Chatham Rise, and alfonsino is widespread on the north Chatham Rise. The exploratory development of the areas should be encouraged to determine the distribution and relative abundance of alfonsino. Any areas of potential alfonsino habitat near the vicinity of the area of the main fishery should be investigated before considering any resource survey in the area. It is unknown whether alfonsino associated with an individual hill feature represent a localised population or whether there is mixing between features.

7.2 Acoustic surveys

Horn & Massey (1989) reviewed the potential of resource survey techniques, principally a combined trawl and acoustic survey, to monitor the abundance of alfonsino and bluenose in BYX 2. Due to difficulties with assumptions made in both acoustic and trawl surveys, decided to use a combined acoustic and trawl survey as this allowed the acoustic data to be calibrated against the trawl catches. They concluded that the acoustic methods were capable of measuring school density, and that more precise estimates could be gained from using a higher resolution echosounder with a narrower beam. However trawling proved to be unreliable for determining the density and composition of fish schools, as trawl efficiency varies considerably between trawls. The variation in trawl efficiency observed by Horn and Massey (1989) may be related to the highly aggregated distribution and flighty behaviour of alfonsino.

During the last decade, there have been considerable advances in the application of acoustic techniques to the assessment of fisheries resources, but there are a number of factors that would need to be addressed before they could be applied to the BYX 3 fishery. The association of alfonsino with other species, principally bluenose, would require estimates of acoustic target strength to be available for the main species present and considerable trawl sampling to determine the species composition of the main fish aggregations.

The distribution of alfonsino associated with the main features fished is reported to be highly variable, with fish moving between and around the individual features. The variation in the distribution of the species appears to be partly due to diurnal movements. The mobility of the species could potentially introduce significant biases into the results of an acoustic survey and would require careful consideration in any survey design. Diurnal changes in the vertical distribution of alfonsino could influence the acoustic availability of alfonsino, particularly around seamount features, due to the effect of the dead zone. The patchy distribution of alfonsino would necessitate a relatively intensive survey design to achieve acoustic biomass estimates of reasonable precision (c.v.s less than 20%).

It is considered that an acoustic survey of alfonsino within BYX 3 is currently not appropriate due to the problems associated with undertaking such a survey and the high associated cost.

7.3 CPUE

Trends in CPUE from the alfonsino trawl fishery have been proposed as a monitoring tool for the BYX 2 fishery (Blackwell 2000). However, the BYX 2 fishery is complex, supported by a number of geographically distinct fishing grounds, and there is considerable variation in the geographical distribution of the fishery and in the fleet composition over the recent history of the fishery. As a result, the reliability of CPUE as an index of relative abundance for BYX 2 is unknown, particularly given the absence of an alternative index of stock abundance.

The use of CPUE to monitor the abundance of BYX 3 was investigated by Langley & Walker (2002). This analysis revealed a decline in the unstandardised catch rates, while CPUE indices derived from a GLM modelling approach revealed no strong trend in catch rates from the fishery. However, the report concluded that the CPUE analysis was limited by the small amount of data available from the fishery, by confounded changes in the distribution of fishing effort, by the high variation in observed catch rates, and by the short time-series of catch and effort data available (five years). Nevertheless, routine monitoring of the catch and effort data from the fishery is required to determine whether current catch rates are sustained and to identify any changes in the geographic distribution of the target fishery.

7.4 Size composition of the commercial catch

Very limited information is available concerning the size composition of the commercial catch from BYX 3. The only data available are from limited sampling conducted by the Scientific Observer Programme in 1994–95. These data were collected from a single feature fished during the early development of the target fishery on a single trip. It is recommended that additional sampling of the commercial catch be conducted to determine the length and age composition of the current catch. This sampling needs to be representative of the total catch in the fishery, covering all the features being fished by the target fishery. As well, this sampling should be maintained for at least three years and then evaluated. There is potential to undertake catch sampling during vessel discharge, given that most of the BYX 3 catch is landed in the unprocessed state. However, at-sea sampling, either by dedicated scientific observers or through an industry-based sampling programme, would provide a greater level of spatial definition and enable differences in length composition to be investigated between the main features fished. This information may provide some indication of the extent of movement of fish between each of main fishing areas.

Protocols for ageing alfonsino were established by Massey & Horn (1990) based on the reading of otoliths from the BYX 2 fishery. The collection of length and age data from the BYX 3 fishery would enable the determination of growth for the alfonsino population(s) supporting the BYX 3 commercial catch. The resulting age composition of the catch would reveal the age at recruitment to the fishery, the number of age classes supporting the commercial catch, the maximum age of fish in the catch, and the variability in recruitment strength in BYX 3. These data would provide a useful base line for future monitoring of trends in the length and age composition of the BYX 3 catch. Therefore, the sampling programme proposed in the previous paragraph should also include the determination of the age distribution of the catch.

In addition, the collection of length and age data from the BYX 3 fishery would enable comparison with the age composition and biological parameters derived from recent catches from the BYX 2 fishery (Blackwell et al. 2001). A recent study proposed four potential stock models for the relationship between alfonsino in BYX 2 and BYX 3 (Smith & Paul 2000). However, limited information is available to investigate potential stock differences of alfonsino within BYX 3 and/or between BYX 3 and BYX 2. Comparison of the length and age data from the BYX 2 and BYX 3 fisheries may assist in the evaluation of the various stock hypotheses proposed for alfonsino.

7.5 Summary

It is important that future monitoring of the BYX 3 fishery considers the cost of the monitoring regime and the likely utility of the resulting information, the level of risk of managing the fishery at current catch levels, and the economic value of the fishery. The current level of catch from the fishery is relatively small, given the large area included in the QMA and the extent of the known distribution of this species over the entire Chatham Rise. However, the spatial extent of the current fishery is limited and it is unknown whether the magnitude of the current catch levels is sustainable in the long term in this smaller area.

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9. REFERENCES

Anderson, O.F.; Bagley, N.W.; Hurst R.J.; Francis, M.P.; Clark, M.R.; McMillan, P.J. (1998). Atlas of New Zealand fish and squid distributions from research bottom trawls. *NIWA Technical Report 42*. 303 p.

Annala, J.H.; Sullivan, K.J.; O'Brien, C.J. (Comps) (2000). Report from the Fishery Assessment Plenary, May 2000: stock assessments and yield estimates. 495 p. (Unpublished report held in NIWA library, Wellington.)

Alekseev, F.E.; Alekseeva, E.I.; Trunov, I.A.; Shlibanov, V.I. (1986). Macroscale water circulation, ontogenetic geographical differentiation and population structure of alfoncino, *Beryx splendens* Lowe, in the Atlantic Ocean. *International Council for the Exploration of the Sea [ICES]* 1986/C:10 16 p.

Baird, G.G.; McKoy, J.L. (1988). Papers from the workshop to review fish stock assessments for the 1987-88 New Zealand fishing year. 300 p. (Preliminary discussion paper held in NIWA library, Wellington.)

Blackwell, R.G. (2000). Alfonsino (*Beryx splendens*) abundance indices from standardised catch per unit effort (CPUE) analysis for the East Coast North Island (BYX2) midwater trawl fishery 198990 to 199798. *New Zealand Fisheries Assessment Report 2000/53*. 40 p.

Blackwell, R.G.; McMillan, P.J.; Horn, P.L.; Paul, L.J. (2001). Commercial catch sampling of alfonsino, bluenose, gemfish, and rubyfish in QMA 2 in 1999-2000. Final Research Report for Ministry of Fisheries Research Project INS1999/01. (Unpublished report held by MFish, Wellington).

Busakhin, S.V. (1982). Systematics and distribution of the family Bercidae (Osteichthyes) in the World Ocean. *Journal of Ichthology 22(6):* 1–21.

Chen, Y.; Liggins, G.W.; Graham, K.J.; Kennelly, S.J. (1997). Modelling the length-dependent offshore distribution of redfish, *Centroberyx affinis*. *Fisheries Research* 29: 39–54.

Darby, A. (2000). Trawlers threaten new-found riches. *Sydney Morning Herald*, 3 July 2000.

Galaktionov, G.Z. (1984). Features of the schooling behaviour of the alfonsina *Beryx splendens* (Berycidae) in the thalassobathyl depths of the Atlantic Ocean. *Journal of Ichthology 24:* 148–151

Horn, P.L. (1988). Alfonsino. *New Zealand Fisheries Assessment Research Document* 88/7. (Unpublished report held in NIWA library, Wellington.)

Horn, P.L. (1994a). Trawl survey of hoki and middle depth species on the Chatham Rise, December 1991-January 1992 (TAN9106). *New Zealand Fisheries Data Report No. 43.*

Horn, P.L. (1994b). Trawl survey of hoki and middle depth species on the Chatham Rise, December 1992-February 1993 (TAN9212). *New Zealand Fisheries Data Report No. 44.*

Horn, P.L.; Massey, B.R. (1989). Biology and abundance of alfonsino and bluenose off the lower east coast North Island, New Zealand. *New Zealand Fisheries Technical Report No. 15.* 32 p.

Hurst, R.J.; Bagley, N.W.; Anderson, O.F. (2000) Atlas of juvenile and adult fish and squid distributions from bottom and midwater trawls in New Zealand waters. *NIWA Technical Report No. 84.* 162 p.

Ikenouye, H. (1969) Age determination by otolith of a Japanese alfonsin, *Beryx splendens*, with special reference to growth. *Journal of the Tokyo University of Fisheries 55(2)*: 91–98.

Kotlyar, A.N. (1987). Age and growth of alfonsino, *Beryx splendens*. *Journal of Ichthology 27:* 104–111.

Langley, A.D. (1995). Analysis of commercial catch and effort data from the QMA 2 alfonsino-bluenose trawl fishery, 1989–1994. New Zealand Fisheries Assessment Research Document 95/18. 22 p. (Unpublished report held in NIWA library, Wellington)

Langley, A.D.; Walker, N.A. (2002). CPUE analysis of the target BYX 3 alfonsino fishery and associated bluenose bycatch. *New Zealand Fisheries Assessment Report 2002/24.* 45 p.

Lehodey, P (1996b). Influence of temperature and ENSO events on the growth of the deep demersal fish alfonsino, *Beryx splendens*, off New Caledonia in the western tropical South Pacific Ocean. *Deep-Sea Research. Part I, Oceanographic Research Papers 43(1):* 49–57.

Lehoday, P.; Grandperrin, R. (1994). A study of the fishery and biology of *Beryx splendens* (alfonsin) in New Caledonia. *SPC Fisheries Newsletter 71:* 30–36.

Lehoday, P.; Grandperrin, R. (1996). Age and growth of the alfonsino *Beryx splendens* over the seamounts off New Caledonia. *Marine Biology 125:* 22–49

Lehoday, P.; Grandperrin, R.; Marchal, P. (1997). Reproductive biology and ecology of a deep-demersal fish, alfonsino *Beryx splendens*, over the seamounts off New Caledonia. *Marine Biology 128(1):* 17–27.

Lehoday, P.; Marchal, P.; Grandperrin, R. (1994). Modeling the distribution of alfonsino, *Beryx splendens*, over the seamounts of New Caledonia. *Fishery Bulletin 92(4):* 748–759.

de Leon, E.; Malkov, A. (1979). Preliminary study of the age and growth of the *Beryx splendens* Lowe of the west-central Atlantic. *Revista Cubana de Investigaciones Pesqueras 4(4):* 67–73.

Massey, B.R.; Horn, P.L. (1990). Growth and age structure of alfonsino (*Beryx splendens*) from the lower east coast, North Island, New Zealand. *New Zealand Journal of Marine and Freshwater Research 24(1):* 121–136.

Masuzawa, T.; Kurata, Y.; Onishi, K. (1975) Results of group study on a population of demersal fishes in waters from Sagami Bay to southern Izu Islands: population ecology of Japanese alfosin and other demersal fishes. *Japan Aquatic Resources Conservation Association Fishery Research Paper No 28* (In Japanese, English translation held in NIWA library, Wellington.)

Paulin, C. (2000). Alfonsino and golden snapper: splendid confusion. *Seafood New Zealand 8(9):* 66–68.

Relini, L.; Orsini Palandri, G.; Garibaldi, F. (1995). First record of *Beryx splendens* (Osteichthyes, Berycidae) in the Mediterranean. *Cybium 19(3):* 317.

Schofield, K.A.; Horn, P.L. (1994). Trawl survey of hoki and middle depth species on the Chatham Rise, January 1994 (TAN9401). *New Zealand Fisheries Data Report No. 53.*

Schofield, K.A.; Livingston, M.E. (1995). Trawl survey of hoki and middle depth species on the Chatham Rise, January 1995 (TAN9501). *New Zealand Fisheries Data Report No. 59.*

Schofield, K.A.; Livingston, M.E. (1996). Trawl survey of hoki and middle depth species on the Chatham Rise, January 1996 (TAN9601). *New Zealand Fisheries Data Report No. 71.*

Smith, P.; Paul, L. (2000). Stock relationships of alfonsino and cardinalfish in New Zealand waters. Final Research Report for Ministry of Fisheries Research Project DEE1999/03. (Unpublished report held by MFish, Wellington).

Southward, G.M. (1976). Sampling landings of halibut for age composition. *Scientific Report 58, International Pacific Halibut Commission.* 31 p.

Stocker, M.; Blackwell, R. (1991). Biomass and yield estimates for alfonsino in BYX 2 for the 1991-92 fishing year. New Zealand Fisheries Assessment Research Document 91/12. 12 p. (Unpublished report held in NIWA library, Wellington)

Uchida, R.N.; Tagami, D.T. (1984). Groundfish fisheries and research in the vicinity of seamounts in the North Pacific Ocean. *Marine Fisheries Review 46(2):* 1–17.

Uchida, R.N.; Uchihama, J.H. (1986) Fishery atlas of the northwestern Hawaiian Islands. *NOAA Technical Report NMFS No. 38.* 142 p.

Vignaux, M. (1994). Documentation of Trawl survey Analysis Program. MAF Fisheries Greta Point Internal Report No. 225. 44 p. (Unpublished report held in NIWA library, Wellington.

Vinnichenko, V.L. (1997): Vertical diurnal migrations of the slender alfonsino *Beryx splendens* (Berycidae) at the underwater rises of the open North Atlantic. *Journal of Ichthyology 37(6):* 438–444.

Table 1: Annual catch of alfonsino spp. by FAO statistical area (see Appendix 1) and nation for the 1996 to 1999 (from FAO Yearbook 1999).

FAO statistical area	Country	Catch (t)			
		1996	1997	1998	1999
21	Russian Fed.	141	0	0	0
27	Faeroe Isl.	0	5	0	0
	France	0	3	27	75
	Iceland	1	0	0	0
	Portugal	0	0	0	87
	Spain	97	247	195	0
	UK	0	4	0	0
31	Iceland	0	7	0	0
	Russian Fed	0	15	0	0
34	Portugal	126	58	51	3
	Russian Fed.	0	0	10	21
	Spain	24	47	18	0
41	Chile	0	0	144	0
47	Iceland	0	466	128	0
	Namibia	1 805	368	168	175
	Norway	0	825	1 066	0
	Poland	0	1 964	0	0
	Portugal	0	0	0	3
	Russian Fed	0	48	69	0
	Spain	0	186	402	0
	Ukraine	747	392	0	0
51	Ukraine	3 079	1 031	859	1964
61	Russian Fed.	6	0	4	38
71	New Caledonia	0	0	0	0
81	Korea Rep	0	0	77	0
	New Zealand	2159	2617	3516	2570
87	Chile	0	0	0	706
Total		8 185	8 283	6 734	5 642

Table 2: Comparison of von Bertalanffy growth parameters for alfonsino from different areas (where: M, Male; F, Female; L_∞, asymptotic length; K, rate at which L_∞ is approached; t_0, age at length=0 according to von Bertalanffy growth function) (Table based on that from Lehoday & Grandperrin 1996).

Area	L_∞		K		t_0		Source
	M	F	M	F	M	F	
New Caledonia							
Norfolk-Loyalty Ridges	45.2	50.8	0.146	0.134	-2.34	-2	Lehoday & Grandperrin 1996
New Zealand							
Palliser Bank	51.1	57.5	0.11	0.088	-3.56	-4.1	Massey & Horn 1990
Tuaheni	54.9	76.3	0.093	0.042	-4.3	-8.25	Massey & Horn 1990
Paoanui	49.1	---	0.144	---	-1.81	---	Massey & Horn 1990
Japan							
Sagami Bay	37.8		0.439		0.40		Ikenouye 1969
Sagami Bight	45.8		0.323		-0.22		Masusawa et al. 1979
Zunan Sea	54.4		0.181		-0.08		Masusawa et al. 1979
Atlantic							
Angular Rise	48.5		0.170		-2.63		de Leon & Malkov 1979
New Year Rise	44.8		0.209		-0.89		de Leon & Malkov 1979

Table 3: **Reported estimated catch (tonnes) of BYX 3 from CELR and TCEPR forms as a percentage of the total catch, the total estimated catch, Quota Management Returns (QMR) and the Total Allowable Commercial Catch (TACC) for each fishing year.**

	Percentage of total catch by form type					
Fishing year	CELR	TCEPR	Total catch (t)	Percent QMR	QMR (t)	TACC (t)
1985–86	-	-	-	-	3	-
1986–87	-	-	-	-	75	220
1987–88	-	-	-	-	101	1 000
1988–89	-	-	-	-	64	1 000
1989–90	88.5	11.5	123	83.7	147	1 007
1990–91	36.8	63.2	187	92.6	202	1 007
1991–92	6.0	94.0	237	89.8	264	1 007
1992–93	2.5	97.5	77	68.1	113	1 007
1993–94	1.2	98.8	243	88.4	275	1 007
1994–95	3.9	96.1	334	69.3	482	1 010
1995–96	0.7	99.3	777	80.9	961	1 010
1996–97	0.0	100.0	943	95.9	983	1 010
1997–98	0.1	99.9	1 054	90.5	1 164	1 010
1998–99	0.2	99.8	874	95.8	912	1 010
1999–2000	0.2	99.8	669	73.6	743	1 010

Table 4: **Percentage distribution of the total estimated catch of alfonsino (BYX 3) by target species and fishing year. The total estimated catch in each fishing year and the percentage of the total catch for all fishing years combined is also presented (source: MFish CELR and TCEPR data).**

	Target species							
Fishing year	Alfonsino	Bluenose	Hake	Hoki	Ling	Orange roughy	Other	Total catch (t)
1989–90	88.1	0.0	2.3	5.8	0.2	0.0	3.7	123
1990–91	61.4	0.0	1.3	13.5	4.2	0.2	19.5	187
1991–92	23.8	0.0	1.0	49.2	0.5	23.7	1.8	237
1992–93	3.9	0.1	21.3	45.6	0.3	4.5	24.3	77
1993–94	3.6	0.0	2.7	21.1	0.2	71.2	1.2	243
1994–95	49.6	0.1	8.7	19.4	0.0	21.8	0.3	334
1995–96	81.7	0.0	0.8	9.9	0.0	7.0	0.5	777
1996–97	69.5	0.0	0.8	25.3	0.0	3.8	0.5	943
1997–98	64.7	0.0	5.7	15.4	0.1	13.8	0.3	1 054
1998–99	86.8	0.1	1.6	4.2	0.0	7.0	0.2	874
1999–2000	81.2	0.0	0.5	13.3	0.3	2.7	1.9	669
Total	67.6	0.0	2.7	16.4	0.2	11.3	1.7	

Table 5: **Percentage distribution of the total estimated catch of alfonsino (BYX 3) by fishing method and fishing year. The total estimated catch in each fishing year and the percentage of the total catch for all fishing years combined is also presented (source: MFish CELR and TCEPR data).**

	Fishing method					
Fishing year	Bottom trawl	Midwater trawl	Set net	Bottom long-line	Other	Total catch (t)
1989–90	21.8	77.8	0.4	0.0	0.0	123
1990–91	32.3	67.4	0.2	0.0	0.0	187
1991–92	65.1	34.7	0.2	0.0	0.0	237
1992–93	87.8	11.9	0.2	0.2	0.0	77
1993–94	92.6	7.2	0.1	0.1	0.0	243
1994–95	56.3	43.6	0.1	0.1	0.0	334
1995–96	75.1	24.9	0.0	0.0	0.0	777
1996–97	92.4	7.4	0.0	0.0	0.2	943
1997–98	92.7	7.2	0.1	0.0	0.0	1 054
1998–99	87.5	12.3	0.2	0.0	0.0	874
1999–2000	89.8	10.1	0.1	0.0	0.0	669
Total	81.9	17.9	0.1	0.0	0.0	

Table 6: **Percentage distribution of the total estimated catch of alfonsino (BYX 3) by month and fishing year. The total estimated catch in each fishing year and the percentage of the total catch for all fishing years combined is also presented (source: MFish CELR and TCEPR data).**

	Month (in order within Fishing year)												
Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Total catch (t)
1989–90	1.4	3.8	7.5	40.5	0.1	0.0	0.0	0.1	3.2	8.1	24.3	10.9	123
1990–91	0.0	0.2	1.2	29.0	8.0	13.0	5.1	0.3	11.4	0.0	0.0	31.8	187
1991–92	0.0	0.3	0.1	16.9	13.9	4.3	7.2	4.3	14.7	2.3	0.2	35.8	237
1992–93	6.9	6.5	8.0	8.0	28.5	0.6	3.6	4.8	0.9	0.4	6.6	25.1	77
1993–94	2.4	2.6	23.0	43.7	17.9	1.8	0.7	0.9	5.5	0.0	0.0	1.5	243
1994–95	4.9	15.2	13.1	18.3	3.4	8.0	0.4	6.2	0.4	0.0	1.6	28.5	334
1995–96	2.1	3.2	17.6	20.0	33.8	16.9	1.6	1.1	0.0	0.0	0.0	3.8	777
1996–97	2.2	33.1	20.6	15.7	7.8	10.5	1.3	5.6	1.3	0.0	0.0	1.9	943
1997–98	7.1	5.9	32.0	15.5	19.6	8.2	3.3	0.4	5.6	0.6	0.0	1.7	1 054
1998–99	1.4	18.1	17.9	15.8	8.8	21.2	2.7	0.2	0.1	0.1	0.1	13.5	874
1999–2000	13.5	1.1	10.2	11.3	35.0	13.6	1.6	0.9	1.3	0.1	0.0	11.4	669
Total	4.4	11.5	18.3	18.1	17.7	11.9	2.3	2.0	2.8	0.4	0.8	9.7	

Table 7: **Percentage distribution of the total estimated catch of alfonsino (BYX 3) by statistical area and fishing year. The total estimated catch in each fishing year and the percentage of the total catch for all fishing years combined is also presented (source: MFish CELR and TCEPR data).**

	General statistical areas within BYX 3															Other areas on		Total
Fishing year	18	19	20	21	22	23	401	402	404	406	412	49	50	51	52	Chatham Rise	Other areas	catch (t)
1989–90	39.8	48.6	0.0	0.0	0.0	0.0	3.6	0.0	7.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	123
1990–91	74.8	0.7	6.5	2.2	0.2	0.0	9.3	1.5	1.4	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	187
1991–92	35.0	0.0	1.8	2.3	0.1	0.0	21.2	3.3	3.6	0.0	23.7	0.0	0.4	0.0	0.0	0.0	8.5	237
1992–93	9.8	0.0	0.4	21.2	0.0	0.3	2.7	8.0	22.0	0.0	4.5	0.4	0.0	28.5	0.1	0.7	1.4	77
1993–94	12.6	0.0	0.3	2.2	0.0	0.0	1.2	5.5	3.7	0.0	71.6	0.0	0.0	1.6	0.0	0.1	1.1	243
1994–95	24.1	0.0	1.7	21.0	0.0	0.0	3.4	2.4	14.6	0.1	27.5	0.4	3.1	1.0	0.0	0.6	0.0	334
1995–96	6.1	1.4	0.4	6.6	0.0	0.1	0.0	0.2	0.9	12.2	18.8	0.1	0.0	52.7	0.0	0.5	0.0	777
1996–97	5.3	0.0	2.8	0.7	0.0	2.2	5.5	0.4	1.1	12.1	19.2	0.4	0.6	49.5	0.0	0.2	0.0	943
1997–98	0.8	0.0	2.4	1.0	0.0	2.0	8.1	0.1	6.8	34.2	20.9	0.6	1.3	21.1	0.3	0.1	0.5	1 054
1998–99	0.5	3.4	0.4	6.2	0.0	2.3	2.1	1.1	4.9	19.0	25.3	0.0	10.4	24.2	0.0	0.2	0.0	874
1999–2000	2.1	0.0	8.3	11.3	0	0.4	0.4	1.5	10.2	15.2	10.6	0.3	0.1	39.3	0.0	0.1	0.0	669
Total	9.3	1.9	2.5	5.4	0.0	1.2	4.5	1.1	5.4	15.2	21.1	0.4	2.2	29.0	0.1	0.2	0.5	

Table 8: **Percentage distribution of the total estimated catch of alfonsino (BYX 3) for each of four main fishing areas by fishing year. The total estimated catch in each fishing year and the percentage of the total catch for all fishing years combined is also presented (source: MFish CELR and TCEPR data).**

Fishing year	East Chathams	Kaikoura	Mernoo	Other	Total catch (t)
1989–90	0.0	88.5	0.0	11.5	123
1990–91	0.0	59.6	2.1	38.3	187
1991–92	0.0	24.2	0.0	75.8	237
1992–93	0.2	4.4	0.3	95.1	77
1993–94	3.0	0.8	0.4	95.8	243
1994–95	10.1	21.2	20.3	48.4	334
1995–96	77.0	2.0	3.4	17.5	777
1996–97	68.2	1.4	0.0	30.4	943
1997–98	64.1	0.0	0.6	35.3	1 054
1998–99	74.3	0.2	9.4	16.2	874
1999–2000	62.6	0.1	7.3	30.0	669
Total	54.8	7.0	4.3	33.9	

Table 9: **Percentage distribution of the total estimated catch of alfonsino from the BYX 3 target fishery by fishing method and fishing year. The total estimated catch in each fishing year and the percentage of the total catch for all fishing years combined is also presented (source: MFish CELR and TCEPR data).**

	Fishing method		Total catch (t)
Fishing year	Bottom trawl	Midwater trawl	
1989–90	11.7	88.3	109
1990–91	1.1	98.9	115
1991–92	0.0	100.0	56
1992–93	0.0	100.0	3
1993–94	85.3	14.7	9
1994–95	13.6	86.4	166
1995–96	74.6	25.4	635
1996–97	99.9	0.1	656
1997–98	96.1	3.9	681
1998–99	87.7	12.3	759
1999–2000	91.2	8.8	544
Total	80.1	19.9	

Table 10: **Percentage distribution of the total estimated catch of alfonsino from the BYX 3 target fishery by month and fishing year. The total estimated catch in each fishing year and the percentage of the total catch for all fishing years combined is also presented (source: MFish CELR and TCEPR data).**

	Month (in order within Fishing year)												
Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Total catch (t)
1989–90	0.0	3.9	7.8	46.0	0.0	0.0	0.0	0.0	0.0	9.2	27.6	5.5	109
1990–91	0.0	0.0	0.0	36.8	13.0	5.5	1.3	0.0	0.0	0.0	0.0	43.4	115
1991–92	0.0	0.0	0.0	51.2	0.0	0.0	0.0	0.0	23.0	0.0	0.0	25.7	56
1992–93	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	3
1993–94	3.4	0.0	0.0	77.0	0.0	0.0	0.0	11.3	0.0	0.0	0.0	8.3	9
1994–95	0.1	3.0	10.8	17.5	0.2	8.3	0.0	0.4	0.0	0.0	2.4	57.2	166
1995–96	1.6	2.8	20.4	20.7	35.8	18.7	0.0	0.0	0.0	0.0	0.0	0.0	635
1996–97	2.0	35.6	19.1	18.2	10.6	14.4	0.0	0.0	0.0	0.0	0.0	0.0	656
1997–98	9.6	0.2	38.1	20.6	28.7	2.8	0.0	0.0	0.0	0.0	0.0	0.0	681
1998–99	0.0	12.5	19.0	16.7	9.9	23.5	3.0	0.0	0.0	0.0	0.0	15.4	759
1999–2000	16.2	0.7	11.9	12.9	31.2	13.0	0.9	0.0	0.0	0.0	0.0	13.2	544
Total	4.8	9.7	20.1	20.0	20.2	13.4	0.8	0.1	0.3	0.3	0.9	9.5	

Table 11: Percentage distribution of the total estimated catch of alfonsino from the BYX 3 target fishery by statistical area and fishing year. The total estimated catch in each fishing year and the percentage of the total catch for all fishing years combined is also presented (source: MFish CELR and TCEPR data).

Fishing year	Statistical areas															Other Chatham Rise areas	Other areas	Total catch (t)
	18	19	20	21	22	23	401	402	404	406	412	49	50	51	52			
1989–90	45	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	109
1990–91	95	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	115
1991–92	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	56
1992–93	83	0	0	0	0	8	8	0	0	0	0	0	0	0	0	0	0	3
1993–94	3	0	0	11	0	0	0	0	0	0	82	0	0	0	0	4	0	9
1994–95	39	0	0	41	0	0	0	0	0	0	15	0	3	1	0	0	0	166
1995–96	2	0	0	4	0	0	0	0	0	15	16	0	0	64	0	0	0	635
1996–97	2	0	0	0	0	3	0	0	0	14	12	0	1	68	0	0	0	656
1997–98	0	0	0	1	0	3	0	0	0	53	11	0	0	32	0	0	0	681
1998–99	0	4	0	7	0	3	0	0	4	22	21	0	12	28	0	0	0	759
1999–2000	2	0	1	8	0	0	0	0	12	19	10	0	0	48	0	0	0	544
Total	8.4	2.4	0.1	5.5	0.0	1.7	0.0	0.0	2.5	21.7	13.5	0.0	2.7	41.3	0.0	0.1	0.0	

Table 12: Percentage distribution of the total estimated catch of alfonsino from the BYX 3 target fishery by fishing method, main fishing area, and fishing year. The total estimated catch in each fishing year and the percentage of the total catch for all fishing years combined is also presented (source: MFish CELR and TCEPR data).

Area	Bottom trawl			Midwater trawl			Total catch (t)
	East Chatham	Kaikoura	Mernoo	East Chatham	Kaikoura	Mernoo	
1989–90	0.0	0.0	0.0	0.0	0.0	0.0	0
1990–91	0.0	0.0	0.0	0.0	100.0	0.0	47
1991–92	0.0	0.0	0.0	0.0	100.0	0.0	43
1992–93	0.0	0.0	0.0	0.0	90.9	9.1	3
1993–94	87.8	0.0	0.0	0.0	0.0	12.2	8
1994–95	13.4	0.0	0.7	4.0	40.1	41.8	159
1995–96	73.0	1.6	0.0	21.2	0.0	4.2	635
1996–97	97.9	2.0	0.0	0.1	0.0	0.0	656
1997–98	96.1	0.0	0.0	3.0	0.0	0.9	681
1998–99	81.1	0.0	6.2	7.7	0.0	5.1	731
1999–2000	89.6	0.0	1.0	0.0	0.0	9.4	467
Total	81.6	0.7	1.5	6.4	4.6	5.3	

Table 13: **Percentage distribution of the number of trawls from the BYX 3 target fishery by fishing method, main fishing area, and fishing year. The total estimated catch in each fishing year and the percentage of the total catch for all fishing years combined is also presented. Source: MFish CELR and TCEPR data.**

	Bottom trawl			Midwater trawl			Number of trawls
Area	East Chatham	Kaikoura	Mernoo	East Chatham	Kaikoura	Mernoo	
1989–90	0.0	0.0	0.0	0.0	0.0	0.0	0
1990–91	0.0	0.0	0.0	100.0	0.0	0.0	10
1991–92	0.0	0.0	0.0	100.0	0.0	0.0	12
1992–93	0.0	0.0	0.0	75.0	0.0	25.0	12
1993–94	87.9	0.0	0.0	0.0	0.0	12.1	33
1994–95	58.1	8.1	0.0	12.8	10.1	10.8	148
1995–96	82.3	13.1	2.1	0.0	2.3	0.2	487
1996–97	96.5	0.7	1.2	0.0	1.6	0.0	567
1997–98	95.3	2.4	0.0	0.0	0.0	2.4	509
1998–99	87.3	10.6	0.0	0.0	0.4	1.8	800
1999–2000	96.9	0.7	0.1	0.1	0.2	2.0	1 126
Total	90.1	0.5	1.1	5.0	1.4	2.0	

Table 14: **The number of vessels using different methods by fishing year within the East Chatham area targeting alfonsino.**

	Bottom trawl	Midwater trawl	Any method
1993–94	4	1	4
1994–95	3	3	4
1995–96	2	2	2
1996–97	2	1	2
1997–98	5	2	5
1998–99	7	2	7
1999–2000	8	3	8

Table 15: **Percentage distribution of the total estimated catch of alfonsino from the BYX 3 target fishery by month and fishing year. The total estimated catch in each fishing year and the percentage of the total catch for all fishing years combined is also presented (source: MFish TCEPR data).**

	Month (in order within Fishing year)												Total
Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	catch (t)
1993–94	0.0	0.0	0.0	94.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.9	7
1994–95	0.0	14.6	65.3	0.0	0.0	0.0	0.0	1.8	0.0	0.0	13.1	5.2	27
1995–96	0.0	3.0	21.6	21.9	33.6	19.9	0.0	0.0	0.0	0.0	0.0	0.0	598
1996–97	0.0	36.8	18.5	18.8	10.9	14.9	0.0	0.0	0.0	0.0	0.0	0.0	635
1997–98	9.8	0.2	36.9	21.0	29.3	2.8	0.0	0.0	0.0	0.0	0.0	0.0	669
1998–99	0.0	14.7	22.4	13.9	11.0	27.0	0.0	0.0	0.0	0.0	0.0	11.1	645
1999–2000	10.6	0.4	14.5	16.8	26.7	14.1	1.1	0.0	0.0	0.0	0.0	15.7	419
Total	3.7	11.8	23.9	18.6	21.6	15.5	0.2	0.0	0.0	0.0	0.1	4.6	

Table 16: The percentage distribution of the estimated catch of alfonsino for each of seven sub-areas, where alfonsino is targeted by the trawl methods within the East Chatham area by fishing year. The total estimated catch in each fishing year and the percentage of the total catch for all fishing years combined is also presented (source: MFish TCEPR data).

	Sub-areas								
Fishing year	1	2	3	4	5	6	7	Other	Total catch (t)
1993–94	0.0	0.0	0.0	96.9	0.0	0.0	0.0	3.1	7
1994–95	0.0	0.9	65.2	17.4	0.0	0.0	0.0	16.5	27
1995–96	0.1	46.6	15.9	0.0	20.7	0.0	16.6	0.0	598
1996–97	2.8	35.7	8.5	1.3	34.7	0.0	13.2	3.7	635
1997–98	1.7	21.4	10.3	1.1	5.3	0.1	56.3	4.0	669
1998–99	9.8	15.2	15.6	3.2	9.9	8.3	25.0	13.0	645
1999–2000	10.3	45.7	12.3	0.8	6.4	0.0	23.8	0.7	419
Total	4.5	31.3	12.9	1.7	15.7	1.8	27.3	4.7	

Table 17: The number of tows recorded for the five main vessels, in the East Chatham area and in the TCEPR data where alfonsino was targeted in BYX 3, the percentage of the TCEPR data that the five main vessels and the East Chatham area made up, and the average percentage of the total number of trawls for the fishing years shown.

	Five main vessels		East Chatham area		TCEPR data
Fishing year	Number of tows	% of TCEPR	Number of tows	% of TCEPR	No. of tows
1990–91	0	0.0	0	0.0	5
1991–92	0	0.0	0	0.0	7
1992–93	0	0.0	0	0.0	7
1993–94	15	55.6	18	66.7	27
1994–95	29	25.4	82	71.9	114
1995–96	263	94.6	263	94.6	278
1996–97	311	95.7	311	95.7	325
1997–98	255	90.7	268	95.4	281
1998–99	383	65.4	548	93.5	586
1999–2000	345	64.2	443	82.5	537
% of total		73.9		89.2	

Table 18: The total alfonsino catch, where targeted, for the five main vessels, in the East Chatham area and the TCEPR data in BYX 3.

	Five main vessels		East Chatham area		TCEPR data
Fishing year	BYX catch (t)	% of TCEPR	BYX catch (t)	% of TCEPR	BYX catch (t)
1990–91	0.0	0.0	0.0	0.0	47.0
1991–92	0.0	0.0	0.0	0.0	43.4
1992–93	0.0	0.0	0.0	0.0	3.0
1993–94	0.4	5.0	7.2	84.8	8.5
1994–95	3.6	2.3	27.4	17.2	159.7
1995–96	597.9	94.2	597.9	94.2	634.7
1996–97	634.7	96.8	634.7	96.8	655.8
1997–98	638.1	93.7	668.9	98.2	681.3
1998–99	391.2	51.6	645.1	85.0	758.6
1999–2000	304.5	56.0	418.8	77.0	543.7
% of total	72.7	11.3	84.8	15.6	

Table 19: Percentage distribution of the estimated catch of alfonsino for the five main vessels where alfonsino was targeted by fishing method and fishing year (source: MFish TCEPR data).

	Fishing method		
Fishing year	Bottom trawl	Mid-water trawl	Total catch (t)
1993–94	100.0	0.0	0.4
1994–95	100.0	0.0	3.6
1995–96	77.5	22.5	597.9
1996–97	99.9	0.1	634.7
1997–98	96.7	3.3	638.1
1998–99	93.5	6.5	391.2
1999–2000	100.0	0.0	304.5
% of total	92.9	7.1	

Table 20: Summary of landed catch (percent of total) from the target BYX 3 fishery by state code and fishing year. Target fishing trips were defined as trips conducting at least 15 target alfonsino trawls within BYX 3 (source: MFish TCEPR and Catch Landing Return data).

Fishing	State code				Landed
Year	Green	Dressed	Head and gut	Other	weight (t)
1995–96	100	-	-	-	639.8
1996–97	46	54	-	-	639.2
1997–98	64	26	8	2	676.7
1998–99	61	39	-	-	811.0
1999–2000	61	39	-	-	635.7

Table 21: **Percentage distribution of the total estimated bycatch from the target alfonsino fishery (BYX 3) by species and fishing year. The total estimated bycatch (tonnes) in each fishing year and the percentage of the total bycatch for all fishing years combined is also given (source: MFish *CELR and TCEPR data*).**

Fishing year	Bycatch species												Total catch (t)	
	Bluenose	Cardinalfish	Hoki	Ling	Oreo	Orange roughy	Other sharks and dogfish	Rubyfish	Smooth oreo	Silver warehou	White warehou	Other		Bycatch as % of target BYX catch
1993–94	0.0	0.0	0.0	0.0	0.0	84.0	0.0	0.0	15.6	0.0	0.0	0.4	32	
1994–95	55.2	0.0	0.5	0.0	10.6	23.4	0.0	8.8	0.0	0.9	0.0	0.6	51	30.1
1995–96	80.4	0.5	0.3	0.1	0.0	0.1	0.0	0.3	0.3	1.5	14.7	2.0	155	24.4
1996–97	69.7	2.7	0.0	0.1	0.0	13.6	0.0	3.8	2.2	0.3	7.2	0.5	186	28.4
1997–98	79.8	0.5	1.8	1.1	0.9	2.9	0.0	0.1	0.4	0.2	6.5	5.8	133	19.6
1998–99	55.9	0.0	9.8	0.4	0.0	11.7	0.0	0.1	3.4	4.9	11.2	2.6	229	30.2
1999–2000	43.4	2.1	3.9	0.7	0.0	15.6	1.3	0.0	3.8	6.8	17.0	5.3	161	29.6
% of total	61.9	1.0	3.4	0.4	0.7	12.7	0.2	1.3	2.5	2.7	10.3	2.8		

Table 22: **Summary of sampling data from the BYX 3 fishery collected by MFish Scientific Observer Programme by target species and fishing year.**

Target species	Fishing year	Number of samples	Total catch sampled (t)	No. fish measured
Alfonsino	1994–95	14	19.09	930
Hake	1994–95	1	18.25	100
	1997–98	2	38.01	219
Hoki	1994–95	1	0.01	6
	1995–96	2	0.08	28
	1996–97	2	0.05	10
	1999–2000	1	0.04	43
Orange roughy	1994–95	3	6.09	233
	1996–97	2	1.95	48

Table 23: **Summary of alfonsino catch data from the time-series of *Tangaroa* trawl surveys of the Chatham Rise. For each survey, the total number of stations conducted during the survey, the total number of stations where BYS was caught, the total weight of BYS caught, the weight of the largest catch of BYS and the number of BYS measured are presented.**

Survey	Survey period		Total No. stations	No. BYS stations	Total BYS Catch (kg)	Weight of largest BYX catch (kg)	No. fish measured
	Start date	End date					
TAN9106	27-Dec-91	01-Feb-92	186	51	4 292	1 372	1 412
TAN9212	30-Dec-92	07-Feb-93	195	64	4 681	3 323	1 044
TAN9401	01-Jan-94	01-Feb-94	165	51	12 639	11 113	1 461
TAN9501	03-Jan-95	01-Feb-95	136	34	737	165	1 059
TAN9601	27-Dec-95	14-Jan-96	93	31	588	288	871
TAN9701	02-Jan-97	24-Jan-97	105	39	2 712	1 902	1 111
TAN9801	02-Jan-98	25-Jan-98	130	36	967	424	902
TAN9901	03-Jan-99	27-Jan-99	142	39	2 656	1 368	1 465
TAN0001	27-Dec-99	21-Jan-99	134	51	941	98	1 603
Total			1 286	396	30 212	20 052	10 928

Table 24: **Relative biomass estimates (tonnes) of alfonsino (*Beryx splendens*) and associated coefficient of variations from the time series of *Tangaroa* Chatham Rise trawl surveys. The number of stations repesents the number of survey stations included in the estimate of biomass.**

Survey	Total stations	Biomass estimate (t)	Coefficient of variation (%)
TAN9106	184	6 624	50.9
TAN 9212	194	7 181	85.3
TAN 9401	165	25 970	90.0
TAN 9501	123	1 335	36.5
TAN 9601	89	1 814	57.5
TAN 9701	103	4 158	62.8
TAN 9801	91	2 295	51.8
TAN 9901	100	4 240	50.8
TAN 0001	132	1 221	19.5

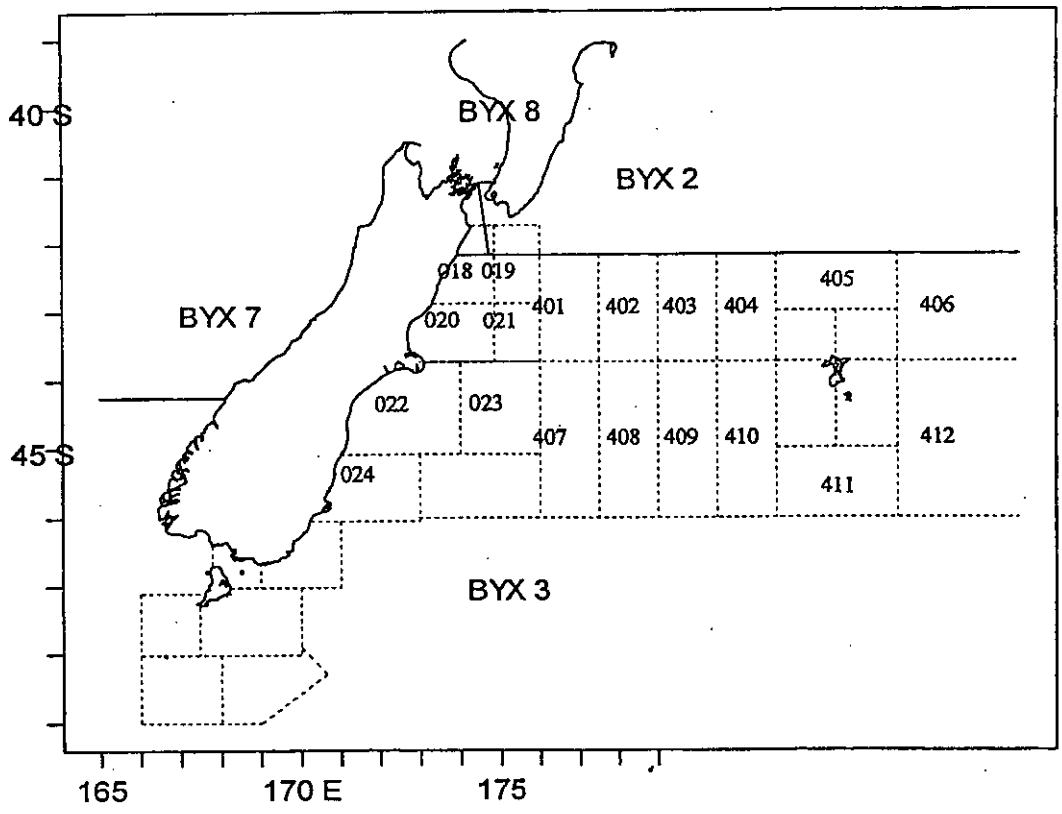

Figure 1: **Map defining the boundaries of the BYX 3 fishstock and the main statistical areas within BYX 3 referred to in the text.**

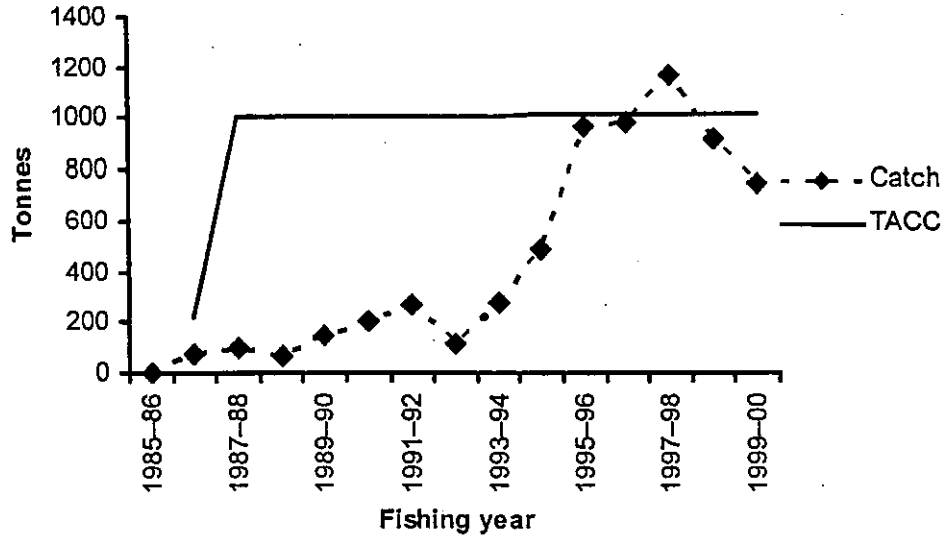

Figure 2: **Catch from QMR and TACC (tonnes) for alfonsino in BYX 3 from 1985–86 t to 1998–99.**

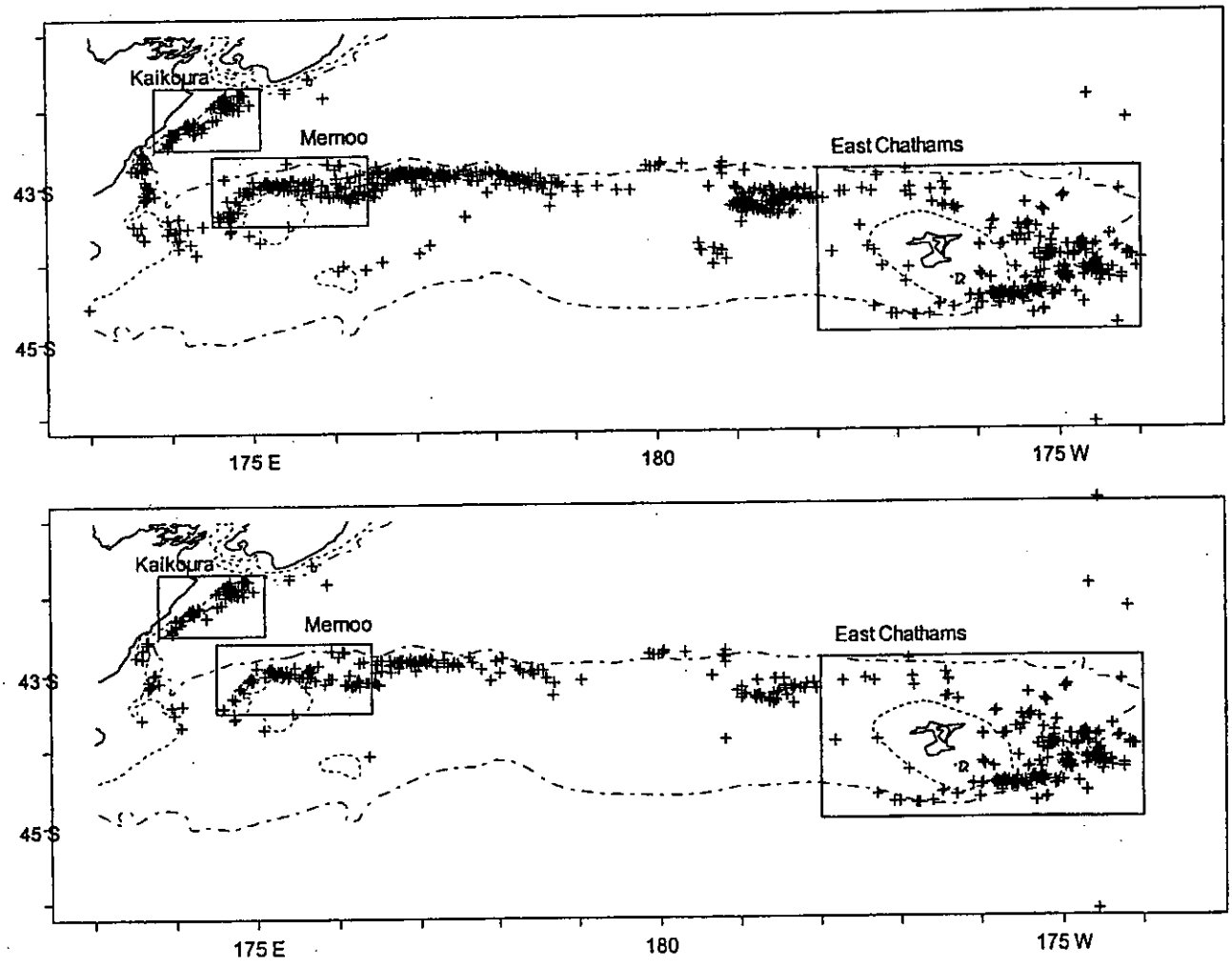

Figure 3: Location of trawls catching alfonsino (top) in BYX 3 with a catch of alfonsino (> 50 kg) (top) and catches exceeding 1 t (bottom) between 1989–90 and 1999–2000 (source: MFish TCEPR data).

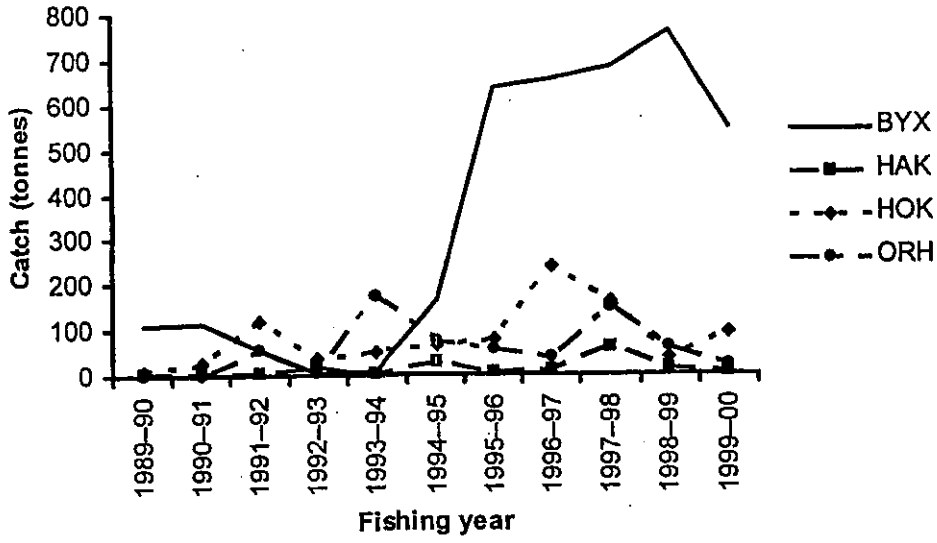

Figure 4: **Annual reported alfonsino catch by fishing year in four main target trawl fisheries, alfonsino (BYX), hake (HAK), hoki (HOK), and orange roughy (ORH).**

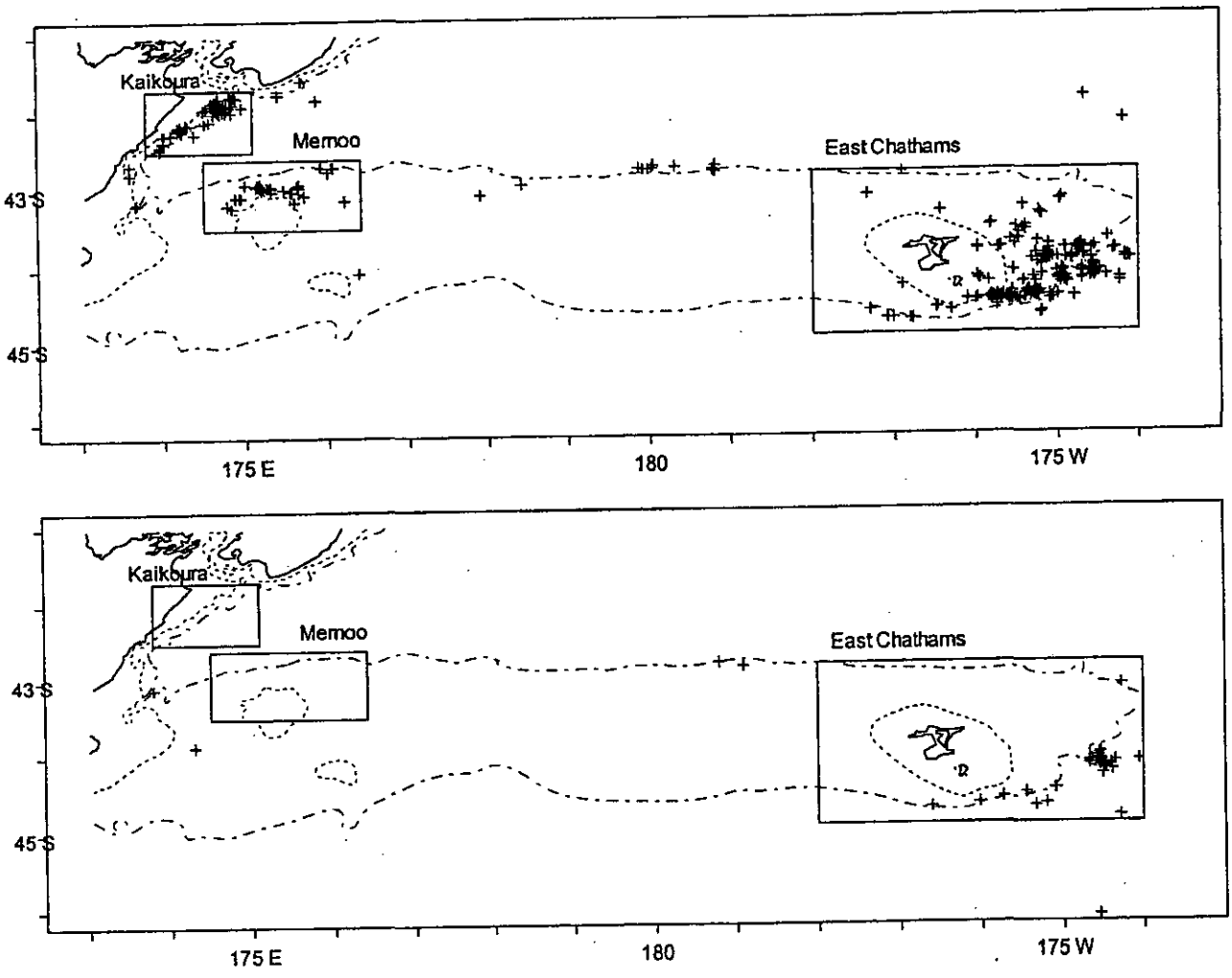

Figure 5: **Location of trawls targeting alfonsino (top) and orange roughy (bottom) in BYX 3 with a catch of alfonsino (over 50 kg) between 1989–90 and 1999–2000 (source: MFish TCEPR data).**

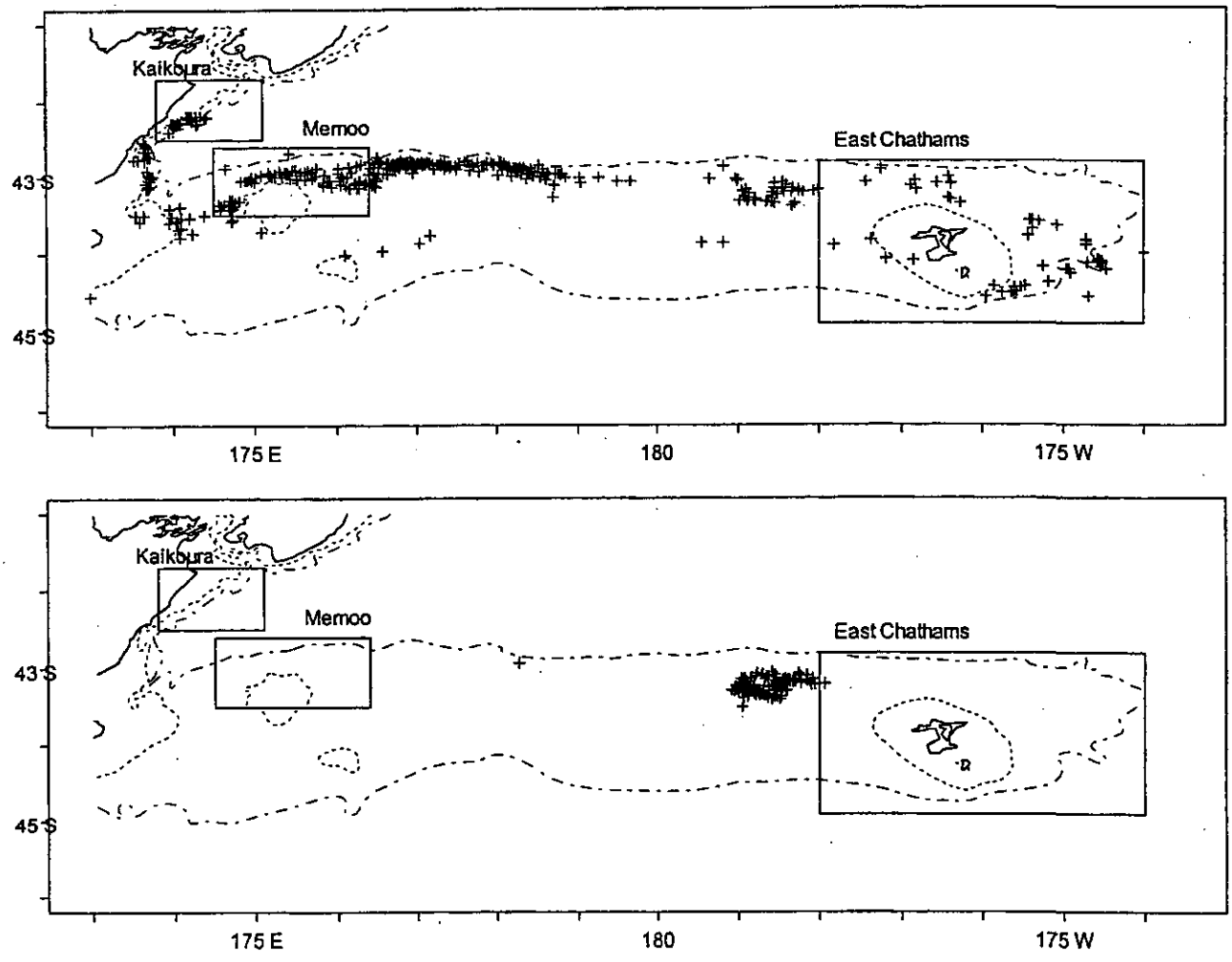

Figure 6: Location of trawls targeting hoki (top) and hake (bottom) in BYX 3 with a bycatch of alfonsino (over 50 kg) between 1989–90 and 1999–2000 (source: MFish TCEPR data).

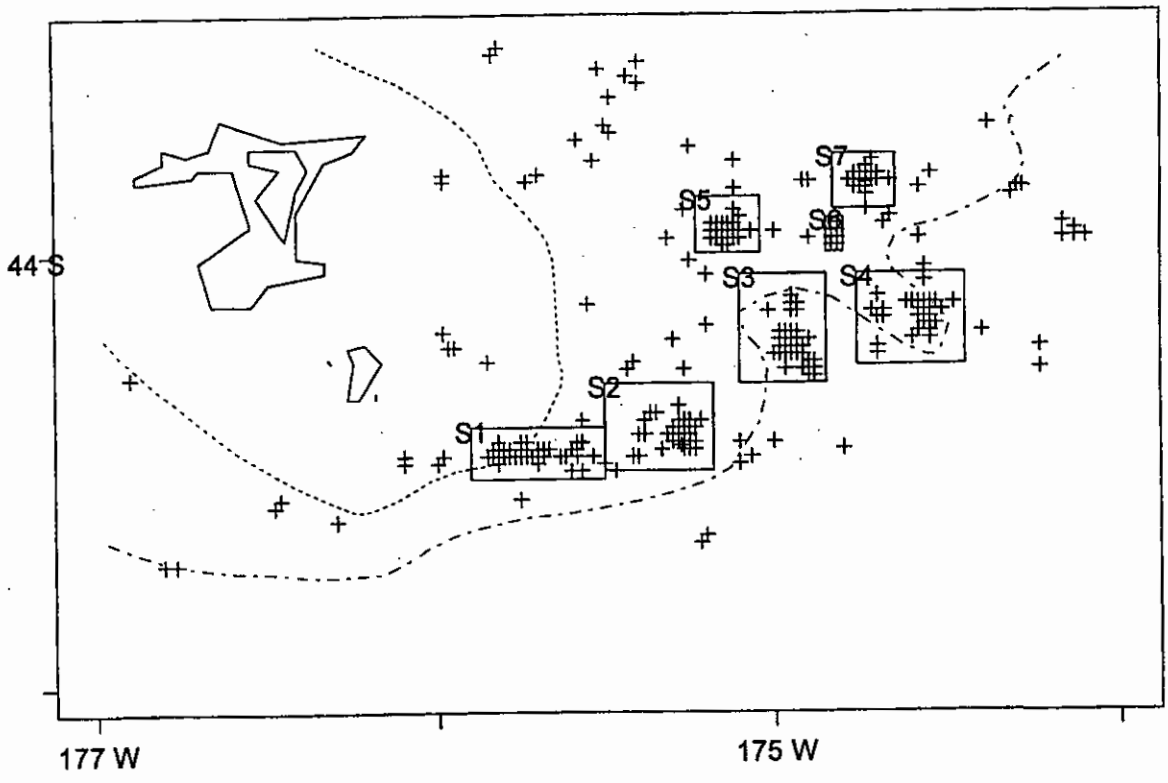

Figure 7: Location of trawl positions targeting alfonsino in the East Chatham area of BYX 3 between 1989–90 and 1999–2000. The boxes denote the main features fished in the area (source: MFish TCEPR data).

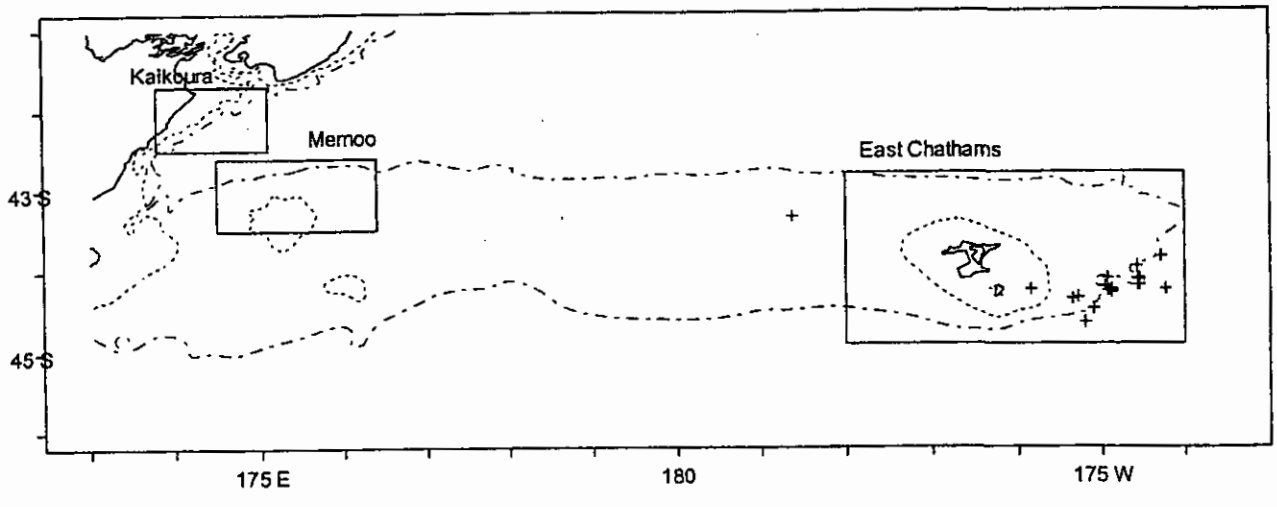

Figure 8: Location of trawls targeting alfonsino BYX 3 monitored by the MFish Scientific Observer Programme between 1989–90 and 1999–2000 (source: MFish SOP data).

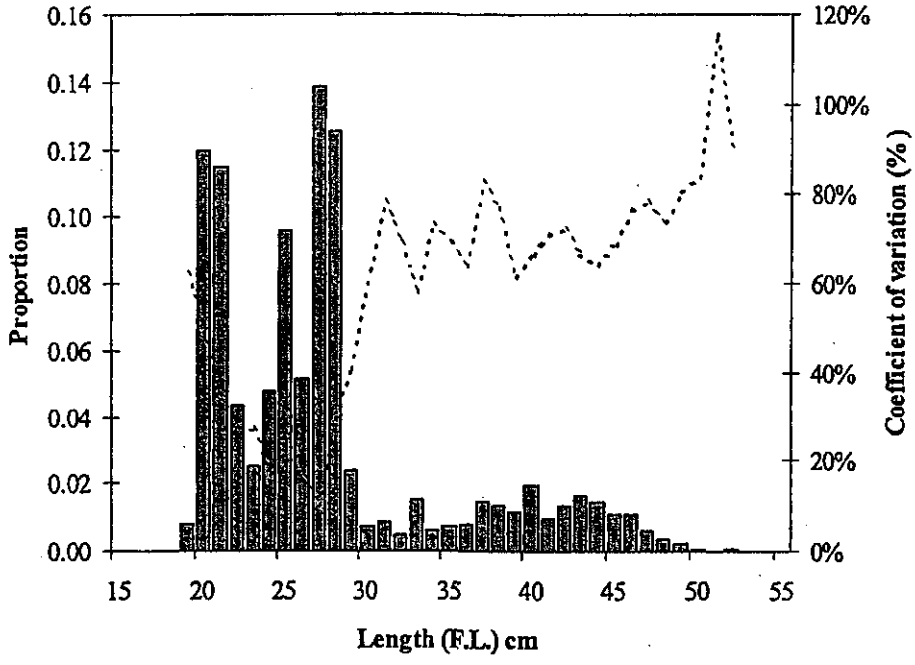

Figure 9: Length composition of alfonsino catch sampled by the Scientific Observer Programme from one trip in 1994–95. The bars represent the estimated proportion at each length class and the dashed line represents the associated coefficient of variation. Number of samples, 14; number of fish measured, 930.

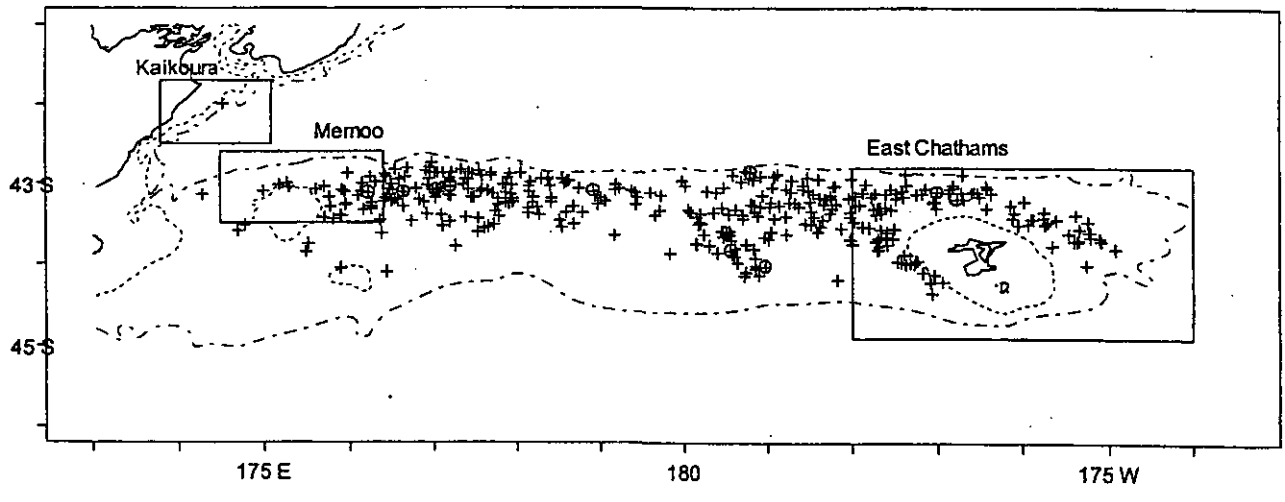

Figure 10: Location of trawls catching alfonsino in BYX 3 from the time series of *Tangaroa* hoki trawl surveys of the Chatham Rise (TAN9106 to TAN0001). The circles denote catches exceeding 500 kg (11 stations) (source: MFish research data).

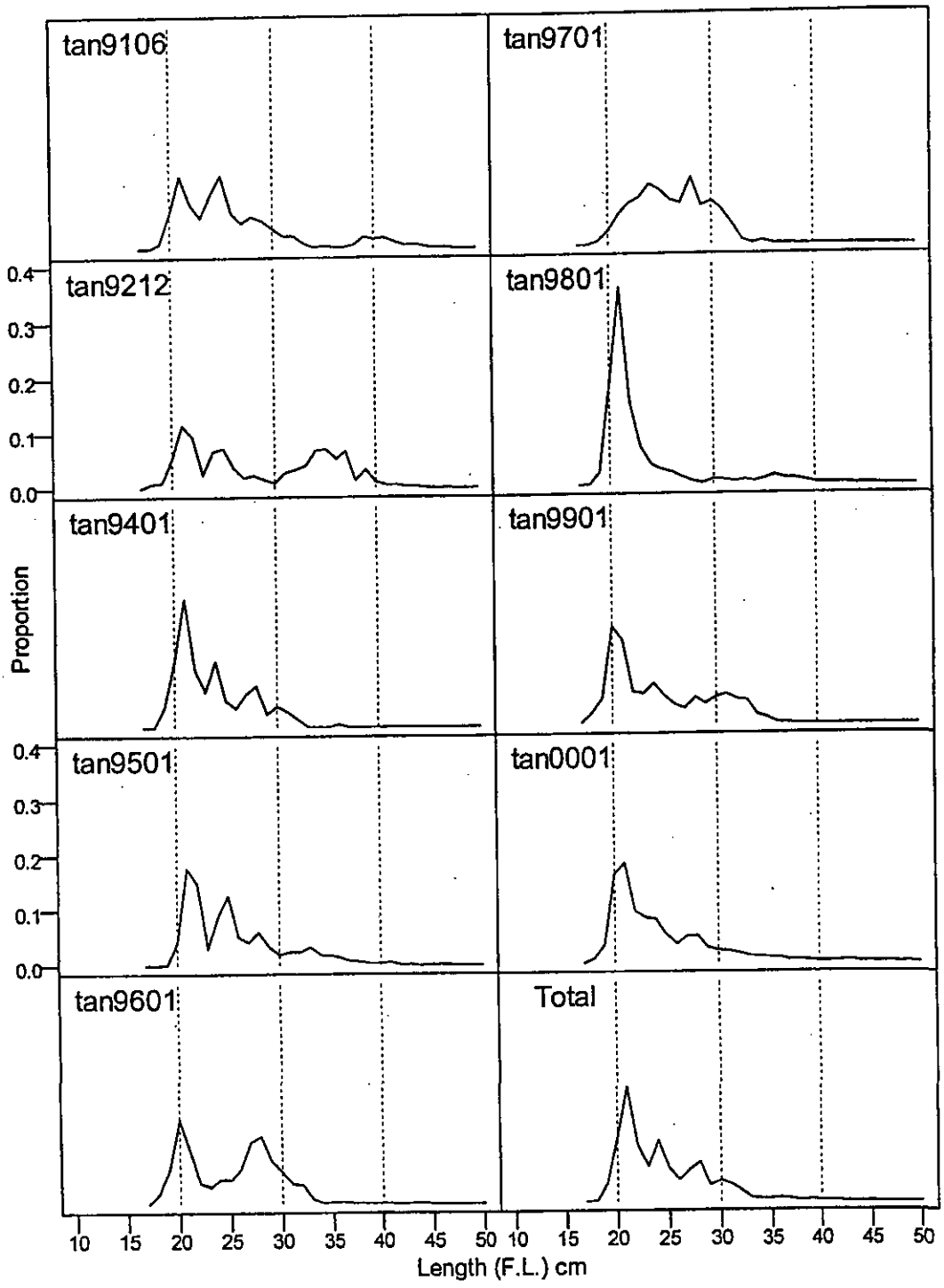

Figure 11: Length compositions of alfonsino derived from the time series of *Tangaroa* Chatham Rise trawl surveys.

Appendix 1. Map of FAO Statistical Areas.