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EXECUTIVE SUMMARY

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This report characterises the main commercial fisheries for blue moki, principally by summarising recent catch and effort data, but augmented by interviews with members of the main stakeholder groups participating in the fishery.

Blue moki in MOK 1 and in the northern area of MOK 3 is principally caught by bottom trawl and setnet. The setnet catch is taken mainly by the target fishery or as a bycatch of the blue warehou and tarakihi fisheries, while the trawl catch is principally taken as a bycatch of the tarakihi and red gurnard target fisheries. The seasonal and spatial trends in blue moki catch from each of these fisheries are described. These trends are consistent with previously described migrations of blue moki associated with spawning.

Annual trends in catch by fishery reveal an increase in the reported blue moki bycatch from the trawl fisheries in the late 1980s and early 1990s, while the level of bycatch from the target tarakihi setnet fishery has declined. There has also been a recent increase in the level of target setnet catch, with a corresponding decline in the level of blue moki bycatch from the blue warehou setnet fishery.

The blue moki fishery is largely situated off the central east coast of the North Island and the northern east coast of the South Island. Four main seasonal fisheries operating in this area were identified. Catch and effort data from these fisheries are available from 1989 to 2002. Setnet data are also available from 1983 to 1988 (FSU data). A detailed analysis of these data was undertaken to determine whether a reliable abundance index could be developed from the CPUE indices derived from one (or more) of these fisheries.

For each fishery, three sets of CPUE indices were calculated: unstandardised indices, standardised loglinear indices, and standardised negative binomial indices (proportion zero catch). Annual indices were derived for 1989 to 2002. In addition, for the target blue moki setnet fishery, a further analysis was undertaken extending the time series to include 1983–87. The comparability of the setnet data from the two periods is examined.

The standardised CPUE analyses reveal different trends in the relative abundance of blue moki in the four fisheries examined. The datasets are small and, consequently, the annual indices are poorly determined. There are also some concerns about the reliability of some of the data included in each of the datasets. Overall, the annual indices should be considered as indicative indices only, capable only of suggesting general trends in the performance of each fishery. At this stage, the indices are not sufficiently reliable to be included in a comprehensive assessment of MOK 1.

The report concludes that the setnet fisheries, in particular the target fishery, represent the best candidates for ongoing monitoring via catch and effort data. The two setnet fisheries off the east coast of the North Island reveal a peak in catch rates during the early 1990s, and have remained relatively stable in subsequent years. However, there are a number of outstanding data issues that need to be addressed before a robust monitoring tool can be developed from catch and effort data. A catch sampling programme is also recommended to determine the age composition of the catch from each of the main fisheries, with particular emphasis on the target setnet fishery.

1. INTRODUCTION

The commercial blue moki fishery is essentially managed as two separate Fishstocks; MOK 1 encompasses the entire area around the North Island and the west coast of the South Island and MOK 3 includes the area off the east coast of the South Island (Figure 1). The MOK 1 and MOK 3 fisheries account for about 84% and 15% of the total blue moki catch, respectively (Annala et al. 2002).

Blue moki was introduced to the Quota Management System in 1986 and TACCs of 130 t and 60 t were established for MOK 1 and MOK 3 respectively. The TACCs were established at low levels as the blue moki stocks were considered to be seriously depleted (Annala et al. 2002). In subsequent years, TACCs increased slightly as the result of Quota Appeal Authority decisions.

In MOK 1, annual catches increased steadily from 1986–87 to 1995–96, exceeding the TACC in almost every year by an increasing margin (Figure 2). In 1993–94, the TACC was increased to 200 t and further increased in 1995–96 to 400 t. Since 1995–96, annual reported catches have remained at about the level of the TACC.

For MOK 3, annual catches exceeded the initial TACC level between 1987–88 and 1990–91. The TACC was increased to 126 t in 1992–93, although catches have not reached this level in any of the subsequent years and have generally declined over the period (Figure 2). Recent annual catches from MOK 3 averaged about 70 t (Table 1).

The recreational catch from MOK 1 is estimated at about 70–90 t (Annala et al. 2002). The cultural significance of blue moki to Maori in the Whangaparaoa district, Cape Runaway, is described in Appendix D.

Adult blue moki migrate annually between Kaikoura and East Cape. The migration begins off Kaikoura in late April–May as fish move northwards. Spawning takes place in August–September in the Mahia Peninsula to East Cape region, the only known spawning ground, with the fish then returning south towards Kaikoura (Francis 1979, 1981).

There is currently no formal stock assessment for MOK 1, although yields have been estimated based on average annual catches (Annala et al. 2002). There are currently no reliable indices of relative abundance for blue moki and monitoring of the fishery has been limited to the occasional analysis of catch and effort data (Annala et al. 2002). Consideration was given to the development of a trawl survey specifically for MOK 1, but the proposal was not developed.

The specific objective of this project was to characterise the MOK 1 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. The fishery characterisation was undertaken by summarising catch and effort data from 1989–90 to 2001–02 and the analysis was augmented through interviews with important stakeholders in the fishery. In addition, the utility of the catch and effort data for developing feasible indices of relative abundance for the MOK 1 Fishstock was explored.

2. FISHERY CHARACTERISATION

2.1 Dataset

The characterisation was expanded from MOK 1 to include the main areas of catch from MOK 3 and MOK 5. This enabled a more comprehensive investigation of seasonal trends in the fishery and the interaction between MOK 1 and the other areas.

The initial dataset included all catch and effort records from Ministry of Fisheries statutory reporting forms that recorded blue moki either caught or targeted from 1989–90 to 2001–02. The data were collected in two formats; Catch, Effort, Landing Returns (CELR) and Trawl, Catch, Effort, and Processing Returns (TCEPR). The CELR format records catch and effort data for smaller vessels aggregated by fishing day and statistical area; TCEPRs record the catch and effort of individual trawl tows for larger vessels (generally over 35 m in length).

The characterisation dataset included the statistical areas that account for most of the blue moki catch, i.e., the inshore statistical areas off the central east coast of the North Island and the east coast of the South Island (statistical areas 010 to 026, excluding 019, 021, and 023) (Figure 3). This includes the main areas of catch from MOK 1 and MOK 3 and the small amount of catch from MOK 5. Most of the catch from MOK 3 occurs on the boundary between MOK 1 and MOK 3 (statistical area 018).

Considerable error checking of the initial dataset was required, principally due to the incorrect recording and/or data entry of the blue moki species code MOK as HOK, the species code for hoki. Records were excluded from the dataset where other information suggested that a catch of blue moki was unlikely, specifically,

- the fishing method was midwater trawl.
- the target species code was included in the following list: HOK, SWA, SQU, STA, SKI SDO, SCA, RIB, NULL, NOT, MIX, QSC, RAT, PMA, ORH, HAK, HAP, JMA, GSP, GSH, ALB, BNS, CDL, BPE, BTU, BWH.
- very large catches of MOK were reported (over 10 000 kg).
- for TCEPR records, trawls were conducted in depths greater than 300 m.
- vessel length was greater than 43 m.
- other records where the target species was very rare (SHA, SPZ, BYX, BAI, OCT, HPB, OSD, KEL, KIN, JDO, CON, CRA, SPD, SKA, WWA, SPE, GAR, POR, KAH, THR).

Trawl tows recorded on TCEPRs in depths less than 100 m, that caught blue moki but reported the target species as hoki, were assumed to be targeting blue moki.

Most of the data were reported on the CELR format, accounting for 94% of the blue moki catch that was included in the dataset following error checking.

For comparison with the QMR data, MOK 1 was defined as the area encompassed by statistical areas 010 to 017. MOK 3 was defined as statistical areas 018, 020, 022, and 024, and MOK5 defined as statistical areas 025 and 026 (see Figure 1 and 3). The estimated catch accounted for about 75% of the total landings from MOK 1 and MOK 3 in recent years (Table 1).

The annual distribution of the estimated catch of blue moki was summarised by statistical area, month, target species, and fishing method. This initial analysis identified the most important method/target fisheries, and data from those fisheries are described in more detail.

2.2 Areal distribution

Most of the blue moki catch is taken from the central east coast of the North Island (statistical areas 012 to 016, Figure 3) and the northern east coast of the South Island (statistical area 018) (Table 2). A small component of the catch is also taken off the southeast coast of the South Island (statistical area 024) and from Cook Strait (statistical area 017).

From 1989–90 to 2001–02, the proportion of the total catch taken from Mahia (statistical area 013), and Palliser (statistical area 016) remained relatively constant, while the proportion of the catch taken from northern and southern Wairarapa (statistical areas 014 and 015, respectively) was more variable (Table 2). The northern Wairarapa accounted for a higher proportion of the catch between 1996–97 and 1999–2000, a period when the catch from the southern Wairarapa was relatively low. In contrast, the latter area accounted for a higher proportion of the catch in 2001–02 when catches from the northern Wairarapa were relatively low.

In recent years, the Kaikoura area (statistical area 018) has accounted for a smaller component of the total blue moki catch than during the early 1990s (Table 2).

2.3 Target species

The blue moki catch is principally taken by setnet (60%) and bottom trawl (40%) (Table 3). The distribution of catch between the two methods remained relatively constant from 1989–90 to 1998–99. However, subsequently there was a steady increase in the proportion of the catch taken by setnet, and in 2001–02 this method accounted for 68% of the total catch (Table 3).

Blue moki caught by setnet are mostly targeted or a bycatch of the blue warehou fishery (Table 3). Blue moki is also taken as a bycatch of the tarakihi and shark (rig and school shark) target setnet fisheries. The recent increase in blue moki setnet catch is due to an increase in the target fishery, while the proportion of catch from the blue warehou setnet fishery has declined since 1999–2000.

The tarakihi setnet fishery accounted for 10–15% of the total blue moki catch between 1989–90 and 1996–97, but catches from the fishery in subsequent years have been insignificant (Table 3).

Most of the blue moki taken by the trawl method is a bycatch of the target tarakihi fishery, with a smaller component taken from the red gurnard and blue warehou target fisheries (Table 3). The remainder of the trawl catch is taken in the other main target fisheries operating in the inshore areas of the east coast (flatfish, barracouta, and red cod). Overall, from 1989–90 to 2001–02, the proportion of the total blue moki catch taken in the target tarakihi trawl fishery declined, while the proportion of catch from the red gurnard and blue warehou fisheries remained relatively constant.

2.4 Depth distribution

Limited data on depth distribution of blue moki catches are available from the commercial fishery, because only a small proportion of the blue moki trawl catch is reported in the TCEPR format. Records from all trawl fisheries operating in the main area of the fishery (statistical areas 012 to 015) were examined to investigate possible trends in the catch rate of blue moki, with respect to fishing depth and season. A total of 2347 records were available from all years combined, mainly from the target tarakihi and red gurnard trawl fisheries. For each target fishery (tarakihi, red gurnard, and other), the average catch rate (kg per trawl) of blue moki was calculated for each 10 m depth interval and quarter of the calendar year.

The analysis is based on estimated catch and includes only records where blue moki was included in the five main species caught, and therefore overstates the true catch rate of blue moki. Overall, trawl catch rates are poorly determined due to the low number of records and high between-trawl variance (Figure 4). However, trends in catch rate by depth are broadly comparable for the three separate target fisheries, at least for the last two quarters of the calendar year.

Catch rates in the first quarter were generally low and relatively constant through the 20–100 m depth range. In the second quarter of the year, catch rates were generally higher and, in the tarakihi and other fisheries, tended to increase in the 80–130 m depth range. There was also a strong peak in catch rates in the 50–60 m depth range (Figure 4).

During the third quarter there is an apparent increase in blue moki catch rate with increasing depth, with maximum catch rates at 100–120 m (Figure 4). Catch rates in this depth range are considerably lower in the last quarter, with higher catch rates in the 30–60 m depth range.

Given the broad similarities in trends between each of the target fisheries, the data were further aggregated and monthly trends in catch rate by depth were examined (Figure 5). Seasonal trends were also examined by statistical area, although data were sparse (Appendix C). In February–April high catch rates of blue moki occurred in the 30–60 m depth range (Figure 5), principally in statistical areas 014 and 015 (Appendix 3). This trend persisted during May–June, although the catch rates were lower and increasingly higher catch rates were achieved in deeper water (80–120 m). In July, catch rates were highest in deeper water, principally due to the higher catch rates from statistical area 014.

Catch rates were low in all statistical areas in August, but catch rates in deeper water were relatively high in September in all four areas (Figure 5). From September to November, there was a general decline in catch rates in deeper water and an increase in catch rates in the 50–60 m depth range. In December, catch rates were generally lower than in the preceding months, particularly in deeper water (Figure 5, Appendix C).

2.5 Tarakihi target bottom trawl fishery

Most of the blue moki catch from the tarakihi bottom trawl fishery is taken from statistical areas 012 to 016, with the highest proportion of catch taken from the Mahia and Palliser areas (Table 4). The distribution of the blue moki catch between the main statistical areas has remained relatively constant since 1992–93.

There is a strong seasonal trend in blue moki catch from the tarakihi fishery. Most of the catch is taken during September–November and catches steadily decline over the following months to a low level in March (Table 5). There is a subsequent increase in catch from March to July before catches decline sharply in August and then recover to a high level in September.

The overall seasonal trend is a composite of seasonal patterns in the main statistical areas (012, 013, 014, and 016), but there are differences between statistical areas. For each area, there are generally two seasonal peaks in blue moki catch: the first between May and July and the second between September and November (Figure 6). The timing of the two seasonal peaks varies spatially, occurring during April–June in the southern area of the fishery (015 to 017) and in July in the northern area (012 to 014); the secondary peak occurs later in the southern area (October–December) than in the northern area (September–October). The period of low catches is more protracted in the southern area (from July to September) compared to the northern area (August) (Figure 6).

The trends in monthly catch distribution imply a northern movement of fish during April to July and a subsequent southern migration from September to November. The low catch in August in the northern area suggests that blue moki are not vulnerable to the tarakihi trawl fishery during this period. These results are consistent with the conclusions of Francis (1979, 1981).

2.6 Red gurnard target bottom trawl fishery

The blue moki catch from the target red gurnard bottom trawl fishery is also principally taken from statistical areas 012 to 016 (Table 6). A large proportion of the catch is taken from the Mahia area, accounting for almost 50% of the blue moki catch from this fishery in recent years. A significant proportion of the catch is also taken from the northern and southern Wairarapa coastal areas.

As for the tarakihi trawl fishery, there is a persistent seasonal trend in the distribution of blue moki catch from the red gurnard trawl fishery. A high proportion is taken during September–November

(Table 7), decreases in December–January, and then increases to a relatively high level from March to May. Over the following months, catches decline to a very low level in August before increasing sharply in September (Table 7).

However, when examined by statistical area, the seasonal trend in blue moki catches in the red gurnard fishery differs from the trends previously described for the tarakihi trawl fishery. In both fisheries, catches are low in winter and the period of low catch is more protracted in the south (August to September in 016) than in the north. However, within each of the main statistical areas the blue moki catch from the red gurnard fishery is more evenly distributed throughout the remainder of the year and there is no clear shift in the seasonal distribution of catch between adjacent statistical areas (Figure 7). As the preferred depth of gurnard is shallower than that of tarakihi, this implies that a proportion of the blue moki population may be resident in shallower water.

2.7 Blue moki target setnet fishery

The blue moki target setnet fishery principally operates in statistical areas 013 to 015 (Table 8). These areas collectively accounted for about 80% of the catch from this fishery from 1989–90 to 2001–02. During the same period, small target setnet fisheries also operated in statistical areas 010, 016, and 024 (Table 8).

There has been considerable interannual variation in the distribution of the blue moki target catch between the three main statistical areas fished. From 1989–90 to 1992–93, most of the catch was taken from statistical area 015, although the proportion of the catch taken from this area declined over the following years and was very low from 1996–97 to 1998–99 (Table 8). The decline in the proportion of catch from statistical area 015 was countered by an increase in the level of catch initially in statistical area 013 followed by an increase in catch from statistical area 014. Since 1998–99, this pattern has reversed with a recovery in the proportion of catch from statistical area 015 and a decline in the total catch from 014 (Table 8).

Catches from the target blue moki setnet fishery are generally low from November to April and higher from May to October (Table 9). However, there is considerable variation in the seasonal distribution of catch between years, in particular a steady decline in the proportion of the catch taken in May and a corresponding increase in the catch from September. These trends are likely to be at least partly due to a shift in the spatial distribution of the fishery from 1989–90 to 2001–02, as well as seasonal changes in the distribution of fishing effort.

2.8 Blue warehou target setnet fishery

The blue warehou target fishery principally catches blue moki in the northern Wairarapa area (statistical area 014), with sporadic catches in statistical areas 013, 015, 016, and 018 (Table 10).

Overall, seasonal trends in blue moki catch from the blue warehou setnet fishery are comparable to the those in the blue moki target fishery, with low catches from November to April and higher catches from May to October (Table 11). There is also considerable interannual variation in the distribution of the monthly catch. There has been a steady decline in the proportion of the catch taken in May and a strong increase in the proportion of catch taken in August since 1998–99. In the previous years, catches from the blue warehou target fishery were very low in August (Table 11).

Many of the main setnet vessels catching blue moki in the target blue warehou fishery also target blue moki.

2.9 Tarakihi target setnet fishery

The blue moki catch from the target tarakihi setnet fishery was principally taken from the Kaikoura area (statistical area 018) (Table 12). From 1991–92 to 1996–97, a small component of the blue moki catch was also taken by the tarakihi setnet fishery in the Mahia area (statistical area 013).

There is a strong seasonal trend in the blue moki catch from the target tarakihi setnet fishery. Most of the catch was taken from April to June with a peak in catch during May (Table 13).

2.10 Setnet fishery – seasonal trends

Seasonal trends in blue moki catch for the setnet fishery (all target species) were examined for each of the main statistical areas fished (Figure 8). For the statistical areas in the southern area of MOK 3 (statistical areas 022, 024–026), catches were negligible from June to October and peaked during summer, November–March. Further north, in statistical areas 014 to 018, there was a general peak in catches from March to July, followed by a period of low catch, and a subsequent peak in catch in September–October (Figure 8). There was a general shift in the seasonal distribution of catch between statistical areas that indicated a northern movement of blue moki during March–July and a returning migration from September–November. During August, catches were low in almost all statistical areas, except in statistical area 013. High catches were also achieved in this area in September (Figure 8).

Proportionally high catches were also taken in August in statistical areas 010, 011, and 020. However, the actual tonnage was small and comprised few records.

2.11 Summary

The blue moki catch proportions by method and target fishery (see Table 3) were scaled up to the combined annual QMR catch from MOK 1 and 3 to estimate the total annual catch from each method/target fishery (Figure 9). Most of the increase in the total catch during the late 1980s and early 1990s was attributable to the increase in the bycatch of blue moki from the blue warehou setnet fishery and the collective increase in bycatch from the minor trawl fisheries (principally targeting red gurnard and flatfish) (Figure 9).

Annual catches from the target blue warehou setnet fishery were lower from 1994–95 to 1997–98, but the decline in catch was countered by an increase in the target setnet fishery (Figure 9). Trends in catch from these two fisheries are inversely proportional, with increased catch from the blue warehou fishery in 1998–99 and 1999–2000, while catches from the target fishery dropped in these years. Conversely, catches from the target fishery increased in the two subsequent years, while the blue moki bycatch from the blue warehou fishery declined (Figure 9). In 2001–02, the target fishery accounted for about half of the total blue moki catch from MOK 1 and MOK 3 combined.

From 1989–90 to 2001–02, annual catches of blue moki from the tarakihi target trawl fishery varied with no significant trend (Figure 9). Similarly, the level of annual catch of blue moki from the minor setnet fisheries remained relatively stable. Catches from the tarakihi setnet fishery were very low from 1997–98 to 2001–02. The combined catch of blue moki from the other minor trawl fisheries also declined from 1998–99 to 2001–02 (Figure 9).

3. CPUE ANALYSIS

The characterisation of the blue moki fishery identified four main fisheries defined by target species, fishing method, area, and season.

a) MOK SN – the target blue moki setnet fishery in statistical areas 013 to 016 between May and October.

b) WAR SN – the target blue warehou setnet fishery in statistical areas 013 to 016 between May and October.
c) TAR SN – the target tarakihi setnet fishery in statistical area 018 between April and June.
d) TAR BT – the target tarakihi bottom trawl fishery in statistical areas 012 to 014 between July and December.

For each of these fisheries, a detailed analysis of the catch and effort data was conducted. Trends in annual catch and effort were examined and annual indices of unstandardised and standardised CPUE were determined. Historical data (from before the introduction of the QMS) were combined with contemporary data for an alternative CPUE analysis of the target blue moki setnet fishery. This alternative fishery definition is referred to in this study as MOK FSU.

3.1 Datasets

Catch and total effort data from the three setnet fisheries (MOK SN, WAR SN, and TAR SN) are available for the 1989–90 to 2001–02 fishing years in CELR format. This includes any qualifying effort with no associated catch of blue moki. These data were aggregated by fishing vessel, fishing day, and statistical area and included the total estimated catch of blue moki (and associated species) and several measures of effort: the total length of fishing net set, the duration of the set, and mesh size of nets used.

Catch and effort data of a simpler form are also available for the setnet fishery for 1983 to 1988 from the Fisheries Statistics Unit (FSU) databases, and these were used to extend the time series of the target MOK setnet fishery in an alternative dataset (MOK FSU) that included fewer auxiliary data.

Most of the target tarakihi bottom trawl data (TAR BT) were also in the CELR format and were aggregated by fishing vessel, fishing day, and statistical area. For each record, the data included the total estimated catch of tarakihi, blue moki, blue warehou, and red gurnard where the species was included among the five main species caught. The main effort variables were the number of trawls and the total duration of trawling. Data extracts included qualifying effort that had no associated catch of blue moki. A small proportion of the tarakihi bottom trawl effort was reported in TCEPR format. These records were aggregated by fishing vessel, fishing day, and statistical area to be in a format compatible with the CELR data.

For each of the fishing trips that reported fishing effort in one (or more) of the four main fisheries, the associated landings data for blue moki and for the other main species were also obtained. The landings data included the vessel, landing date, and the landed catch of each species by Fishstock. The landings data were linked to the effort information by a trip index.

3.1.1 Setnet

Contemporary (QMS) data, 1989–90 to 2001–02

The catch and effort data for each of the three main setnet fisheries were collated in accordance with the criteria defined in Table 14. For each of the main variables, range checks were defined to remove extreme outliers from the data (Table 14).

Setnet length was determined from the *effort.a* field of the CELR, as specified in the reporting instructions (Appendix B). However, in 1989 and 1990, the two years following the introduction of the CELR form, almost all records included values in the *effort.b* field of the CELR form that were comparable to the values recorded in *effort.a* (range 200–3000). The CELR instructions for the setnet fishery do not allow for the recording of data in the *effort.b* field, but in other fisheries this field is used for the number of fishing events in the day (see Appendix B).

Similarly, from 1996 to 2002 approximately 30% of all CELR records included values in the *effort.b* field. This was contrasted with the records from 1991–1995 that included no additional effort data, although the overall daily fishing effort was considerably less than records from the subsequent years (see Figures 12 and 16) suggesting that there was a policy not to enter the data from the additional effort fields during this period. This has the potential to introduce considerable biases into the annual CPUE estimates.

For days in which two separate nets were fished or the same net was set twice in the same day, fishers are instructed to record the cumulative effort in the *effort.a* field. However, it has been assumed that where data are recorded in both the *effort.a* and *effort.b* fields that this represents two separate sets and the total net length was calculated as the sum of the two values.

The *effort.c* field of the CELR form records the mesh size (mm) of the setnet. For the three setnet datasets, a significant proportion of the records either did not record this value (null) or recorded an unrealistic value. Very small values (4–9) were assumed to be recorded in inches rather than millimetres and were corrected accordingly. The mesh size of the setnets used in the target blue moki and blue warehou fisheries was generally comparable (about 165 mm, 6.5 inch) (Figure 10). However, setnets constructed of slightly larger mesh (178 mm, 7 inch) were more frequently used in the early 1990s.

The tarakihi setnet fishery generally uses nets constructed of 125 mm (5 inch) mesh, although larger mesh sizes have also been recorded (178 mm and 240 mm) (Figure 10). The largest mesh size (240 mm, 9.5 inch) may represent shark target fishing

Due to some uncertainty regarding the reliability of the recording of the mesh size and the relatively high proportion of null records (over 10% for the final datasets), the mesh size variable was not included in the standardised CPUE analyses described in Section 3.2.

In catch and effort studies that use estimated catch, there is a concern that the catch data may represent a biased estimate of the actual catch, either due to fishers providing a conservative estimate of the catch or because the species is reported only when it is among the five main species caught.

To investigate the severity of this problem in each of the main setnet fisheries, fishing effort and the estimated catches of the main species were aggregated by individual fishing trips, and the estimated catch was compared with the landed catch of the same species, an actual weight that is recorded at the end of the trip.

Trips often reported landed catch from multiple fishstocks of each species, and therefore, for the MOK or WAR setnet fisheries, the total estimated blue moki catch for the trip was compared with the combined catch landed against MOK 1 and MOK 3 quota, while the estimated blue warehou catch was compared with the combined catch landed of WAR 2, WAR 7, and WAR 8. For blue moki, there was a good correspondence (reporting rate) between the estimated and landed catch from individual fishing trips (Figure 11). A high proportion of the trips also had good agreement between the estimated and landed catch of blue warehou, although a considerable proportion of the records had a significant estimated catch of blue warehou but no corresponding landed catch. It is possible that there was some confusion about the quota area that the blue warehou catch was reported against.

For the TAR setnet fishery, the estimated blue moki catch was compared with the catch landed against MOK 1 and MOK 3, and the estimated tarakihi catch was compared to the catch landed against TAR 2, TAR 3, and TAR 7 quota. For both species, there was strong agreement between the estimated catch and the landed catch from individual fishing trips (Figure 11).

Given the high correlation between estimated catch and landed catch for blue moki and associated species from the setnet fishery, it was decided to use estimated catch and the individual effort records for the standardised CPUE analysis rather than actual landed catch and the associated effort records aggregated at a trip level.

The CPUE datasets from the three setnet fisheries are defined in Table 14. Overall, the datasets contain relatively few records and limited blue moki catch (Table 14). About 30% of the records from the target blue warehou and tarakihi datasets reported no blue moki catch.

The three datasets reveal considerable inter-annual variation in the reported length of net fished from 1989 to 2002 (Figure 12, Figure 13 and Figure 14). The fishing duration was also variable in both the target blue moki and blue warehou fisheries, while the fishing duration of the tarakihi setnet fishery was relatively static over the study period. The level of blue warehou catch from the blue moki target setnet fishery was high from 1991–92 to 1993–94 (Figure 12).

In each of the datasets, a core group of vessels were identified that accounted for at least 50 records, and an additional vessel category was created that included all remaining records from other vessels.

Fisheries Statistics Unit data, 1983–88

The Ministry of Fisheries provided an extract of catch and effort data from the MOK 1 setnet fishery for 1983 to 1988. These data were collected by the Fisheries Statistics Unit (FSU) and are hereon referred to as FSU data. The data included all records within statistical areas 012 to 017 where blue moki was caught by the setnet method. Data were aggregated by vessel fishing day and included the fishing effort (length of net set) and catch of blue moki, blue warehou, rig, school shark, spiky dogfish, and tarakihi.

Seasonal trends in the catch of blue moki were comparable to those described in Sections 2.7 and 2.8, with most of the catch taken in statistical areas 013 to 016 between May and October. Further analysis of the FSU data was restricted to this area/time component of the fishery (Table 15).

No information is available about the target species of the fishing effort from this period. To include comparable historical data in the alternative definition of the blue moki setnet fishery, the species composition (of the six species of interest) in each trip in the dataset was examined and compared with the species composition in contemporary datasets for which the target species is known. Based on this analysis, the principal target species of the vessel fishing day were inferred. Each vessel-fishing day was assigned as targeting blue moki, blue warehou, tarakihi, or shark, based on the definitions given in Table 16. For each target fishery, the distribution of the catch of the four species is presented in Figure 15.

An alternative technique for categorising the target fishery was investigated using cluster analysis on the catch composition. The clustering technique was applied to determine four fishery categories. The catch composition of each cluster is defined in Table 17. The clustering defined the following fishery groups.

1. Cluster 1. High catch blue moki, moderate catch shark, and low catch blue warehou and tarakihi
2. Cluster 2. Low catch blue moki, high catch shark, and low catch blue warehou and tarakihi
3. Cluster 3. Moderate catch blue moki, high catch shark, high catch blue warehou, and low catch tarakihi and
4. Cluster 4. Low catch for all species.

The clustering approach was not able to delineate between the blue moki and the shark setnet fisheries and, consequently, was not considered adequate to determine the principal target species of the fishing trip. Instead, the qualitative approach to the assignation of the principal target species was used to identify the blue moki target fishery in the FSU dataset.

No detailed information about individual fishing vessels was included in the FSU dataset, neither was the duration of the fishing operation available. Because of the manner in which the data were extracted and then subsequently defined according to likely target species, it was not possible to determine unsuccessful trips, i.e., no zero catch trip records were included.

Few FSU records were available from 1988 (see Table 15). These records were excluded from subsequent analyses as they accounted for only a very small proportion of the total annual catch from the MOK 1 fishery.

A small proportion of the records (7%) had no associated effort data. These records were also excluded from the analysis.

A composite dataset of setnet records from the FSU and CELR datasets was constructed. The dataset, denoted FSU MOK, included FSU records defined as targeting blue moki and the CELR target blue moki setnet records from the SN MOK dataset (Table 14). For the composite dataset, the number of explanatory variables available for inclusion in the standardised CPUE analysis was considerably reduced. It was also not possible to equate fishing activity by individual vessels between the two datasets as different vessel keys were used.

Comparison between FSU and recent data

The annual trends in catch and effort data from the designated target blue moki setnet fishery from the FSU dataset were compared with the more recent data from the target fishery (Figure 16). The daily average vessel catch of blue moki was broadly comparable between the two datasets, although there was a higher proportion of small catches (less than 20 kg) in the FSU dataset (20%) compared to the more recent data (7%) (Figure 16).

There was a considerable reduction in the reported length of net fished between the two datasets, particularly between 1983–90 and 1991–96 (Figure 16). It is unknown whether the decline in net length represented a real change in fishing operation or is an artefact of the change in the reporting regime. For the setnet fishery, there has been considerable confusion in the recording of the effort measure (net length) on the CELR forms. The large increase in catch rates between 1991 and 1993 may be explained by incorrect reporting of net length during the period, persisting through until 1996 (Figure 16). For this reason, the effort variable was excluded from the standardised CPUE analysis of FSU MOK (see Section 3.2.1).

3.1.2 Bottom trawl

The principal bottom trawl fishery catching blue moki is the tarakihi target fishery operating off the central east coast of the North Island (statistical areas 012 to 014) during July and December. For individual fishing trips operating in this fishery, the cumulative estimated catches of blue moki, tarakihi, and blue warehou from the fishery were compared with the landed catches for each species.

This revealed estimated catches were generally lower than the actual catch and this bias was greatest for blue moki, particularly when the total catch from the trip was low (see Figure 11). On this basis, the values of estimated catch were not considered sufficiently accurate for a detailed analysis of catch and effort data from the trawl fishery. Instead, the effort data were aggregated by fishing trip and linked with the associated landed catch of the main species considered (tarakihi, blue moki, and blue warehou). Only fishing trips exclusively targeting tarakihi by bottom trawl within a single statistical area (012, 013, or 014) were included in the dataset.

The effort variables included in the datasets were the total duration of the fishing trip (days), the total number of trawls conducted, and the total duration of trawling (hours). The month of fishing was determined from the start date of the fishing trip.

The definition of the dataset is given in Table 14. The dataset included 1 076 fishing trips of which about 16% reported no landed catch of blue moki. Most of the fishing trips were of short duration (1–3 days) and conducted less than 10 trawls (Figure 17). From 1989 to 2002, the total trawl duration per trip tended to fluctuate between years, although there has been no strong trend in the level of effort over the entire period.

A core group of eight vessels was defined in the dataset, with an additional vessel category that included all records from other vessels.

3.2 Standardised CPUE analysis

3.2.1 Methods

Standardised CPUE analyses of the five datasets were undertaken using the methods of Vignaux (1992). For each dataset, a loglinear analysis was undertaken of the non-zero blue moki catch records. The CPUE index of the natural logarithm of the blue moki catch was defined as the dependent variable, and tested against potential predictor variables.

For the non-target blue moki fisheries, the proportion of zero blue moki catch records was also modelled based on the negative binomial error structure.

For the CELR setnet datasets, the potential predictor variables included the categorical variables year, month, statistical area, and vessel, the continuous variables net length, duration, and the associated catch of blue warehou and/or tarakihi. For the tarakihi trawl dataset, the potential predictor variables included the categorical variables year, month, statistical area, and vessel, the continuous variables trip duration, total trawl duration, total number of trawls, the associated catches of blue warehou, red gurnard, and tarakihi. In addition, the models also included the first order interaction between month and statistical area as a potential explanatory variable. The datasets were too small to allow for the inclusion of other potential interaction terms.

Because of concerns about the comparability of recording practices of the net length between the FSU and CELR datasets, the net length variable was not offered as a potential predictor variable in the FSU MOK loglinear CPUE model. This model was limited to the year, month, and statistical area categorical variables and the continuous variable blue warehou catch.

For the east coast North Island blue moki fisheries, the main fishing season spanned administrative fishing years (starting 1 October), with the exception of the tarakihi setnet fishery. For this reason, the year effect in the CPUE models was defined by the calendar year rather than the fishing year.

The CPUE estimate was regressed against each of the predictor variables to determine which explained the most variability in CPUE. This selected variable was then included in the model and the CPUE regressed against the selected variable and each of the other predictor variables to determine the next most powerful variable. The stepwise regression procedure was continued until the remaining variables contributed no significant explanatory power to the model (less than 1% increase in the R^2 value). Annual indices are determined relative to an appropriate base year (1989–90) and the standard deviation of the annual indices determined following Francis (1999).

For each CPUE model, the fit was investigated by examination of the model residuals and quantile-quantile plots (Venables & Ripley 2000). The predicted relationship between CPUE and each of the main variables included in model is also examined.

The standardised CPUE indices are compared with the unstandardised CPUE from each fishery.

3.2.2 Results

Overall, the five loglinear CPUE models explained about 40–50% of the observed variation in the logarithm of the blue moki catch (Appendix A). The models all included at least one effort variable; net length for the CELR setnet datasets and trip duration and total trawl duration for the trawl fishery (see Appendix A).

The month effect was also included in all models, usually in interaction with the statistical area (with the exception of the tarakihi setnet (TAR SN) fishery that occurred only in a single statistical area). The vessel and year were significant variables in all the loglinear CPUE models. For the tarakihi setnet and bottom trawl fisheries, the catches of the other associated species were also included as significant variables: tarakihi catch in the TAR SN model and the catch of red gurnard, blue warehou, and tarakihi in the TAR BT model (Appendix 1).

The residuals of the loglinear CPUE models generally approximated a normal distribution, although for large values the distributions deviated from normal (Figure 20). There was no strong trend in the model residuals with respect to the fitted values.

The three negative binomial models (TAR SN, WAR SN, and TAR BT) all had a low explanatory power for the probability of a blue moki catch, explaining only about 10% of the observed variation, and generally included the same significant variables as the corresponding loglinear CPUE model (Appendix A).

For the target blue moki and blue warehou setnet fisheries, the loglinear CPUE models included year, vessel, net length, and the statistical area/month interaction term as the significant variables in the model. There were considerable differences between the two models in the statistical area/month interaction. For the target fishery (MOK SN), highest catch rates were achieved in statistical area 013 during July–October, while catch rates in 014 and 016 were low in August and peaked in September (Figure 21). For statistical area 015, catch rates remained relatively constant from May to October.

For the blue warehou target setnet fishery (WAR SN), catch rates of blue moki were highest in statistical area 015, particularly in September–October. Catch rates in statistical area 013 were relatively high in May–June and low in August (Figure 22).

For the tarakihi setnet fishery, the loglinear CPUE model predicts higher catch rates of blue moki during May and June compared to April (Figure 23). The model also predicts an increasing catch of blue moki with both increasing length of net set and set duration, although there is no further increase beyond a threshold of 2000 m of net set and a set duration of 24 h. The predicted blue moki catch is also positively correlated with the catch of the target species tarakihi for the range of most of the data (up to tarahiki catches of 700 kg). This indicates considerable overlap in the distribution of the two species during April–June (Figure 23).

The blue moki bycatch from the tarakihi bottom trawl fishery is generally predicted to increase with increasing trawl duration and trip duration (Figure 24). The level of blue moki catch also increases with the catch of red gurnard and for relatively smaller catches of the target species (less than 2 t). However, the model predicts relatively low catches of blue moki for fishing trips landing large catches of tarakihi (greater than 5 t).

The seasonal trend in the blue moki catch rate from the tarakihi trawl fishery is comparable between the three statistical areas (012, 013, and 014), although the blue moki catch is greater in statistical area 014. For all three areas, catch rates of blue moki are generally high in July, decline in August, and increase again in September (Figure 24). Catch rates of blue moki decline over the subsequent months and are low in November–December.

One of the core trawl vessels in the tarakihi fishery has a substantially higher catch rate of blue moki than the remainder of the fleet (Figure 24).

For each of the four loglinear CPUE models based on recent data, there is considerable inter-annual variation in the annual CPUE indices and relatively high associated variance. There are also differences in the general trends in the annual indices from the four models. For the target setnet fishery, the CPUE model indicates that catch rates increased sharply in the early 1990s, declined in 1994, and have remained relatively constant over the subsequent years (Figure 18). A similar trend in blue moki CPUE is apparent for the bycatch from the blue warehou setnet fishery.

For the tarakihi setnet fishery, the bycatch rate of blue moki was relatively constant from 1990 to 1997. However, the catch rates were considerably lower during the more recent years (Figure 18). For the tarakihi trawl fishery, the annual CPUE indices for blue moki fluctuated about a relatively constant level from 1989 to 1998, although in subsequent years the catch rate of blue moki declined (Figure 18).

For the four fisheries, there are considerable differences between the standardised and unstandardised CPUE indices. This indicates that the unstandardised catch rates were influenced by systematic changes in the spatial and temporal distribution of the target fisheries (Figure 18).

The annual indices derived from the three negative binomial CPUE models are relatively uninformative. For the target blue warehou setnet fishery and the tarakihi trawl fisheries, the annual probability of recording a catch of blue moki remained relatively constant, at about 80%, for the entire study period (Figure 18).

The probability of catching blue moki in the tarakihi setnet fishery was more variable between years and was generally higher from 1990–94 than in later years. This trend is broadly consistent with the higher annual indices from the loglinear CPUE model for the fishery (Figure 18).

The FSU MOK dataset extended the time-series of catch and effort data from the target setnet fishery to include 1983–88. Limited variables were available for inclusion in the FSU MOK loglinear CPUE model. The interaction effect between month and statistical area explained most of the observed variation in the natural logarithm of blue moki catch and the year variable was the only other significant factor included in the model (Appendix 1). The effort variable (length of net set) was not considered to be consistently recorded between the two datasets and, consequently, was not included as a potential explanatory variable in the fitting procedure. Therefore, the model does not take into account any actual change in the length of net fished over the time period.

The annual indices derived for the longer-term model indicate that daily catches of blue moki were broadly comparable between 1983–87 and 1989–92, although annual catch rates were more variable during the earlier period (Figure 19). Catch rates increased sharply in 1993 and remained at a higher level from 1993 to 1996 before declining sharply in 1997. Catch rates remained at a lower level during 1997–2000 and increased in both 2001 and 2002 (Figure 19).

4. INTERVIEWS

During the preliminary characterisation of the MOK1 fishery several major stakeholder sectors in the fishery were identified. These sectors are: the northern QMA 2 trawl fishery, the moki and warehou target setnet fishery, the tarakihi target fishery in statistical area 018, and fish processors. Fishers and processors from these key sectors, and East Cape Maori, were approached for interviews. The

Ministry of Fisheries supplied contact details of quota holders from within these sectors under strict confidentiality, but did not identify the vessel in terms of its catch records.

These interviews generally followed the questionnaire in Appendix D. Questions covered topics such as fishing plans, species distribution and abundance, changes in the operation of the fishery, and market information. Largely unedited notes from individual interviews are contained in Appendix D.

The key opinions and comments from each sector are summarised below.

4.1 Northern QMA 2 trawl fishery

Trawlers in this area target either gurnard or tarakihi depending on how much quota/ actual catch entitlement (ACE) they have available. Moki is taken as bycatch in depths up to 110 m. Trawlers target species based on known grounds in the inshore fishery and based on marks in the offshore/deepwater fishery.

Moki are caught mostly in shallow waters, but the depth range in which they are most abundant varies annually. Moki are thought to have an abundance cycle independent of those of other inshore fish species that is probably related to the relative success of year classes.

There was an observation made that while moki used to travel in large schools over the soft bottom, they are now not so densely aggregated, though the common movement (migration) is still apparent.

Moki from this fishery are sold to the domestic fish and chip market for about $1.50/kg greenweight, and this market cannot handle large volumes of moki.

4.2 Kapiti coast (QMA 2) trawl fishery

Small trawlers operating on the Kapiti coast target tarakihi, moki, and snapper on known grounds. Moki are caught in depths of bout 50 fathoms (91 m). Moki catch rates are observed to decline when the water is clearer and to increase shortly after a southerly front. These moki are not thought by the fishers to be migratory even though they do have the white flesh said to be associated with migratory fish on the east coast of New Zealand.

Moki from this fishery are sold for $1.75/kg greenweight to the Wellington fish and chip market, and sometimes the processors will ask their supplying fishers to target other species in order to avoid flooding the market.

Fishers report that the bycatch trade-off system was used, and now deemed values are paid when moki is overcaught, but that the high deemed value ($0.88/kg) may be encouraging some fishers to discard moki if they can not find enough quota/ACE to cover any excess catch.

4.3 Moki and warehou target setnet fishery

Setnet fishers specifically target moki as they migrate past the Wairarapa coast. Most fishermen will target them only as they run north from May to July, when they are in the best (pre-spawning) condition, but some will also target moki later, as they run south in October, if there is enough quota available. Moki are targeted on known grounds in depths of between 30–60 fathoms (55–110 m) using 7 inch mesh, which allows the smaller moki to escape. Very little bycatch is taken, with only small amounts of tarakihi, hapuku, warehou, and kingfish being taken. The targeted moki tend to weigh between 3 and 5 kg.

Migrating fish have the more desirable white flesh, while the resident moki, which are avoided, have black streaks in the flesh.

Opinions are split on the state of the fishery, with one fisher saying it needs a quota increase and another saying that the fish were of poorer quality this year, but both saying that they could catch more moki if there was more quota available.

There was concern about some larger boats targeting moki in their spawning grounds off Gisborne, and the effect that might be having on the fishery.

Prices in this fishery vary between fishers, lease rates paid range from $0.45 to $0.60 per kg with market prices ranging from $1.30 to $2.00 per kg. One fisher stated that the high deemed values these days are encouraging some fishers to discard species, especially those with low and restrictive quotas. Moki has a deemed value of $0.88/kg, which he thinks is a problem for those trawlers that have little quota.

4.4 Tarakihi target setnet fishery in statistical area 018

Setnetters active in statistical area 018 target tarakihi, hapuku, and ling. Moki are taken as bycatch while they are targeting tarakihi in May, with smaller amounts caught in October. Most moki are caught in depths of 32–35 fathoms (58–64 m) and it is possible to reduce the amount of moki caught by setting nets in deeper waters. Five inch mesh nets are used to target tarakihi and 7 inch mesh for hapuku; both mesh sizes catch moki. Any moki or small hapuku that are still alive when the nets are lifted are released.

Although catches were higher in the mid 1980s, the catches of tarakihi and moki have stayed reasonably constant. One fisher commented that the last 3–4 years have not been as good for moki, while the other said that tarakihi had its best year two years ago.

Prices paid to the fishers are low compared to other areas, $1.00/kg. The processors sell moki to the Christchurch and Nelson fish and chip markets. However, these markets are easily flooded and then fishers are paid $0.50/kg, and it is sold as bait to the rock lobster fishermen. The comment was made that due to the relatively high deemed value compared to the price from the processors, any fisherwho overcaught would be tempted to discard moki.

4.5 Fish processors

The two processors interviewed have 9 to 16 vessels contracted to them in total. These vessels range in size from 4 to 40 m and include both setnetters and trawlers. Species targeted include gurnard, tarakihi, flatfish, ling, hoki, warehou, and moki. Setnetters set their net based on marks seen on the sounder in combination with local knowledge of the area. Setnetters are not numerous, with only a few still operating; this was suggested to be linked to the problem of catching too much shark and rig, both of which have high deemed values, making the operation less economic.

The trawlers operate mainly within statistical areas 012 to 014 (Hawke Bay) and target gurnard and tarakihi in depths of 30–200 m on known grounds. Moki are caught as bycatch in August, September, and October and are impossible to avoid.

One processor said that when the moki quota was increased in the early 1990s they made an agreement not to target moki, and he wasn't sure how some setnetters on the Wairarapa coast were allowed to target moki.

Poor catches from the inshore fishery occur in easterly conditions, with better catches in north-westerly conditions, and the best catches occur three days either side of the full moon.

It was considered that, while deemed values used to be relatively low, with the reramped deemed value system, discarding of certain species, including moki, is probably more prevalent now.

5. SUMMARY

The standardised CPUE analyses reveal different trends in the relative abundance of blue moki in the four fisheries examined. The datasets are sparse and, consequently, the annual indices are poorly determined. There are also concerns regarding the reliability of some of the data included in each of the datasets. These issues are discussed in more detail below.

Overall, the annual indices presented in this report should be considered as indicative indices only, capable only of suggesting a general trend in the performance of each fishery. At this stage, the indices are not sufficiently reliable to be included in a comprehensive assessment of MOK 1.

The two setnet fisheries off the east coast of the North Island (SN MOK and SN WAR) revealed a peak in catch rates during the early 1990s and have remained relatively stable in subsequent years. There is some concern that the high catch rates in the early 1990s may be an artefact of problems in the recording of net length. However, when this variable was excluded from the analysis of the longer time-series of CPUE data (MOK FSU), the peak was still evident The higher catch rates during the early 1990s may indicate a period of strong recruitment to the fishery, although, if so, the effect was relatively short term, as catch rates subsequently declined to levels achieved during the preceding period.

The trend in standardised CPUE from the setnet fishery is generally consistent with the observations of one interviewee who suggested the blue moki fishery was worse than 5 years ago, although this was contradicted by another interviewee who stated that the fishery was better than it used to be (see Appendix D).

The standardised CPUE indices from the SN TAR fishery show catch rates that were relatively stable during the early 1990s, but have been at a lower level (about 50%) since the late 1990s. This is consistent with the observation of one interviewee who considered that there was now less blue moki around, although another interviewee considered that catch rates of blue moki had remained relatively constant (see Appendix D).

The interviews with individual fishers have provided some insights into important operational details of the setnet fishery that are not collected from the MFish statutory reporting forms. These include depth fished, soak time, construction of the net, interaction with other species, and the effects of various management regimes (i.e., deemed values, bycatch trade-off provisions, changes in regulations, etc).

There are problems with the quality of data recorded in the setnet fishery, particularly the confusion about how to record the fishing of multiple nets on a single day. There are also many errors in the recording of the mesh size of the setnet. These are fundamental issues in the measurement of effort from the setnet fishery and need to be addressed to ensure the catch and effort data are sufficiently reliable for the monitoring of the stock. It would also be informative to collect other information from the fishery, in particular the depth that is fished. This would enable a more comprehensive analysis of the CPUE data and may enable a clear demarcation between the target blue moki and target blue warehou setnet fisheries.

For the trawl fishery, standardised CPUE indices declined slightly from 1990 to 1994, then increased in the mid 1990s, before declining sharply from 1998 to 2002. These indices are not consistent with the trends in CPUE from the setnet fisheries operating in the adjacent areas. However, the respective selectivity at age for the setnet and trawl fisheries is unknown and the two fisheries may be harvesting a different component of the adult blue moki population.

Blue moki catch rates in the trawl fishery appear to vary considerably in depth (depending on the time of year) and, consequently, trawl vessels may potentially be able to vary the proportion of blue moki in their catch in response to the availability of quota for blue moki and other species. However, only limited data are available on the depth distribution of the trawl fishery and this variable was not available for inclusion in the CPUE model.

The operation of the trawl fleet and, consequently, the observed catch rate of blue moki, is likely to be influenced by a number of economic factors that affect the level of reported and unreported (discarded) blue moki catch. These include the market price for blue moki, the availability of quota or ACE, the deemed value of blue moki, and any previous bycatch trade-off provisions that existed. These factors affect individual operators in different ways, depending on their individual quota portfolio and the influence of each factor may also vary over time. Consequently, it is difficult to draw strong conclusions from the bycatch CPUE data from the tarakihi trawl fishery. Nevertheless, the recent decline in catch rates from the trawl fishery needs to be examined in greater detail to allay any concerns about the state of the fishery.

6. RECOMMENDATIONS FOR FUTURE MONITORING

The current study has focussed on the analysis of catch and effort data from the main fisheries to derive indices of relative abundance. This study is inconclusive as the different CPUE time-series show different trends in relative abundance during 1989–2002. The annual indices are also imprecise and, consequently, there is considerable between-year variability within each CPUE series. Nevertheless, the various existing CPUE series may provide indicative trends in relative abundance and could be improved through the collection of more detailed information from the respective fisheries.

It is considered that the setnet fisheries, in particular the target fishery, represent the best candidates for ongoing monitoring of catch and effort data. The passive nature of these fisheries and the direction of effort at the main component of the blue moki stock means that these fisheries are less sensitive to operational changes in the fishery, such as may occur in a bycatch trawl fishery.

However, there are a number of outstanding data issues that need to be addressed before the catch and effort data can be applied with sufficient confidence to develop a robust monitoring tool. Specifically, current measurements of fishing effort (length of net set and mesh size) need to be more accurately recorded and consideration needs to be given to the collection of additional data that describe the fishing operation, for example, the soak time of each net and a description of the construction of the net. In addition, the utility of catch and effort data would be greatly improved with the collection of information on fishing depth and more detailed information about fishing location. These parameters are not collected by the current MFish statutory reporting forms and should be given consideration when these forms are revised. Alternatively, it may be appropriate to implement a logbook scheme for the key participants in the setnet fishery.

There is currently no information available on the relative size and age of blue moki caught by each of the main fisheries. It is proposed that catch sampling is undertaken to determine the relative age composition of the catch from each of the fisheries, with particular emphasis on the target blue moki setnet fishery. Such a sampling programme would require consideration of the setnet mesh size currently used in the fishery. The results would provide an indication of the component of the population that was being indexed by trends in the CPUE indices from the respective fishery.

The monitoring programme outlined above is not expected to provide a comprehensive assessment of the blue moki stock, i.e., the formal estimation of sustainable yields and reference biomass levels. Rather, at least in the medium term (3–5 years), monitoring would enable a qualitative assessment of trends in the stock biomass while accumulating information required to undertake an assessment at a later time.

There remain a number of other important parameters of the biology of blue moki that need to be determined before a stock assessment could be undertaken. One of the more significant would be to estimate the proportion of the stock that migrates to the spawning ground each year and, conversely, the proportion of the stock resident along the northeast coast throughout the year. These movements would be best investigated with a comprehensive tagging programme of the stock. This would also potentially provide an estimate of current biomass and fishing mortality rates.

The development of a formal stock assessment for blue moki would require a considerably greater investment in research in the fishery. This is a policy decision for the Ministry that requires balancing the management needs for the fishery against the value of the fishery and the cost of undertaking the research.

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Table 1: Comparison between the estimated blue moki catch (t) and the QMR catch (t) from MOK 1 and MOK 3 from *1989–90* to 2001–02. Note the MOK 1 and MOK 3 estimated catch is determined for the main area of the fishery only. Source: estimated catches, this study; QMR catch, Annala et al. (2002).

Fishing	Estimated catch (t)			QMR catch (t)			Percentage		
year	MOK 1	MOK 3	Total	MOK 1	MOK 3	Total	MOK 1	MOK 3	Total
1989–90	134.1	65.5	199.6	202	89	291	66.4	73.6	68.6
1990–91	188.0	52.5	240.5	264	93	357	71.2	56.4	67.4
1991–92	198.1	40.2	238.3	285	66	351	69.5	60.9	67.9
1992–93	227.2	66.0	293.2	289	94	383	78.6	70.2	76.6
1993–94	282.2	63.3	345.5	374	102	476	75.4	62.1	72.6
1994–95	302.8	65.8	368.6	418	90	508	72.4	73.1	72.6
1995–96	316.6	76.2	392.7	435	91	526	72.8	83.7	74.7
1996–97	257.6	48.3	305.9	408	66	474	63.1	73.2	64.5
1997–98	311.9	61.5	373.5	416	78	494	75.0	78.9	75.6
1998–99	347.9	59.3	407.2	468	78	546	74.3	76.0	74.6
1999–00	285.2	49.0	334.2	381	56	437	74.9	87.5	76.5
2000–01	307.8	52.3	360.1	420	67	487	73.3	78.1	73.9
2001–02	278.3	54.1	332.4	365	77	442	76.2	70.3	75.2

Table 2: Percentage of the annual catch of blue moki by statistical area for the main statistical areas comprising the blue moki fishery from 1989–90 to 2001–02.

Fishing	Statistical area													
year	010	011	012	013	014	015	016	017	018	020	022	024	025	026
1989–90	2.1	0.7	2.3	27.5	16.3	13.7	3.2	1.4	24.7	1.8	0.3	3.6	1.4	1.0
1990–91	2.4	2.0	7.7	23.6	20.3	11.2	9.3	1.7	16.7	1.0	0.1	2.0	1.2	0.8
1991–92	2.1	0.3	4.6	30.9	17.8	14.1	11.6	1.7	12.9	0.1	0.1	2.4	1.2	0.1
1992–93	2.1	0.2	2.0	21.0	23.7	12.3	13.4	2.7	17.2	0.1	0.3	2.4	2.4	0.1
1993–94	3.7	0.3	2.5	25.9	23.5	12.6	8.8	4.3	15.0	0.1	0.1	2.6	0.5	0.1
1994–95	2.5	0.8	3.6	25.7	19.8	11.9	14.5	3.4	13.9	0.2	0.5	3.0	0.3	0.0
1995–96	3.0	0.3	2.8	27.4	18.5	15.0	11.3	2.3	13.9	1.2	0.0	2.6	1.6	0.0
1996–97	0.3	1.1	3.8	33.1	23.2	6.1	11.5	5.0	10.4	0.1	0.7	4.3	0.3	0.0
1997–98	0.2	0.4	4.9	27.8	24.2	7.0	12.2	6.8	11.2	0.4	0.1	4.4	0.2	0.3
1998–99	0.1	0.4	3.3	20.2	39.3	6.2	12.0	3.9	10.9	0.3	0.2	3.1	0.1	0.0
1999–00	0.3	0.3	2.5	29.6	28.3	5.4	14.0	4.9	10.5	0.3	0.6	2.7	0.6	0.1
2000–01	0.3	0.3	2.2	29.2	23.7	14.8	10.3	4.6	10.1	0.5	0.1	2.5	0.7	0.6
2001–02	0.3	0.2	1.3	25.8	17.0	26.9	8.9	3.5	12.1	0.6	0.2	2.8	0.4	0.2
Total	1.4	0.5	3.3	26.6	23.3	12.0	11.1	3.7	13.3	0.5	0.3	3.0	0.8	0.2

Table 3: Percentage distribution of the annual blue moki catch by fishing method and target species for the main statistical areas comprising the blue moki fishery from 1989–90 to 2001–02. Target species codes: BAR, barracouta, FLA, flatfish; GUR, red gurnard; MOK, blue moki; RCO, red cod; SNA, snapper; TAR, tarakihi; TRE, trevally; WAR, blue warehou; BUT, butterfish; SCH, school shark; SPO, rig.

Fishing											Bottom trawl
year	BAR	FLA	GUR	MOK	RCO	SNA	TAR	TRE	WAR	Other	Total
1989–90	4.1	0.9	2.3	0.7	0.3	2.2	24.6	0.5	0.7	0.0	36.2
1990–91	3.5	0.7	4.3	0.3	0.4	0.8	30.8	1.6	2.2	0.0	44.5
1991–92	0.5	0.8	15.3	0.2	0.1	1.1	31.9	2.7	3.5	0.3	56.5
1992–93	1.8	1.1	8.6	0.2	0.3	0.0	14.1	1.9	2.3	0.0	30.3
1993–94	2.2	0.3	7.7	2.5	0.4	1.3	18.0	3.4	4.1	0.0	39.9
1994–95	2.1	0.8	6.1	0.6	3.7	0.3	30.0	2.9	4.3	0.1	51.0
1995–96	3.0	1.9	6.1	1.9	1.4	0.4	17.3	2.3	4.8	0.0	39.1
1996–97	4.0	2.6	9.7	2.4	0.7	0.6	19.2	1.3	3.2	0.1	43.8
1997–98	4.0	1.6	6.9	2.2	1.3	0.9	26.9	1.5	2.2	0.3	47.7
1998–99	4.2	1.2	9.5	1.2	1.0	1.1	25.4	0.6	3.3	0.0	47.5
1999–00	3.4	0.7	6.9	3.8	0.5	0.7	16.5	0.6	4.8	0.0	37.8
2000–01	1.9	1.4	6.6	1.8	0.6	0.3	15.9	0.9	5.6	0.1	35.1
2001–02	0.8	1.5	7.5	1.8	1.4	0.4	15.6	0.4	3.5	0.0	33.0
Total	2.7	1.2	7.5	1.6	1.0	0.7	21.7	1.6	3.6	0.1	41.7

								Setnet	Other
	BUT	MOK	SCH	SPO	TAR	WAR	Other	Total	
1989–90	1.3	27.7	1.9	4.5	14.4	12.2	1.6	63.6	0.3
1990–91	1.8	21.2	1.5	3.9	9.8	16.3	0.9	55.4	0.1
1991–92	2.2	13.0	2.3	4.1	8.2	9.9	3.7	43.5	0.1
1992–93	1.5	18.2	2.0	7.4	15.2	23.1	2.1	69.6	0.1
1993–94	1.4	12.9	1.0	6.3	15.1	22.4	0.9	60.0	0.2
1994–95	1.5	14.2	1.8	5.4	9.6	14.0	2.2	48.7	0.3
1995–96	1.3	29.5	0.8	3.1	11.2	12.6	2.2	60.7	0.2
1996–97	1.8	29.3	1.0	2.7	8.2	12.1	1.1	56.1	0.1
1997–98	0.8	27.0	1.9	3.4	3.1	13.2	1.0	50.4	1.9
1998–99	1.1	18.9	1.6	1.9	3.7	22.8	2.4	52.4	0.1
1999–00	1.3	21.7	0.9	3.2	3.2	30.1	1.7	62.1	0.1
2000–01	1.3	39.4	0.8	4.6	2.3	13.6	2.4	64.6	0.4
2001–02	0.6	47.7	1.2	8.3	3.2	5.1	0.8	66.8	0.2
Total	1.3	24.9	1.4	4.5	7.9	16.2	1.8	57.9	0.3

Table 4: Percentage of annual blue moki catch from the tarakihi target bottom trawl fishery by statistical area for the main statistical areas comprising the blue moki fishery from 1989–90 to 2001–02.

Fishng														Statistical area
year	010	011	012	013	014	015	016	017	018	020	022	024	025	026
1989–90	0.7	0.8	8.2	63.8	18.0	2.9	3.0	0.0	1.4	1.2	0.0	0.0	0.0	0.0
1990–91	0.8	2.5	20.6	50.5	12.9	7.8	3.9	0.2	0.2	0.0	0.0	0.5	0.0	0.0
1991–92	1.1	0.9	8.2	53.8	5.3	10.9	18.4	1.3	0.0	0.0	0.0	0.0	0.0	0.0
1992–93	2.1	1.1	9.0	32.7	9.8	3.7	33.5	5.7	2.5	0.0	0.0	0.0	0.0	0.0
1993–94	0.8	1.3	11.2	36.4	20.4	3.7	21.6	3.7	0.7	0.2	0.0	0.0	0.0	0.0
1994–95	0.4	2.4	9.7	32.8	14.7	7.0	28.2	3.6	1.1	0.0	0.0	0.1	0.0	0.0
1995–96	0.8	1.0	11.9	41.1	12.8	6.0	24.1	1.9	0.3	0.0	0.0	0.0	0.0	0.0
1996–97	1.2	1.5	9.3	55.8	5.9	8.2	15.3	2.7	0.2	0.0	0.0	0.0	0.0	0.0
1997–98	0.1	1.2	10.7	27.6	6.3	13.0	27.9	6.4	6.9	0.0	0.0	0.0	0.0	0.0
1998–99	0.1	0.8	9.8	39.7	9.9	4.8	26.1	1.9	6.9	0.0	0.0	0.0	0.0	0.0
1999–00	0.2	1.2	11.7	33.1	11.1	3.3	33.4	0.7	5.1	0.0	0.0	0.1	0.0	0.0
2000–01	0.5	0.4	5.8	31.7	19.4	6.8	22.5	10.7	2.0	0.0	0.0	0.1	0.0	0.0
2001–02	0.4	0.7	5.8	34.9	12.2	7.7	28.1	1.0	9.1	0.0	0.0	0.0	0.0	0.0
Total	0.6	1.3	10.4	40.3	11.9	7.0	22.4	3.1	2.9	0.1	0.0	0.1	0.0	0.0

Table 5: Percentage of annual blue moki catch from the tarakihi target bottom trawl fishery by month for 1989–90 to 2001–02.

Fishing												Month
year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1989–90	8.1	13.8	8.3	13.2	7.2	3.5	1.1	2.6	3.1	6.0	2.7	30.3
1990–91	16.2	11.4	3.4	4.4	3.5	2.0	1.9	7.1	4.2	8.6	1.9	35.4
1991–92	23.5	22.2	9.2	3.7	6.1	1.8	2.7	5.6	7.1	4.4	1.6	12.1
1992–93	22.4	30.7	9.7	4.6	0.9	2.2	1.1	4.8	7.8	12.4	0.3	3.0
1993–94	23.8	19.3	16.0	1.2	1.9	1.2	2.5	6.1	9.6	4.8	2.2	11.4
1994–95	21.4	13.7	16.0	7.6	5.0	1.6	6.8	6.6	7.5	4.1	1.8	7.9
1995–96	22.4	19.9	6.2	4.2	4.3	2.7	0.6	5.4	8.0	7.2	3.5	15.5
1996–97	23.3	22.9	3.1	3.7	4.4	2.0	1.9	5.8	10.5	7.2	1.6	13.5
1997–98	19.5	15.7	7.7	8.0	5.8	3.5	8.4	8.8	6.6	4.5	3.0	8.5
1998–99	13.2	13.7	8.4	7.1	3.4	3.3	3.5	4.1	7.1	8.0	5.3	22.9
1999–00	19.1	10.2	16.2	6.8	5.2	7.5	2.1	4.4	11.5	8.6	2.0	6.4
2000–01	16.6	10.8	5.9	6.6	7.0	5.0	3.4	5.7	3.9	23.0	2.2	9.9
2001–02	9.1	4.6	6.4	10.7	9.4	6.5	6.0	10.9	9.6	17.4	2.8	6.5
Total	18.5	15.8	9.2	6.3	4.9	3.1	3.7	6.1	7.4	8.2	2.5	14.4

Table 6: Percentage of annual blue moki catch from the red gurnard target bottom trawl fishery by statistical area for the main statistical areas comprising the blue moki fishery from 1989–90 to 2001–02.

Fishing year	Statistical area													
	010	011	012	013	014	015	016	017	018	020	022	024	025	026
1989–90	0.0	0.0	5.6	71.9	19.1	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990–91	0.0	0.0	18.8	49.5	19.7	2.8	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991–92	0.0	0.0	9.1	52.5	20.7	13.9	3.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0
1992–93	0.0	0.0	4.9	40.2	33.3	19.9	0.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0
1993–94	0.0	0.2	0.5	48.3	30.3	11.7	4.6	4.5	0.0	0.0	0.0	0.0	0.0	0.0
1994–95	0.0	0.0	5.9	51.5	11.4	26.4	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995–96	0.2	0.4	6.8	50.8	31.8	2.2	6.1	1.7	0.1	0.0	0.0	0.0	0.0	0.0
1996–97	0.0	0.1	14.0	36.1	29.8	15.3	4.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997–98	0.0	0.2	20.6	37.5	11.9	14.3	13.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0
1998–99	0.0	0.1	3.8	50.8	10.4	22.3	12.4	0.0	0.2	0.0	0.0	0.0	0.0	0.0
1999–00	2.0	0.7	3.8	47.3	17.3	12.6	16.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2000–01	0.2	2.5	12.2	48.0	14.6	14.4	2.8	1.1	4.3	0.0	0.0	0.0	0.0	0.0
2001–02	1.0	0.1	3.2	46.8	20.2	23.2	5.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.3	0.3	8.0	47.0	20.8	15.6	6.8	0.9	0.4	0.0	0.0	0.0	0.0	0.0

Table 7: Percentage of annual blue moki catch from the red gurnard target bottom trawl fishery by month for 1989–90 to 2001–02.

Fishing year	Month											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1989–90	24.3	7.8	2.2	4.7	4.4	12.6	13.5	23.4	3.4	0.6	0.0	3.1
1990–91	5.1	10.4	2.1	5.7	15.9	3.7	6.9	5.1	3.4	4.6	0.6	36.6
1991–92	14.0	33.0	11.1	2.9	7.4	6.7	9.1	5.6	4.1	1.2	0.2	4.7
1992–93	20.1	9.9	5.1	7.3	6.3	10.3	17.2	9.3	7.8	2.3	0.2	4.2
1993–94	22.4	17.1	8.6	0.8	4.6	5.4	9.0	9.9	5.0	0.9	0.0	16.4
1994–95	6.2	9.6	12.7	2.8	1.7	6.4	16.8	6.3	22.0	4.5	0.2	10.6
1995–96	14.4	20.5	1.8	4.4	5.0	16.1	12.3	9.0	4.7	2.0	0.3	9.6
1996–97	8.2	18.6	5.8	5.7	11.3	9.6	7.2	12.7	5.0	4.9	0.7	10.4
1997–98	4.7	7.7	7.9	4.2	6.3	16.2	11.3	15.4	4.1	15.6	1.3	5.3
1998–99	7.8	8.8	7.9	2.6	11.3	11.4	7.3	11.5	9.9	7.5	1.1	13.1
1999–00	8.1	12.8	4.3	8.9	14.0	9.0	7.9	9.4	7.7	6.4	0.2	11.4
2000–01	12.9	2.9	5.5	3.5	5.9	11.7	9.8	10.1	11.6	6.3	1.2	18.7
2001–02	10.3	10.9	4.3	8.8	12.8	14.1	10.0	7.6	5.3	1.8	2.8	11.5
Total	11.6	14.2	6.8	4.6	8.3	10.3	10.3	9.8	7.5	4.8	0.7	11.1

Table 8: Percentage of annual blue moki catch from the target setnet fishery by statistical area for the main statistical areas comprising the blue moki fishery from 1989–90 to 2001–02.

Fishing	Statistical area													
year	010	011	012	013	014	015	016	017	018	020	022	024	025	026
1989–90	6.7	1.5	0.0	20.2	15.1	41.9	2.0	1.0	1.0	2.7	0.0	7.4	0.5	0.0
1990–91	8.5	5.3	0.2	14.3	23.1	37.3	2.4	0.1	0.8	4.3	0.5	2.6	0.8	0.0
1991–92	0.0	0.0	0.0	8.8	10.2	60.9	2.1	0.5	10.4	0.1	0.3	5.4	1.2	0.1
1992–93	7.4	0.0	0.0	13.4	14.0	41.3	3.5	2.2	8.0	0.0	0.3	6.2	3.7	0.0
1993–94	15.5	0.0	0.0	24.3	5.6	17.8	13.1	1.2	9.8	0.2	0.0	11.4	0.9	0.2
1994–95	15.2	0.3	0.0	30.4	1.5	29.8	7.0	3.3	4.8	0.0	0.0	7.3	0.4	0.1
1995–96	9.2	0.1	0.0	37.0	0.6	34.5	3.0	0.3	0.7	3.6	0.0	6.4	4.8	0.0
1996–97	0.0	2.7	0.0	43.0	25.4	1.5	10.3	4.9	0.6	0.1	0.0	11.4	0.0	0.0
1997–98	0.3	0.0	0.0	49.3	23.4	2.5	7.2	0.9	4.4	0.3	0.1	11.2	0.4	0.0
1998–99	0.1	0.0	0.0	16.3	64.1	4.5	4.3	0.0	0.2	0.5	0.0	9.4	0.5	0.0
1999–00	0.1	0.0	0.0	39.7	28.3	14.1	6.9	1.0	0.1	0.0	0.0	8.3	1.4	0.0
2000–01	0.2	0.0	0.0	30.4	31.8	26.5	5.1	0.5	0.0	0.0	0.0	3.7	1.7	0.0
2001–02	0.0	0.0	0.0	31.9	16.0	47.1	1.3	0.5	0.0	0.0	0.0	2.7	0.4	0.0
Total	3.7	0.6	0.0	30.8	21.2	26.5	5.0	1.1	2.1	0.8	0.1	6.8	1.4	0.0

Table 9: Percentage of annual blue moki catch from the target setnet fishery by month from 1989–90 to 2001–02.

Fishing	Month											
year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1989–90	9.6	6.2	1.0	5.1	8.9	4.0	2.6	12.6	17.4	15.8	5.7	11.1
1990–91	10.3	2.0	1.3	1.1	0.6	0.7	3.4	16.7	11.3	32.1	4.1	16.5
1991–92	16.2	1.4	1.6	2.0	4.3	4.3	9.5	17.7	17.8	11.5	1.5	12.0
1992–93	18.2	2.8	4.3	2.1	2.0	5.5	12.4	16.3	14.8	18.8	1.6	1.1
1993–94	26.4	5.7	2.4	5.8	5.7	2.5	6.7	11.0	2.4	9.4	7.9	14.1
1994–95	17.7	4.9	1.2	1.5	3.6	1.0	1.7	16.0	8.0	7.6	18.1	18.7
1995–96	5.6	1.3	0.7	1.6	3.8	2.8	3.3	7.9	2.9	16.1	30.3	23.8
1996–97	1.4	2.3	4.4	5.2	7.5	2.6	5.2	13.9	5.7	11.1	11.6	29.1
1997–98	13.7	5.4	6.9	5.7	8.2	6.6	2.6	7.0	5.0	7.9	0.2	30.6
1998–99	3.6	2.0	5.2	1.4	1.2	2.0	1.9	9.1	3.9	10.6	19.1	40.0
1999–00	11.8	2.6	1.2	3.2	3.2	6.6	5.1	7.3	6.3	2.6	15.4	34.6
2000–01	9.4	2.4	1.4	1.1	3.8	2.3	0.6	2.3	13.1	13.8	2.0	47.8
2001–02	7.5	0.3	0.9	1.8	1.0	2.6	1.2	2.4	14.9	23.2	18.2	25.8
Total	10.0	2.7	2.5	2.7	4.0	3.3	3.4	8.7	9.3	14.4	11.8	27.2

Table 10: Percentage of annual blue moki catch from the target blue warehou setnet fishery by statistical area for the main statistical areas comprising the moki fishery for 1989–90 to 2001–02.

Fishing														Statistical area
year	010	011	012	013	014	015	016	017	018	020	022	024	025	026
1989–90	0.6	0.0	0.0	6.2	46.0	3.5	5.0	0.0	30.5	0.6	0.0	4.9	0.0	2.8
1990–91	0.1	0.0	0.0	0.4	49.6	0.1	38.8	0.0	8.9	0.0	0.0	1.3	0.0	0.7
1991–92	1.7	0.0	0.0	1.8	78.4	0.3	16.8	0.0	0.0	0.0	0.0	0.9	0.0	0.0
1992–93	0.2	0.0	0.0	21.8	48.2	6.6	23.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993–94	0.0	0.0	0.0	12.2	55.4	26.0	5.1	0.0	1.3	0.0	0.0	0.1	0.0	0.0
1994–95	0.0	0.0	0.0	8.8	74.5	11.3	3.8	0.0	0.3	0.0	0.0	1.4	0.0	0.0
1995–96	0.0	0.0	0.0	0.9	76.6	9.1	0.2	0.0	12.6	0.0	0.0	0.6	0.0	0.0
1996–97	0.0	0.0	0.0	1.0	73.9	14.0	3.3	0.0	7.9	0.0	0.0	0.0	0.0	0.0
1997–98	0.0	0.0	0.0	0.0	89.2	7.6	2.1	0.0	0.6	0.0	0.0	0.5	0.0	0.0
1998–99	0.0	0.0	0.0	1.0	94.4	0.7	1.8	0.0	1.0	0.0	0.0	1.1	0.0	0.0
1999–00	0.0	0.0	0.0	33.6	61.4	0.4	1.0	0.0	3.5	0.1	0.0	0.0	0.0	0.0
2000–01	0.0	0.0	0.0	47.4	43.2	2.7	2.1	0.0	1.5	0.7	0.0	2.3	0.0	0.0
2001–02	0.0	0.0	0.0	0.0	82.3	1.6	10.4	0.0	2.5	0.0	0.0	3.2	0.0	0.0
Total	0.1	0.0	0.0	13.2	67.2	7.0	7.3	0.0	4.0	0.1	0.0	0.9	0.0	0.1

Table 11: Percentage of annual blue moki catch from the target blue warehou setnet fishery by month from 1989–90 to 2001–02.

Fishing												Month
year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1989–90	3.3	2.5	6.0	7.1	3.1	1.2	26.3	6.6	8.2	11.9	1.2	22.6
1990–91	7.6	3.5	3.9	2.3	1.3	0.2	4.5	32.4	10.7	4.7	0.4	28.6
1991–92	18.1	18.0	6.0	3.9	0.5	0.5	1.2	9.0	16.5	14.6	0.6	11.2
1992–93	4.9	0.7	1.8	2.6	2.5	0.4	0.8	16.8	22.0	29.0	1.9	16.7
1993–94	16.2	5.4	9.6	2.8	1.2	0.0	4.2	10.0	11.6	11.8	1.3	25.9
1994–95	6.2	10.3	8.0	2.8	0.7	0.4	0.5	13.5	10.3	12.2	3.0	32.2
1995–96	25.4	8.8	6.6	7.2	3.7	6.3	3.5	10.3	9.9	2.5	0.4	15.3
1996–97	17.5	7.1	6.8	7.2	6.3	0.7	3.5	16.8	4.1	19.4	2.2	8.3
1997–98	16.3	6.5	5.5	1.0	3.6	5.8	0.1	3.7	15.4	8.1	2.4	31.7
1998–99	18.8	7.0	3.4	4.6	6.8	1.0	0.3	8.5	6.8	6.9	16.6	19.3
1999–00	12.3	5.1	2.9	5.2	5.0	1.0	0.8	5.7	4.3	18.8	13.9	24.9
2000–01	20.7	1.4	6.4	12.6	1.6	0.4	0.0	0.5	0.0	0.3	27.6	28.6
2001–02	14.1	14.9	17.9	10.2	0.2	0.0	0.0	0.0	0.2	8.3	7.3	26.9
Total	14.2	6.0	5.6	4.9	3.3	1.4	2.5	10.2	9.4	12.2	7.5	22.9

Table 12: Percentage of annual blue moki catch from the target tarakihi setnet fishery by statistical area for the main statistical areas comprising the blue moki fishery for 1989–90 to 2001–02.

Fishing	Statistical area													
year	010	011	012	013	014	015	016	017	018	020	022	024	025	026
1989–90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	97.2	0.0	0.0	1.6	0.0	0.0
1990–91	0.0	0.0	0.0	0.0	0.2	0.4	4.4	0.3	93.9	0.0	0.0	0.8	0.0	0.0
1991–92	9.6	0.0	0.0	8.5	0.1	4.8	0.0	2.4	72.4	0.0	0.0	2.2	0.0	0.0
1992–93	1.9	0.0	0.1	17.3	7.0	0.6	0.3	0.2	71.4	0.0	0.0	1.3	0.0	0.0
1993–94	9.5	0.0	0.0	33.4	1.0	0.3	0.0	0.6	54.8	0.0	0.0	0.3	0.0	0.0
1994–95	1.3	0.0	0.0	31.1	1.3	0.1	0.0	0.2	65.6	0.0	0.0	0.4	0.0	0.0
1995–96	0.5	0.0	0.0	25.2	1.7	0.0	0.0	0.1	72.3	0.1	0.0	0.1	0.0	0.0
1996–97	0.6	0.0	0.0	15.2	1.1	0.0	1.2	0.0	81.9	0.0	0.0	0.0	0.0	0.0
1997–98	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.8	0.0	0.0	0.0	0.0	0.0
1998–99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1	95.9	0.0	0.0	0.0	0.0	0.0
1999–00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	99.7	0.0	0.0	0.0	0.0	0.0
2000–01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.9	0.0	0.0	0.0	0.0	0.0
2001–02	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.3	99.3	0.0	0.0	0.0	0.0	0.0
Total	2.6	0.0	0.0	16.0	1.6	0.5	0.4	0.6	77.6	0.0	0.0	0.6	0.0	0.0

Table 13: Percentage of annual blue moki catch from the target tarakihi setnet fishery by month from 1989–90 to 2001–02.

Fishing	Month											
year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1989–90	4.1	3.4	1.1	0.4	0.5	0.9	24.7	53.2	10.2	1.4	0.0	0.2
1990–91	0.0	0.8	1.6	0.8	0.4	2.1	17.2	68.8	7.9	0.5	0.0	0.0
1991–92	10.5	1.3	2.3	5.0	7.2	4.0	29.1	19.3	17.1	2.0	0.0	2.0
1992–93	4.4	2.3	0.2	3.3	0.3	5.7	16.2	44.6	20.3	0.2	0.1	2.4
1993–94	14.1	3.9	8.4	3.3	0.8	1.8	11.6	37.4	11.7	0.1	5.5	1.4
1994–95	3.3	6.9	5.3	4.9	0.6	2.6	14.9	40.2	12.5	8.7	0.0	0.0
1995–96	8.1	5.2	1.7	1.8	1.2	0.4	6.6	51.6	15.2	0.7	5.5	1.9
1996–97	8.5	5.8	2.6	0.6	0.3	0.9	10.5	61.1	8.1	1.2	0.4	0.0
1997–98	0.2	0.0	0.0	0.0	0.0	0.3	14.3	42.6	41.8	0.7	0.0	0.0
1998–99	1.8	0.0	3.8	0.5	2.4	0.0	5.8	45.8	39.3	0.5	0.0	0.0
1999–00	0.0	1.3	1.9	2.3	0.3	0.3	18.8	67.3	7.3	0.2	0.1	0.2
2000–01	0.0	0.1	0.4	0.4	1.4	0.0	23.3	37.0	35.9	1.3	0.0	0.0
2001–02	0.0	0.0	1.2	1.6	0.2	0.0	23.8	70.6	2.4	0.0	0.3	0.0
Total	6.0	3.3	3.0	2.3	1.1	1.9	15.2	47.6	15.5	1.5	1.7	0.9

Table 14: Summary of the five datasets used in standardised CPUE analyses.

					Dataset
	SN MOK	SN WAR	FSU MOK	SN TAR	BT TAR
Variable					
Fishing method	SN	SN	SN	SN	BT
Target species	MOK	WAR	MOK	TAR	TAR
Month	May–October	May–October	May–October	April–June	Aug–Dec
Statistical areas	013 to 016	013 to 016	013 to 016	018	012 to 014
FSU data	No	No	Yes	No	No
Years	1989–2002	1989–2002	1983–1987, 1989–2002	1990–2002	1989–2002
Catch data	Estimated	Estimated	Estimated	Estimated	Landed
Effort	Net length Duration	Net length Duration	Days fished	Net length Duration	Days Duration Trawls
Vessels	Categoric	Categoric	-	Categoric	Categoric
Range checks					
Net length	200–4000	200–4000	200–4000	200–4000	-
Fishing duration	4–48	4–48	-	4–60	3–80
Trip duration	-	-	-	-	1–6
Number of trawls	-	-	-	-	1–20
MOK catch	< 3000	< 2000	1–3000	< 1000	<3000
WAR catch	< 400	< 2000	< 400	-	<600
TAR catch	-	-	-	< 2000	50–15,000
CPUE (moki kg/m)	< 4 kg/m	< 4 kg/m	< 4 kg/m	< 0.4 kg/m	-
Dataset					
No. of records	1,475	1,687	3,082	2,892	1,076
MOK catch (t)	586.4	350.4	1200.4	179.7	203.8
Percent zero MOK catch	3.3	27.3	-	33.6	15.7
No. of core vessels	7	9	-	13	8

Table 15: Number of records and total annual blue moki catch (t) from the main MOK 1 setnet fishery (Statistical areas 013 to 016, May to October) included in the FSU dataset. The total reported landings for blue moki (Annala et al. 2002) and the percentage represented by the FSU dataset is also presented.

Year	FSU data		Total	Percent FSU
	No. records	Catch (t)	catch (t)	
1983	950	208	602	34.6
1984	967	258	766	33.7
1985	585	180	642	28.0
1986	449	179	636	28.1
1987	143	35	109	32.1
1988	48	5	183	2.7

Table 16: Definitions established from declared target fisheries in contemporary data, that were used to assign the principal target species to FSU data records and the number of records for each resultant target fishery.

Target	Records	Definition
SHA	584	Combined SPO and SCH > 500 kg and/or MOK catch less than 80% of the combined MOK, SPO, SCH catch.
TAR	104	MOK catch less than 80% of the combined MOK, TAR catch.
WAR	282	MOK catch less than 80% of the combined MOK, WAR catch.
MOK	1712	All other records

Table 17: Statistics of the distribution of catch of blue moki, blue warehou, tarakihi, and shark (rig and school shark combined) for the four clusters identified from the cluster analysis of FSU setnet data.

Species	Statistic	Cluster			
		1	2	3	4
	No. records	274	579	1066	763
Blue moki	Min	580	1	3	1
	Q25	772	20	200	6
	Median	922	53	300	13
	Mean	1094	64	322	17
	Q75	1268	99	444	26
	Max	2397	198	1233	79
Blue warehou	Min	0	0	0	0
	Q25	0	0	0	0
	Median	0	0	0	0
	Mean	11	6	50	1
	Q75	0	0	80	0
	Max	350	87	391	20
Tarakihi	Min	0	0	0	0
	Q25	0	0	0	0
	Median	0	0	0	0
	Mean	3	2	3	1
	Q75	0	0	0	0
	Max	42	45	49	30
Shark	Min	0	0	0	0
	Q25	0		0	0
	Median	0	20	0	0
	Mean	24	33	33	2
	Q75	37	50	53	0
	Max	180	198	198	25

Table 18: Deemed values ($ per kg) for MOK 1 by fishing year.

Fishing year	Deemed value
1989–90	
1990–91	0.61
1991–92	
1992–93	
1993–94	0.68
1994–95	
1995–96	
1996–97	0.75
1997–98	
1998–99	
1999–00	
2000–01	0.88
2001–02	

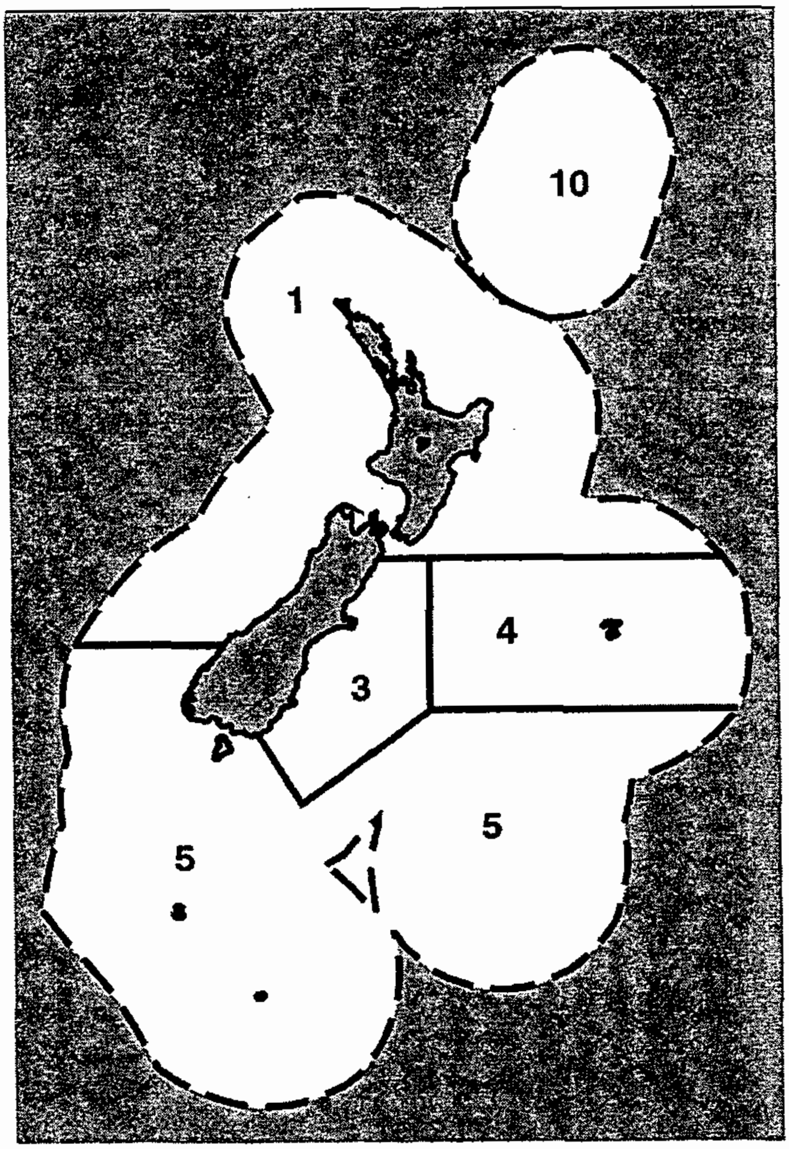


Figure 1: Map of the blue moki fishstock areas (from Annala et al. 2002).

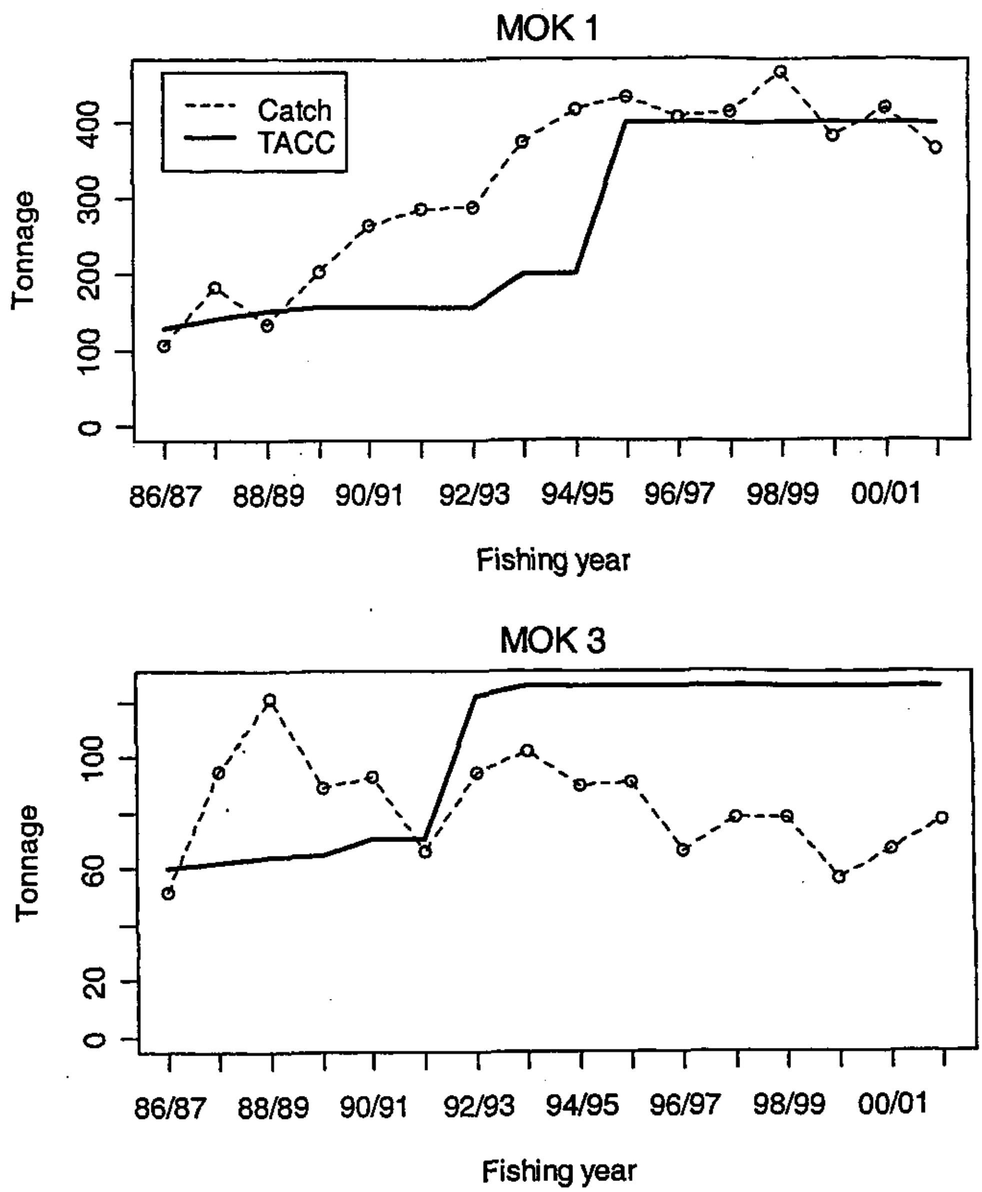


Figure 2: MOK 1 (top) and MOK 3 (bottom) catch and TACCs by fishing year from 1986–87 to 2001–02.

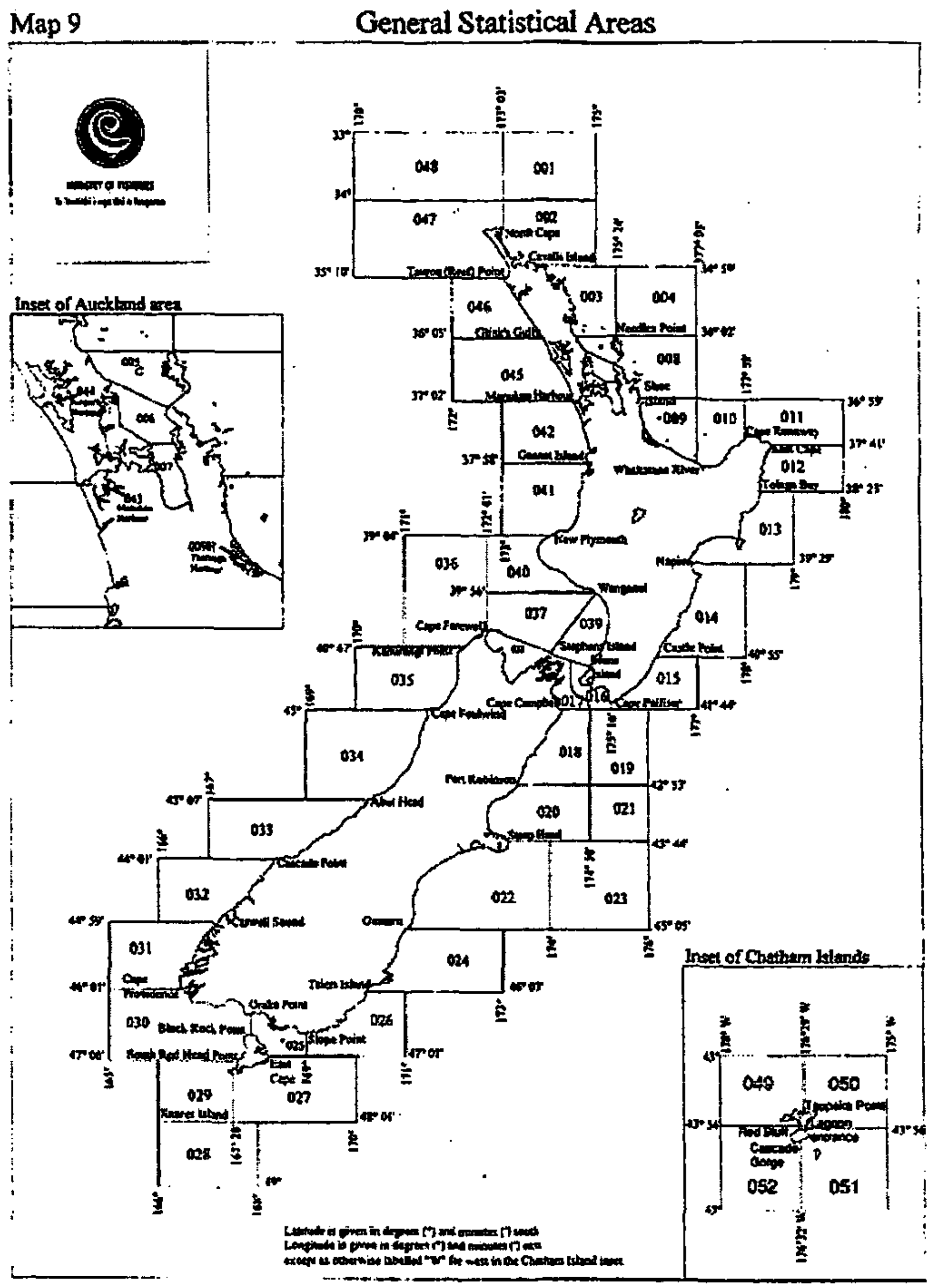


Figure 3: Map of the fishery statistical areas (Source: Ministry of Fisheries Catch Effort reference library).

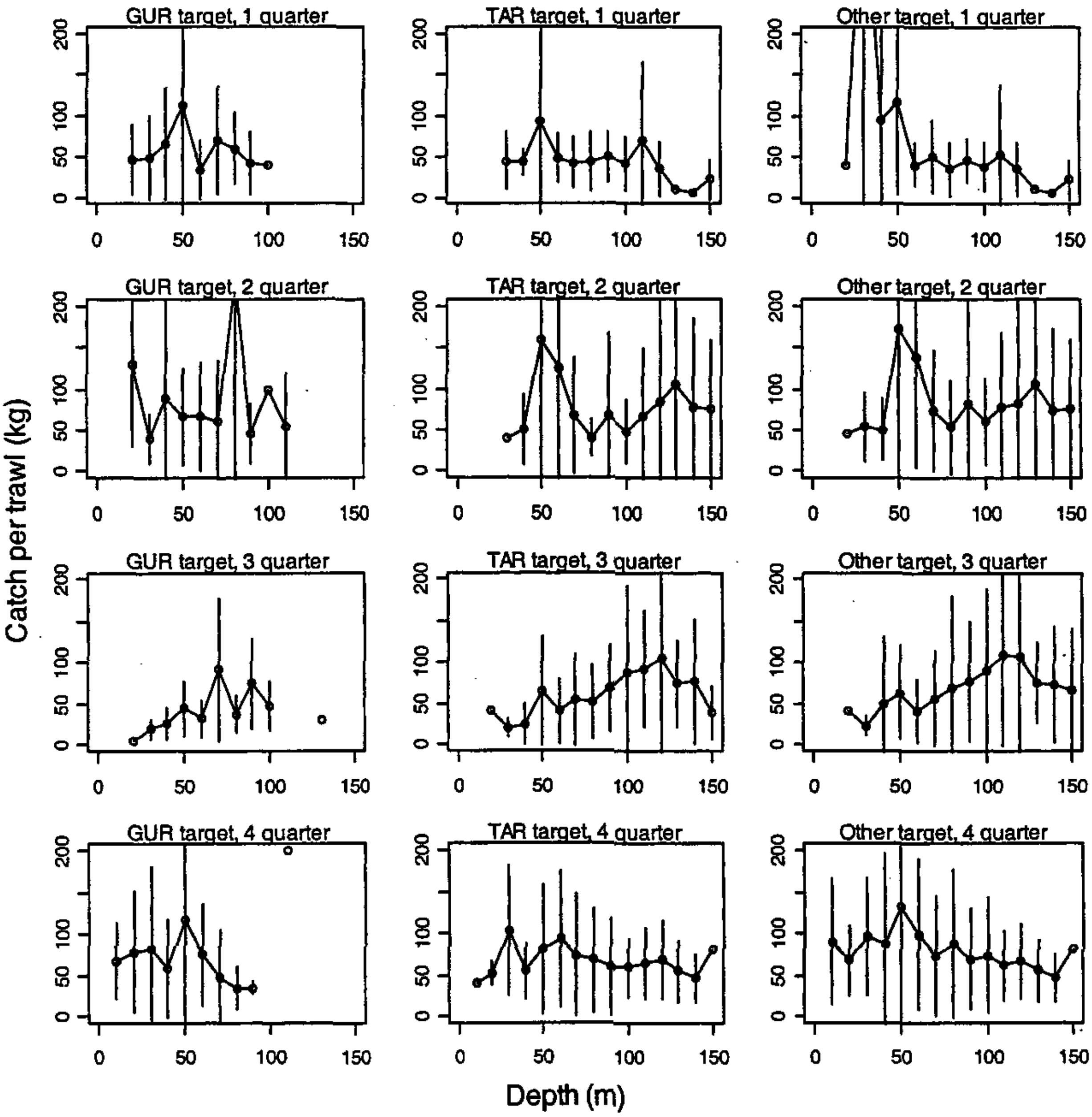


Figure 4: Catch rates (kg per trawl) of blue moki by depth and quarter from the red gurnard (left), tarakihi (centre), and other target trawl fisheries operating in statistical areas 012 to 016 for all years combined (source: MFish TCEPR data). The confidence intervals represent one standard deviation. The year quarters are based on calendar years.

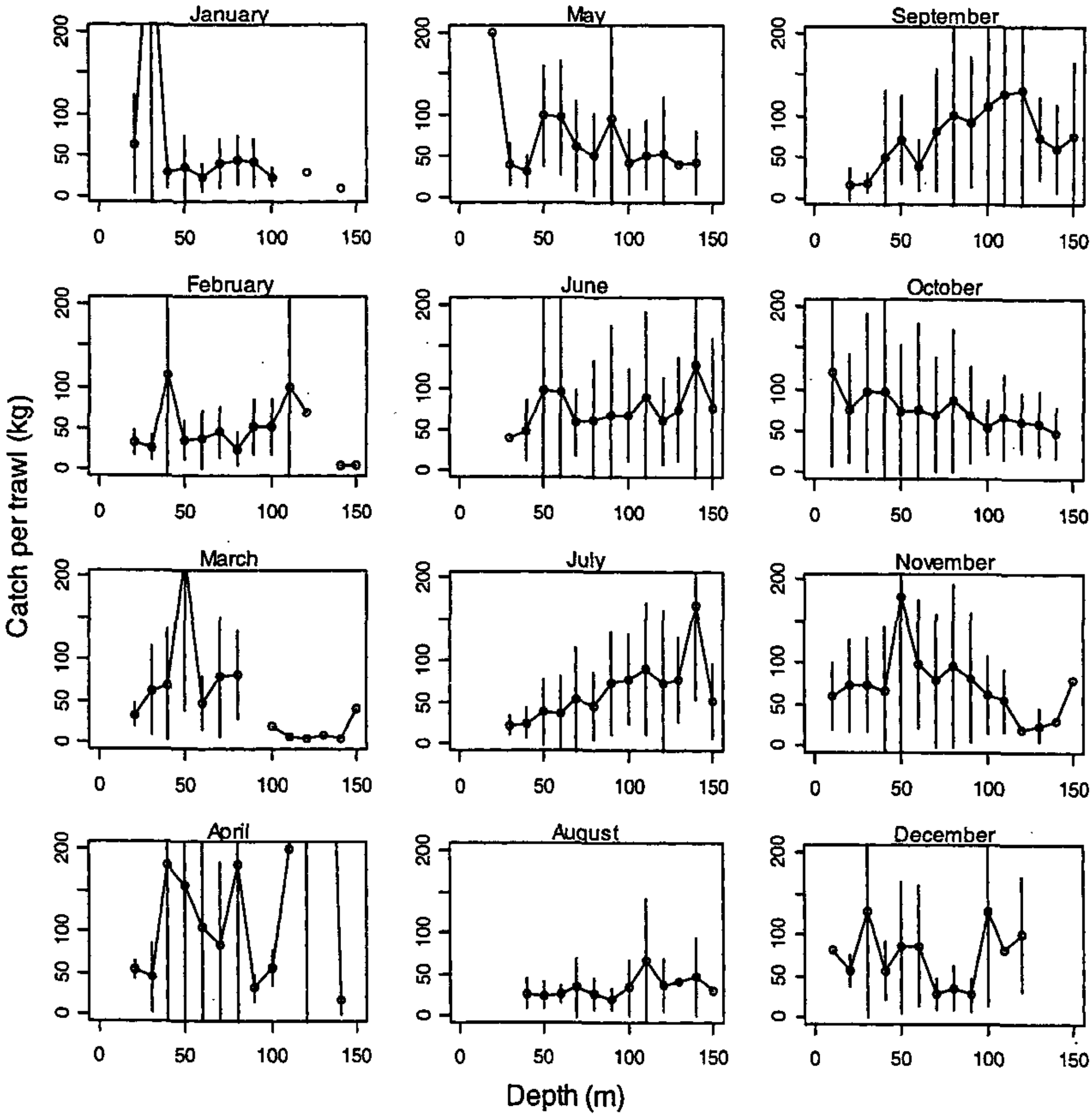


Figure 5: Catch rates (kg per trawl) of blue moki by depth and month from all trawl fisheries operating in statistical areas 012 to 016 for all years combined (source: MFish TCEPR data). The confidence intervals represent one standard deviation.

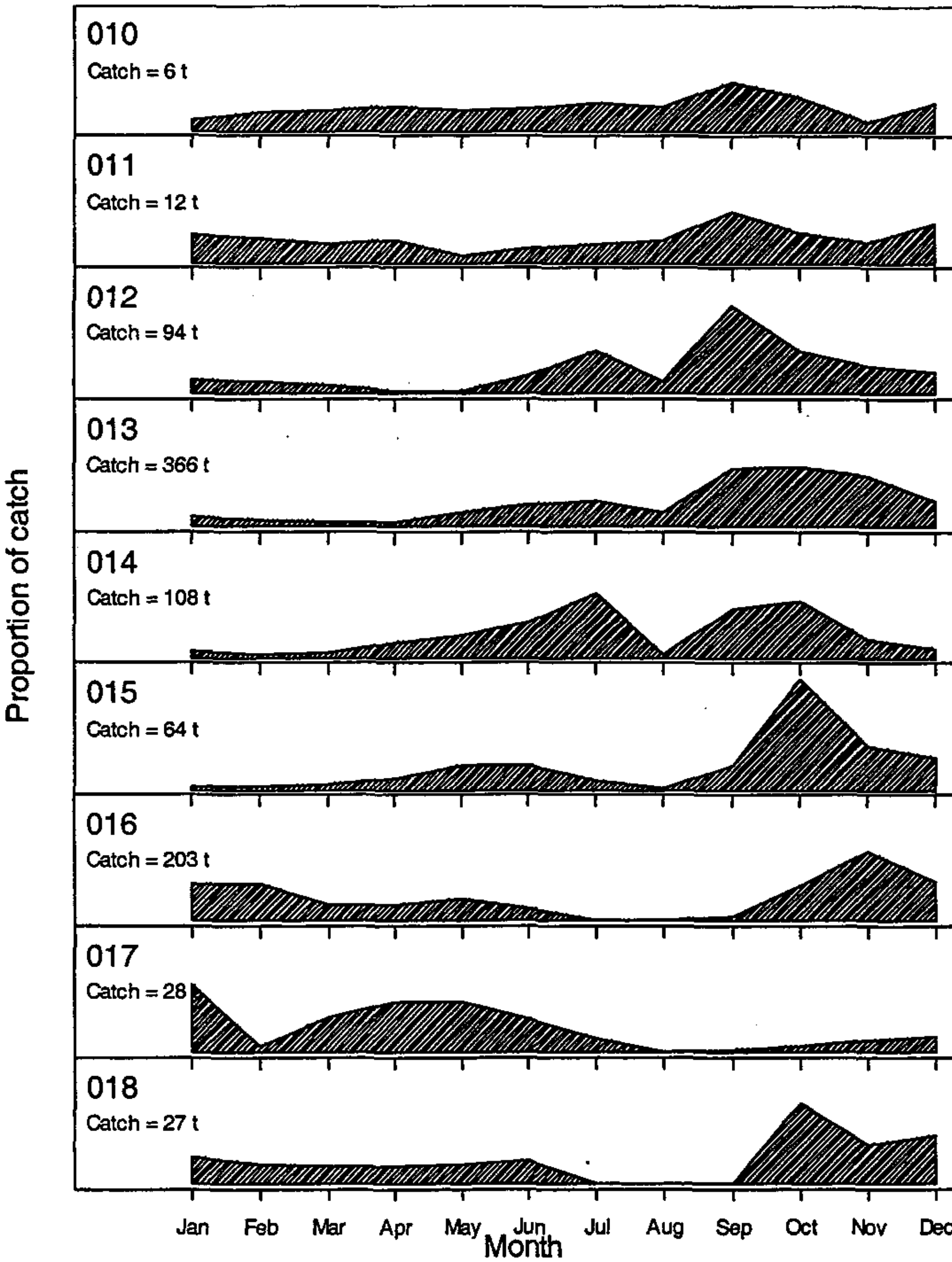


Figure 6: Seasonal distribution of blue moki catch from the tarakihi target bottom trawl fishery for the main statistical areas fished. Catches are aggregated for the 1989–90 to 2001–02 fishing years. The total blue moki catch in each statistical area is also presented.

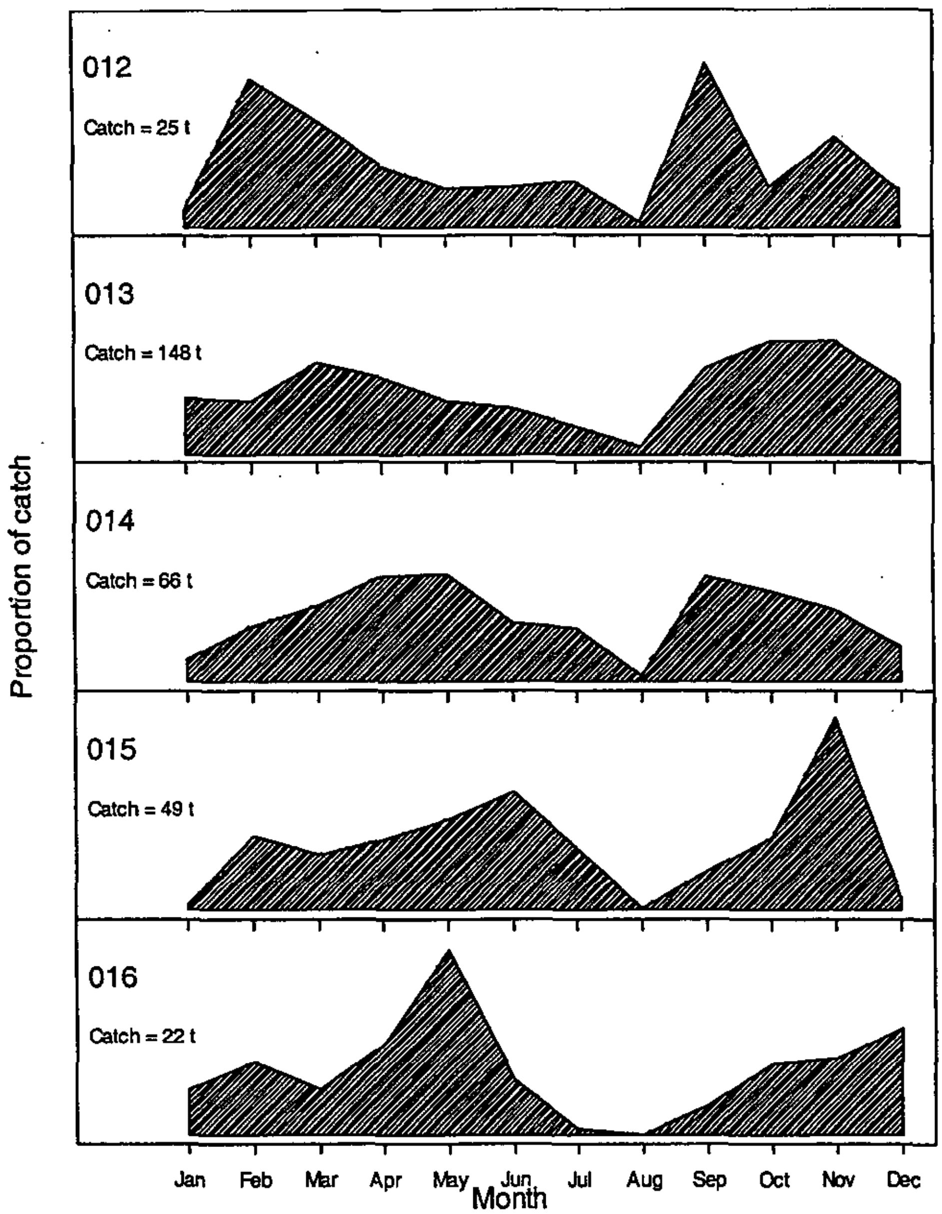


Figure 7: Seasonal distribution of blue moki catch from the red gurnard target bottom trawl fishery for the main statistical areas fished. Catches are aggregated for the 1989–90 to 2001–02 fishing years. The total blue moki catch in each statistical area is also presented.

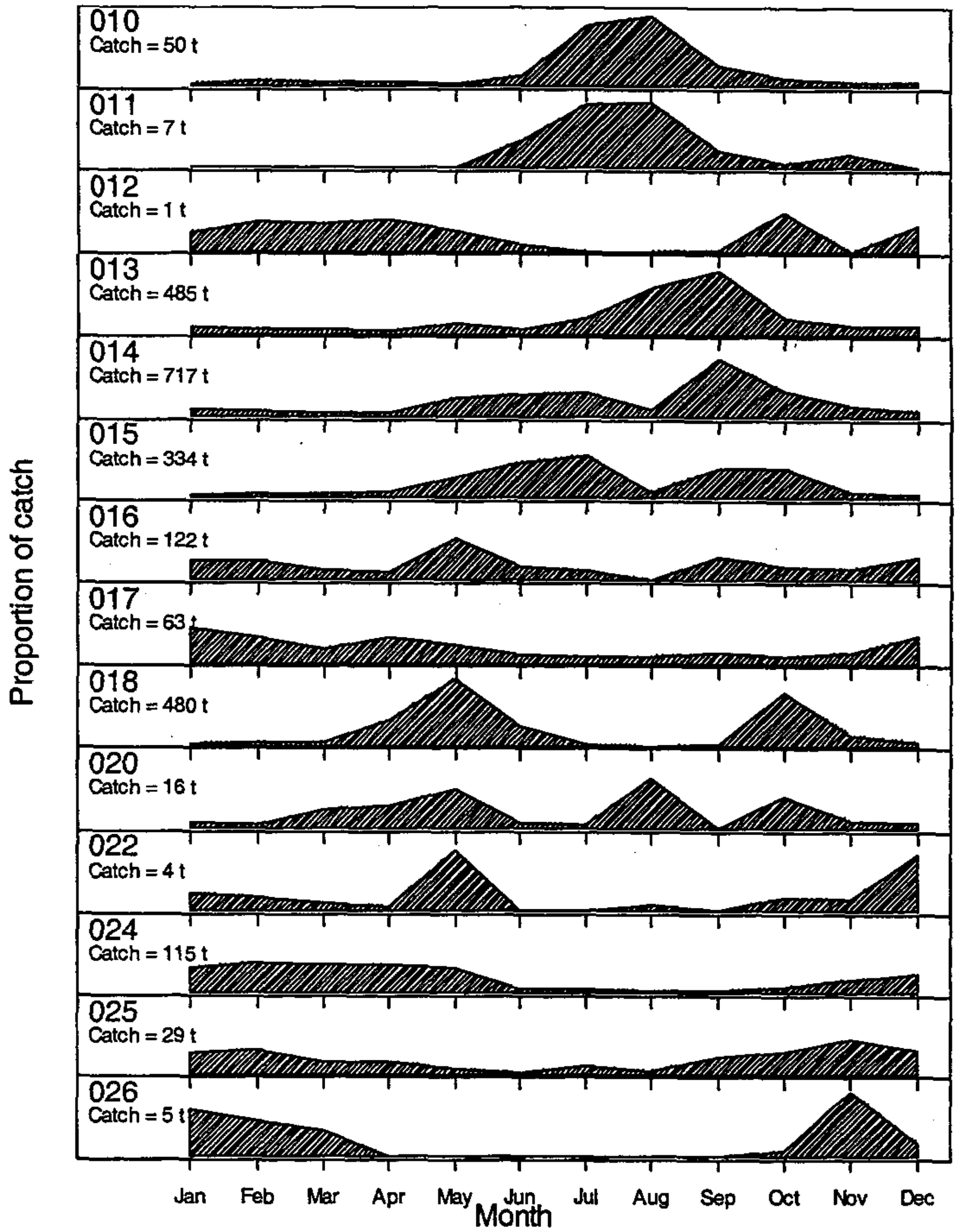


Figure 8: Seasonal distribution of blue moki catch from the setnet fishery (all target species) for the main statistical areas fished. Catches are aggregated for the 1989–90 to 2001–02 fishing years. The total blue moki catch in each statistical area is also presented.

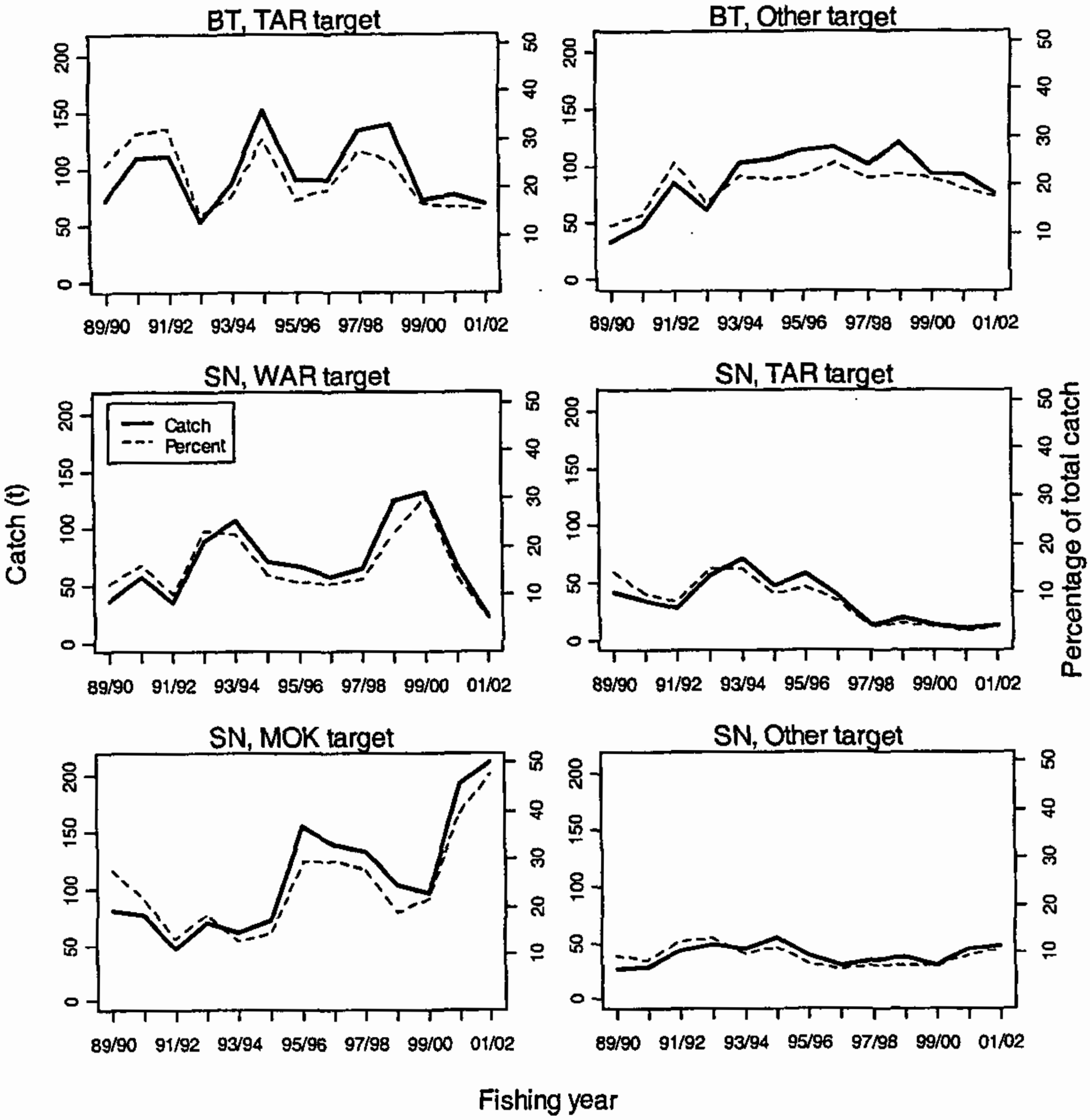


Figure 9: Annual catch estimates (tonnes) and percentage of the total catch by fishing method and target fishery for MOK 1 and MOK 3 combined. The estimates were calculated by applying the annual catch proportions from Table 3 to the QMR totals given in Table 1.

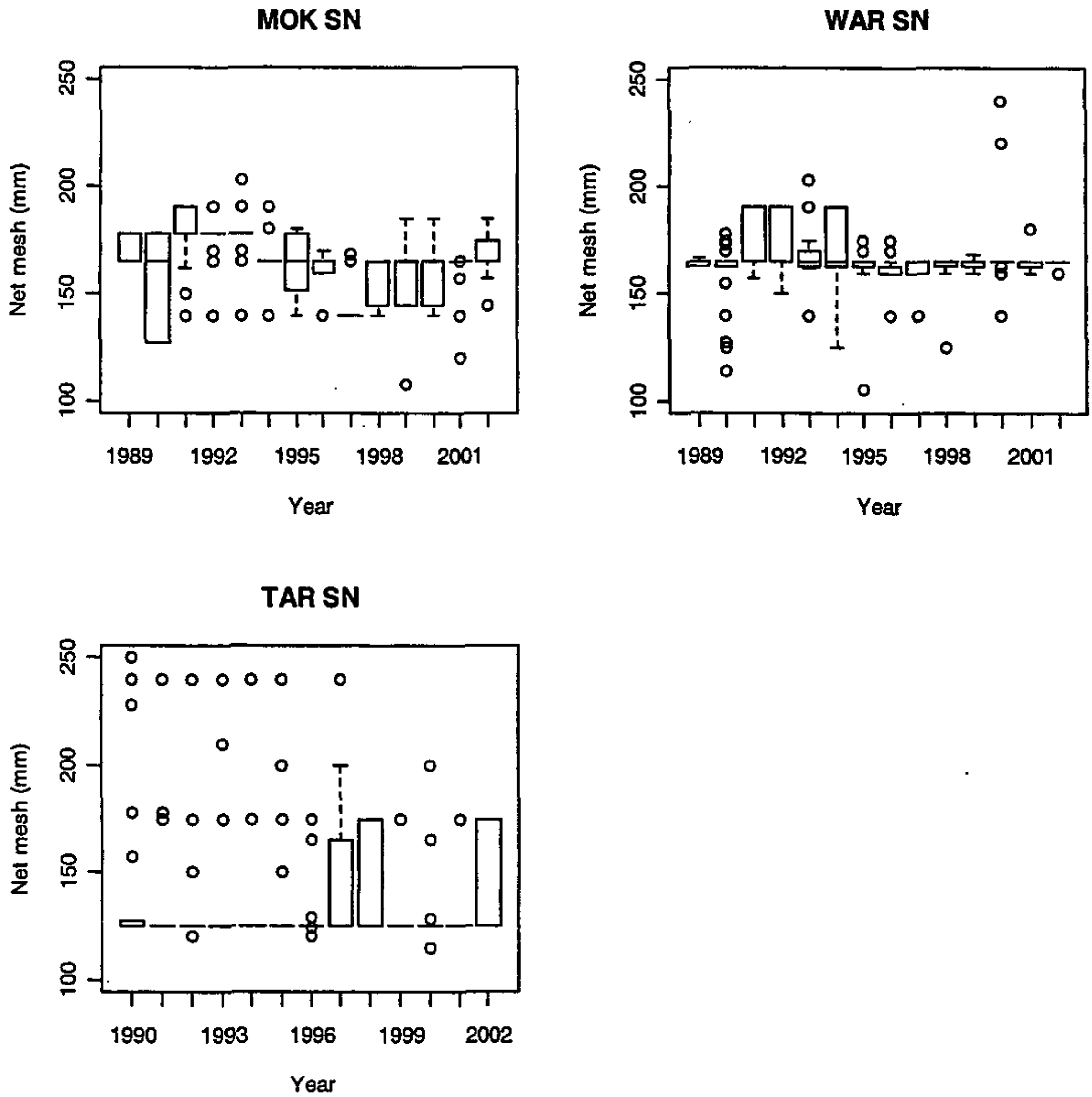


Figure 10: Boxplots of setnet mesh size (mm) for each of the three setnet datasets. The lower and upper boundaries of the box represent the inter-quartile range of the data, the line inside the box represents the median value, the whiskers represent 1.5 times the inter-quantile range, and the points represent the outliers beyond 1.5 times the inter-quantile range.

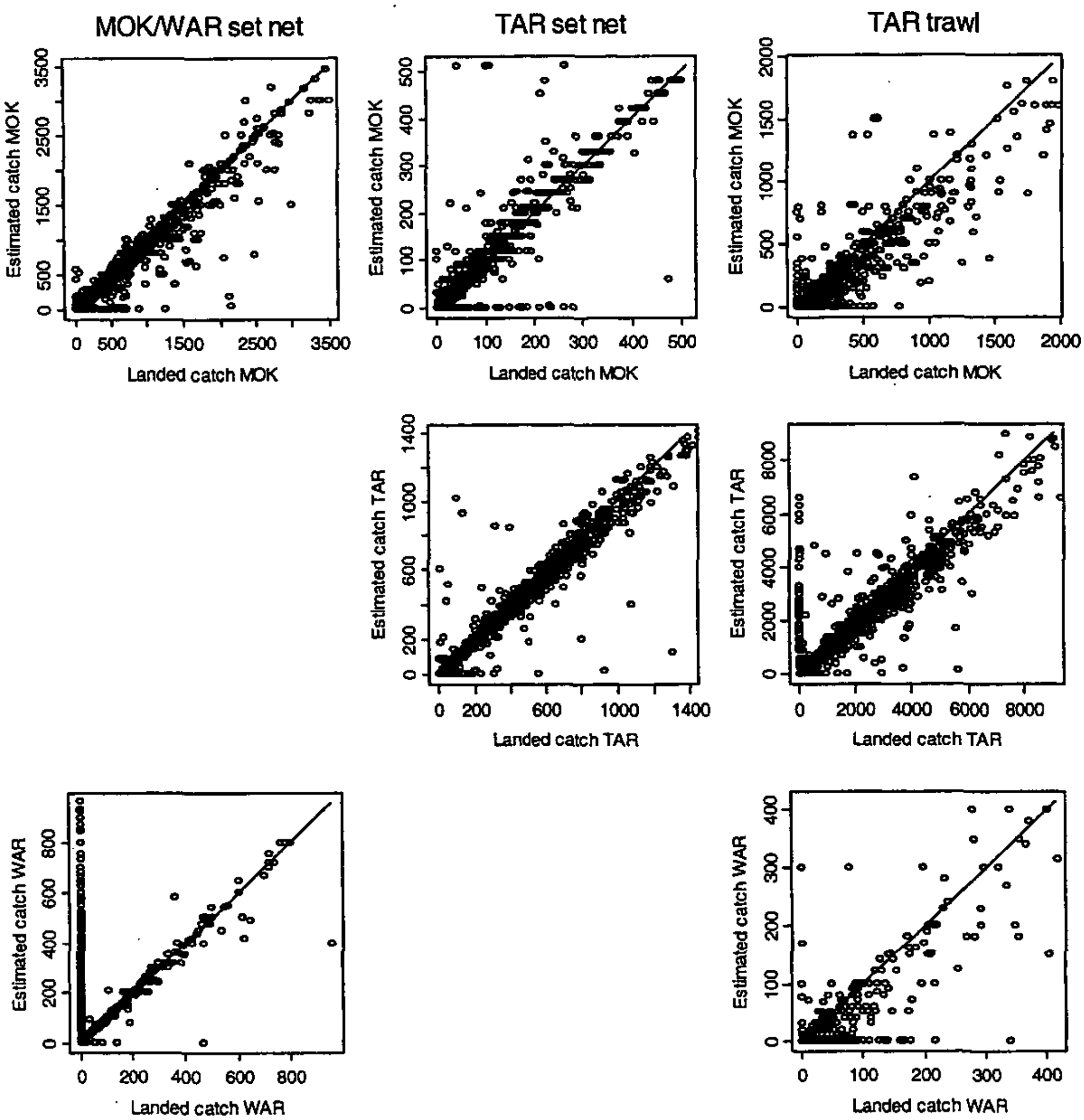


Figure 11: Comparison of total estimated and landed catch for the main species from individual fishing trips from the the blue moki/blue warehou setnet fishery (column 1), tarakihi setnet fishery (column 2), and the tarakihi bottom trawl fishery (column 3). The definitions of each fishery are given in Table 14. The solid line represents unity.

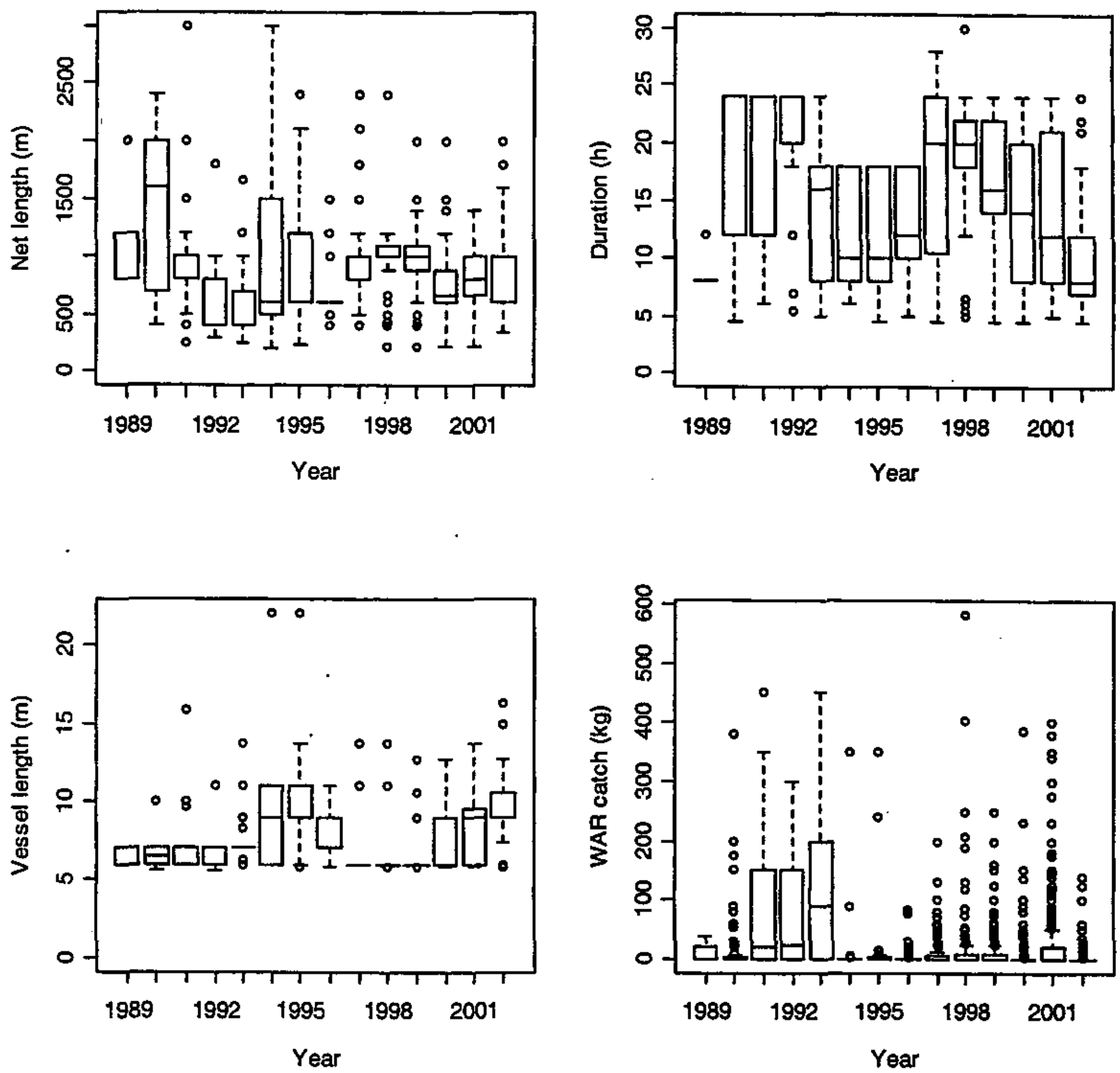


Figure 12: Annual distributions of the main variables included in the *Target MOK* CPUE dataset. The lower and upper boundaries of the box represent the inter-quartile range of the data, the line inside the box represents the median value, the whiskers represent 1.5 times the inter-quantile range, and the points represent the outliers beyond 1.5 times the inter-quantile range.

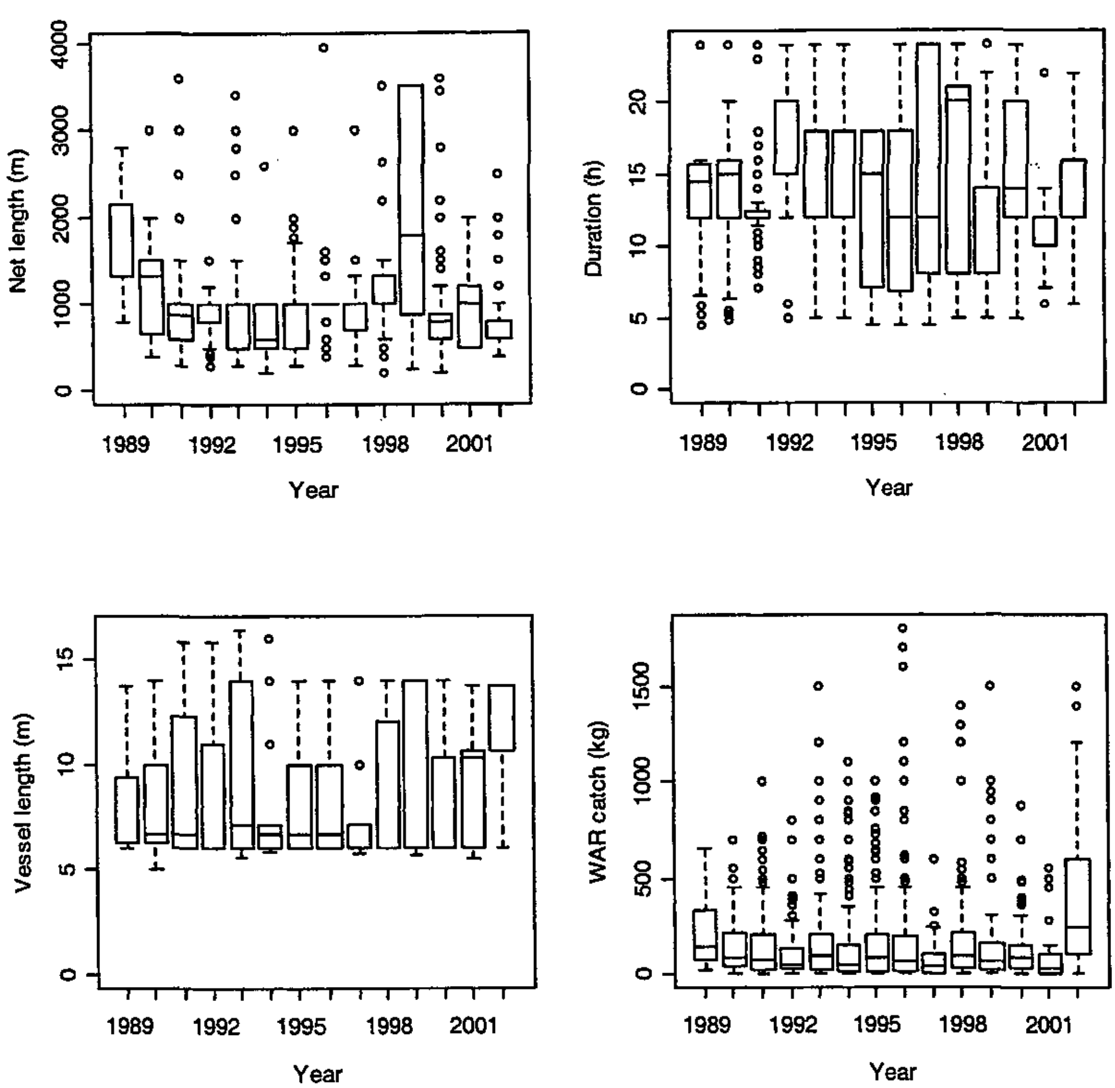


Figure 13: Annual distributions of the main variables included in the *Target WAR* CPUE dataset. The lower and upper boundaries of the box represent the inter-quartile range of the data, the line inside the box represents the median value, the whiskers represent 1.5 times the inter-quantile range, and the points represent the outliers beyond 1.5 times the inter-quantile range.

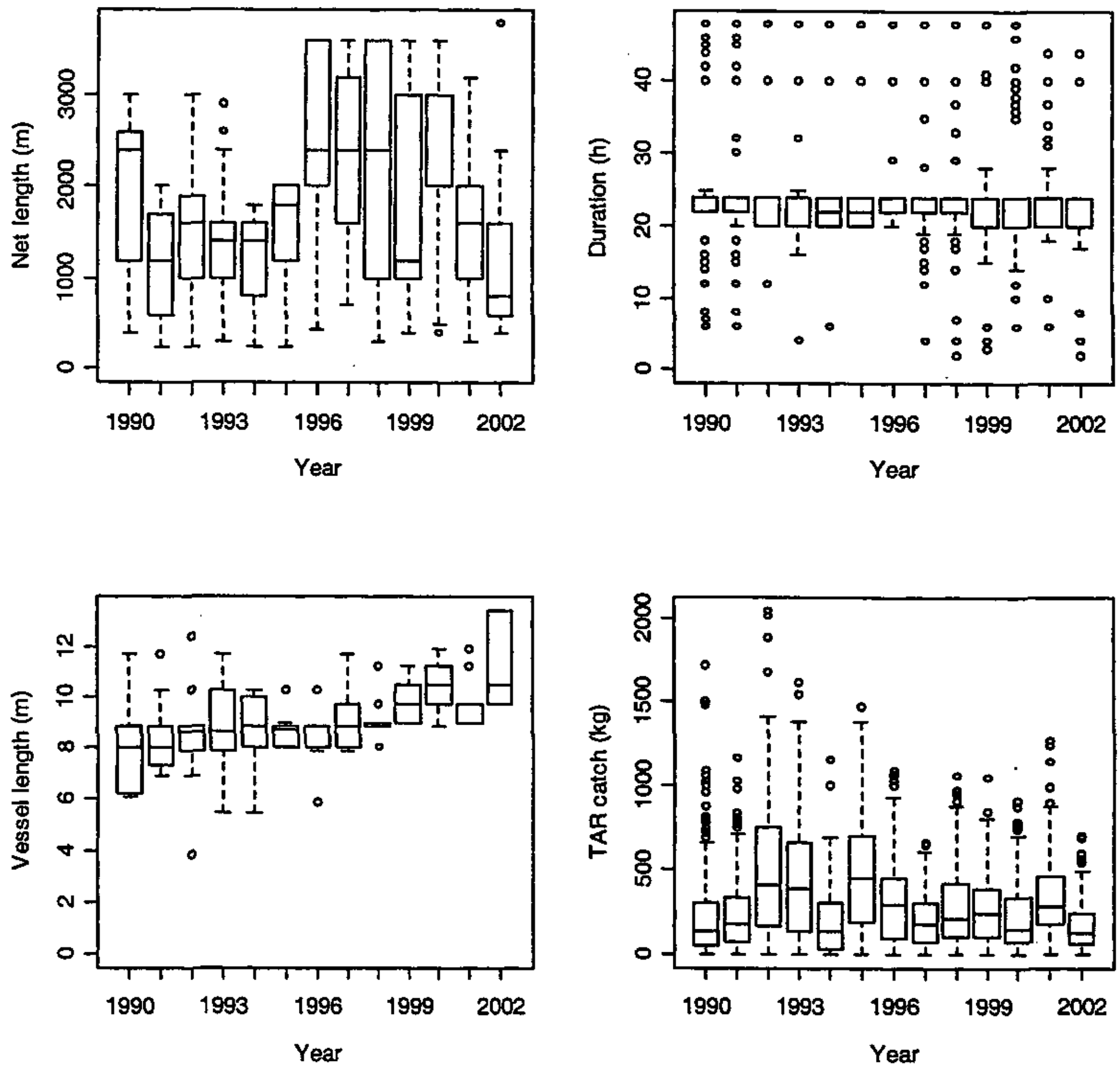


Figure 14: Annual distributions of the main variables included in the *SN TAR* CPUE dataset. The lower and upper boundaries of the box represent the inter-quartile range of the data, the line inside the box represents the median value, the whiskers represent 1.5 times the inter-quantile range, and the points represent the outliers beyond 1.5 times the inter-quantile range.

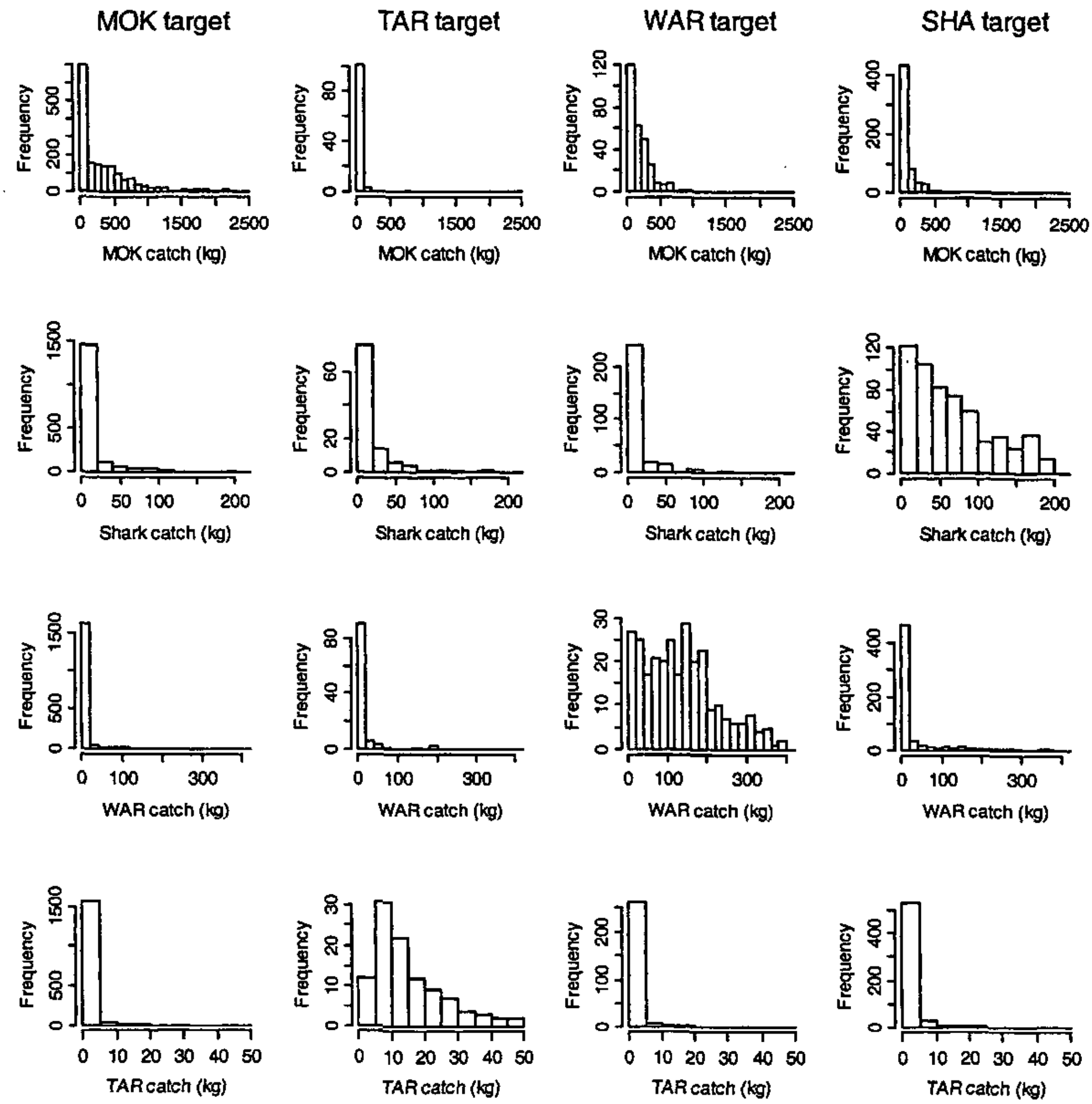


Figure 15: Histograms of the catch of blue moki (MOK), shark (rig and school shark combined), blue warehou (WAR), and tarakihi (TAR) for each of the four fishery groups (columns) qualitatively defined from the FSU setnet data (as per Table 16) from the main blue moki fishery (statistical areas 013 to 016, May to October) from 1983 to 1988 combined.

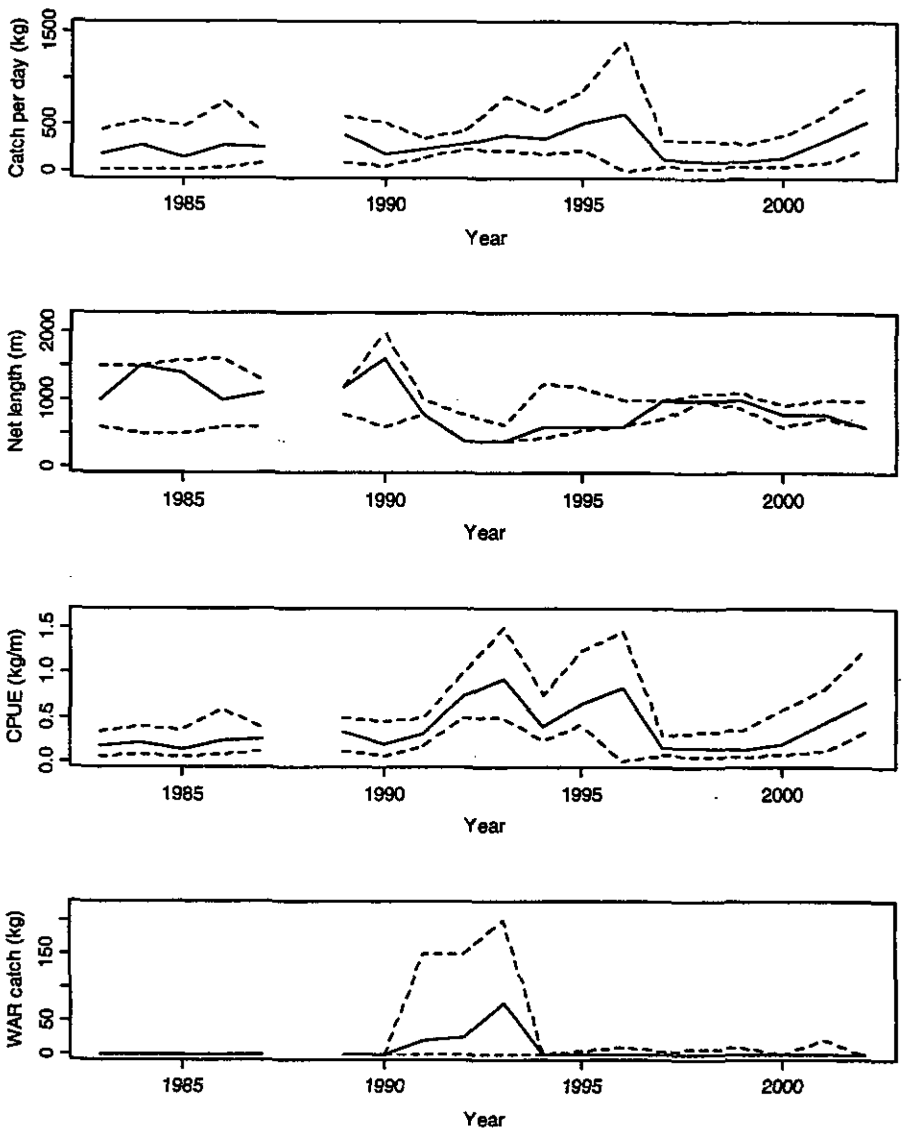


Figure 16: Annual trends in blue moki catch (kg), effort (net length), catch rate (kg/m), and blue warehou catch from the blue moki target setnet fishery from 1983 to 2002 (calendar years). The target fishery is defined as the fishery operating in statistical areas 013 to 016 from May to October. For FSU data (pre 1988), target species was designated based on catch composition (see section Error! Reference source not found.**), while target species was recorded for more recent data. The solid line represents the median value and the dashed lines are the 25% and 75% quantiles.**

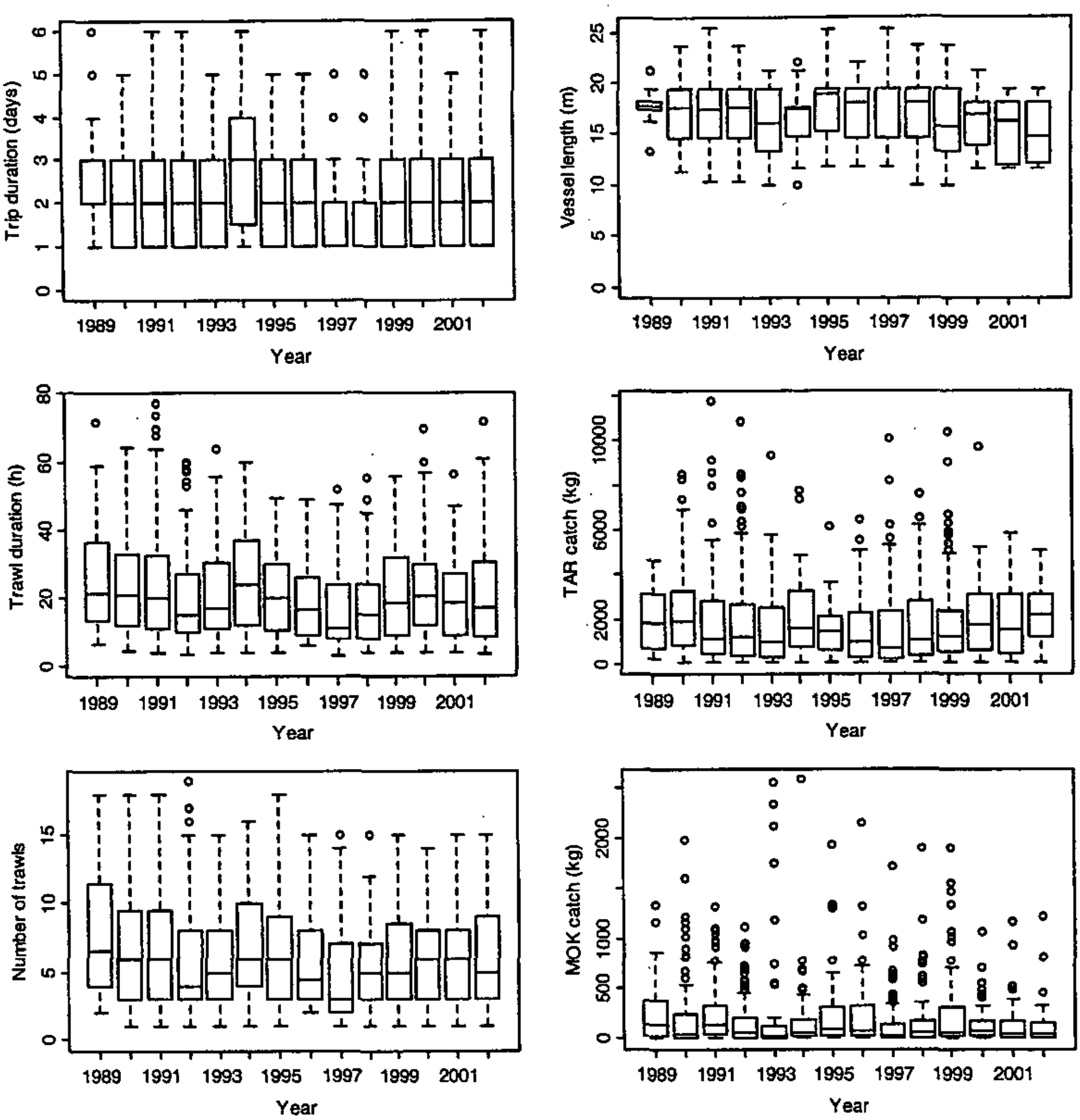


Figure 17: Annual distributions of the main variables included in the *BT TAR* CPUE dataset. The lower and upper boundaries of the box represent the inter-quartile range of the data, the line inside the box represents the median value, the whiskers represent 1.5 times the inter-quantile range, and the points represent the outliers beyond 1.5 times the inter-quantile range.

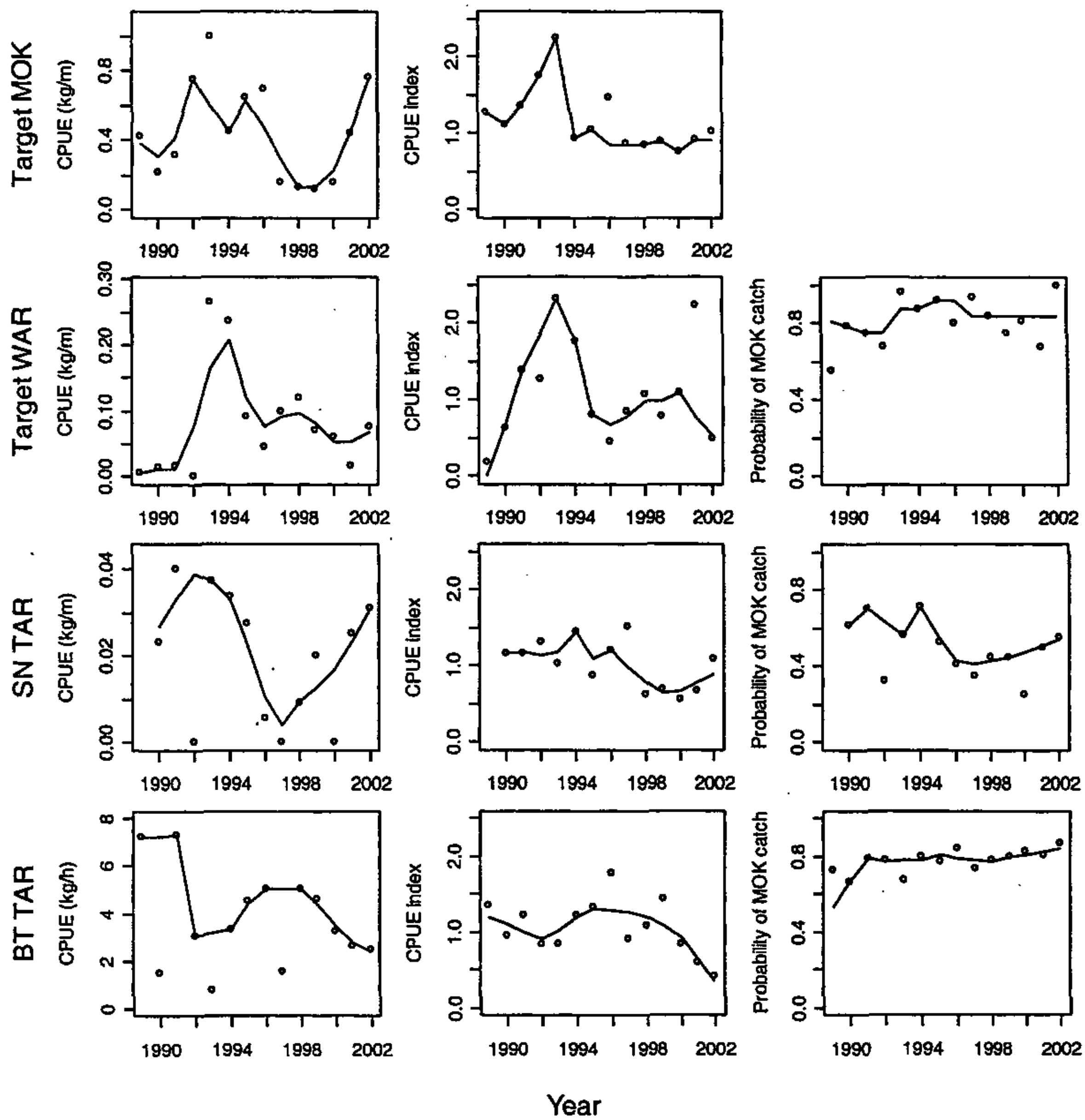


Figure 18: Annual CPUE indices for the blue moki CPUE datasets (rows) for 1989 to 2002. The columns represent the median unstandardised CPUE for the year (column 1), the loglinear standardised indices (column 2), and the negative binomial indices (column 3). The line represents the lowess smoothed fit to the annual indices.

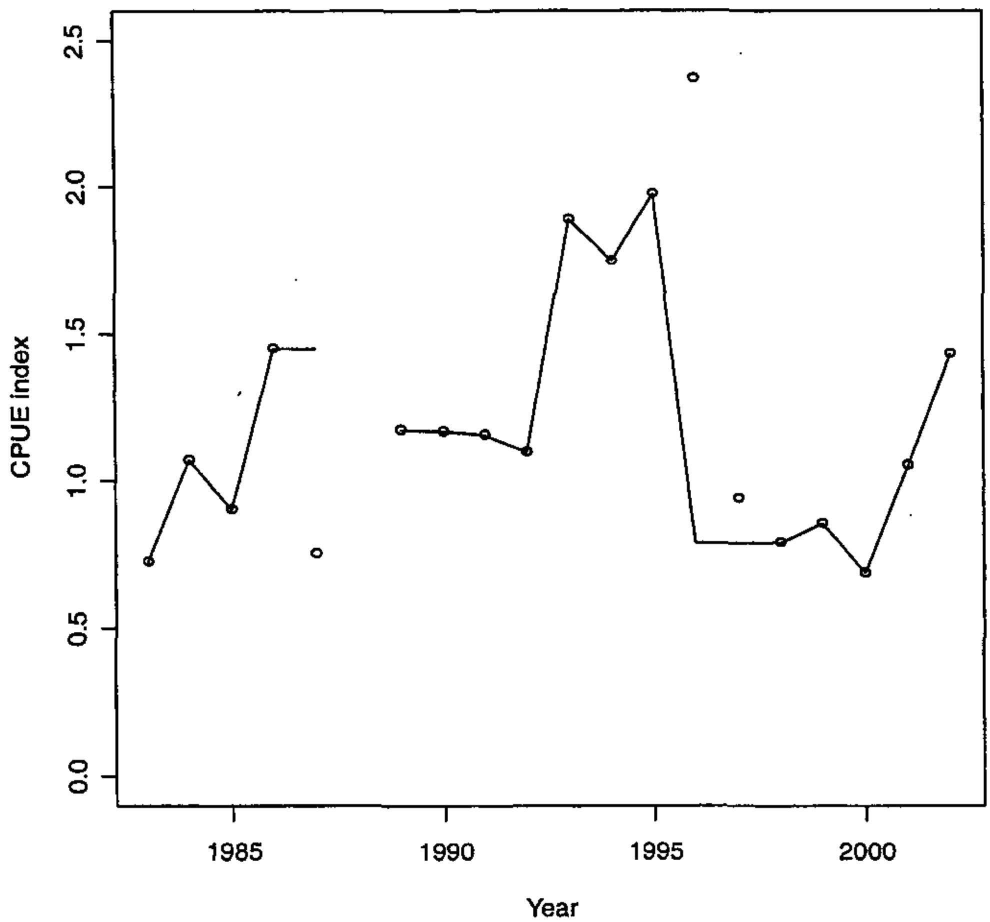


Figure 19: The annual standardised CPUE indices from the combined FSU and CELR data from the main blue moki setnet fishery (FSU MOK dataset). The line represents the lowess smoothed fit to the annual indices.

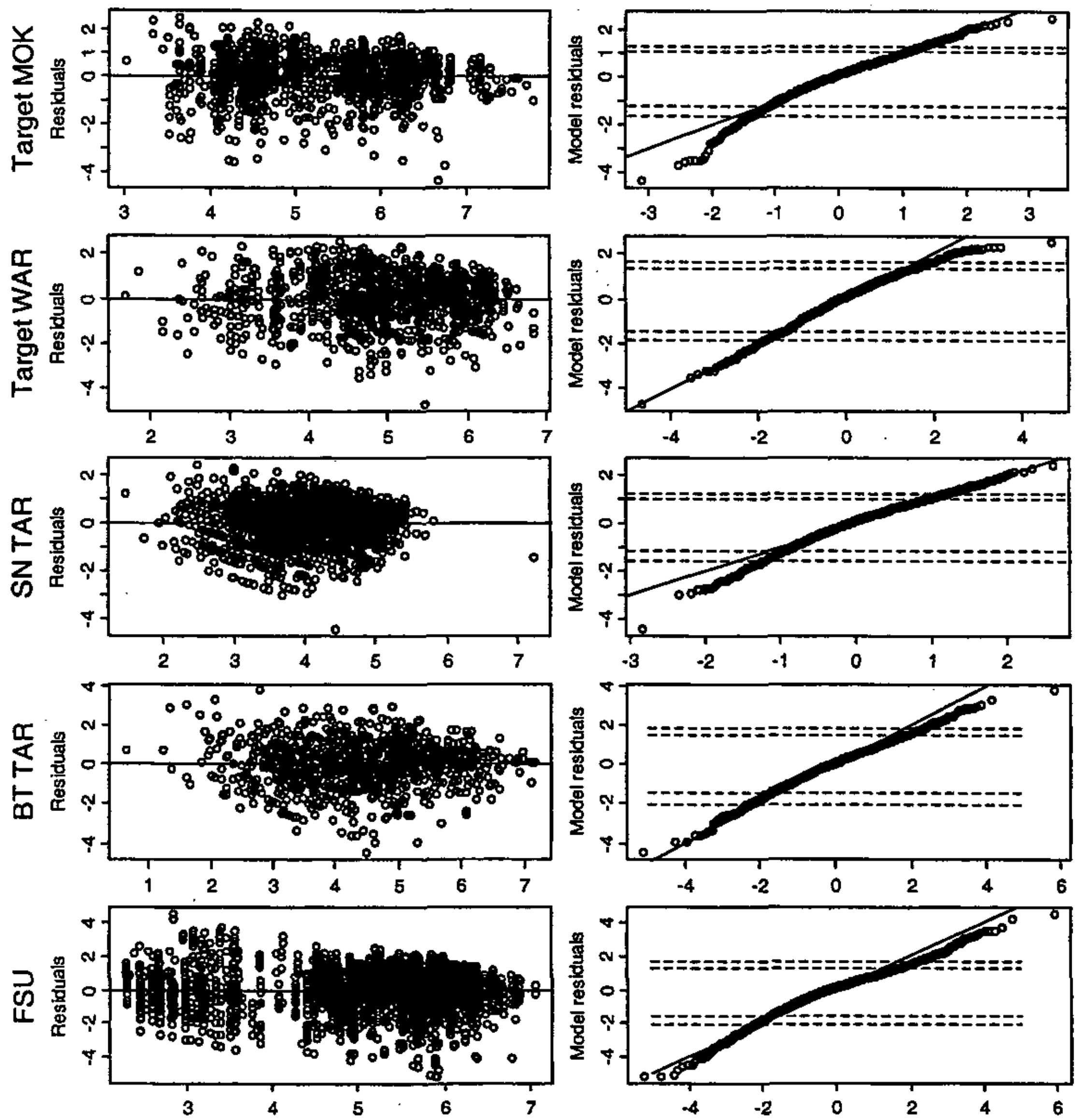


Figure 20: The distribution of model against the fitted values (left column) and the quantile-quantile plot (right column) for each of the five loglinear CPUE models (rows). The dashed lines of the quantile-quantile plots represent the location of the 5%, 10%, 90%, and 95% quantiles of the model residuals.

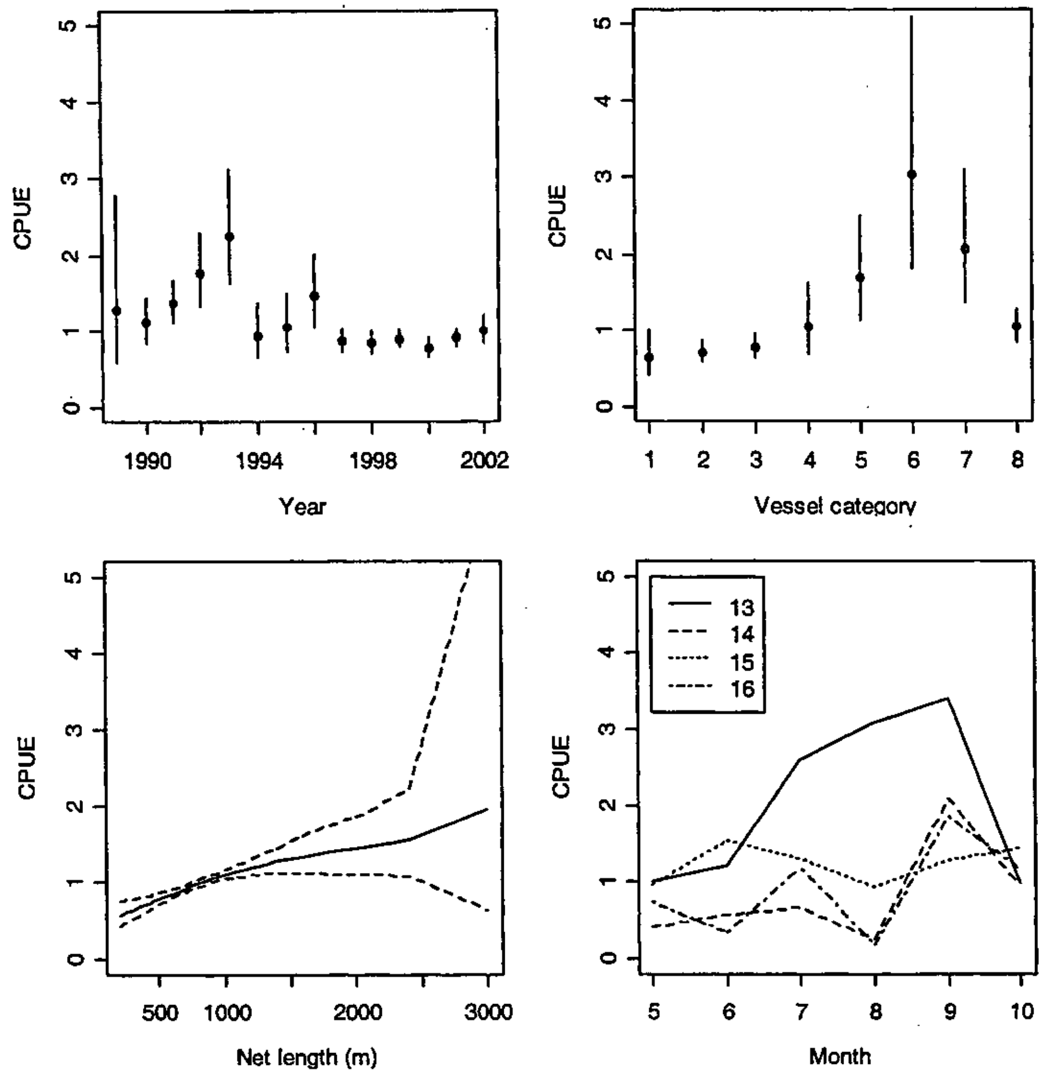


Figure 21: The predicted relationship between blue moki catch and the significant variables included in the MOK target loglinear CPUE model. The confidence intervals represent +/- 2 standard error. The month effects are plotted for each statistical area included in the month*statistical area interaction term.

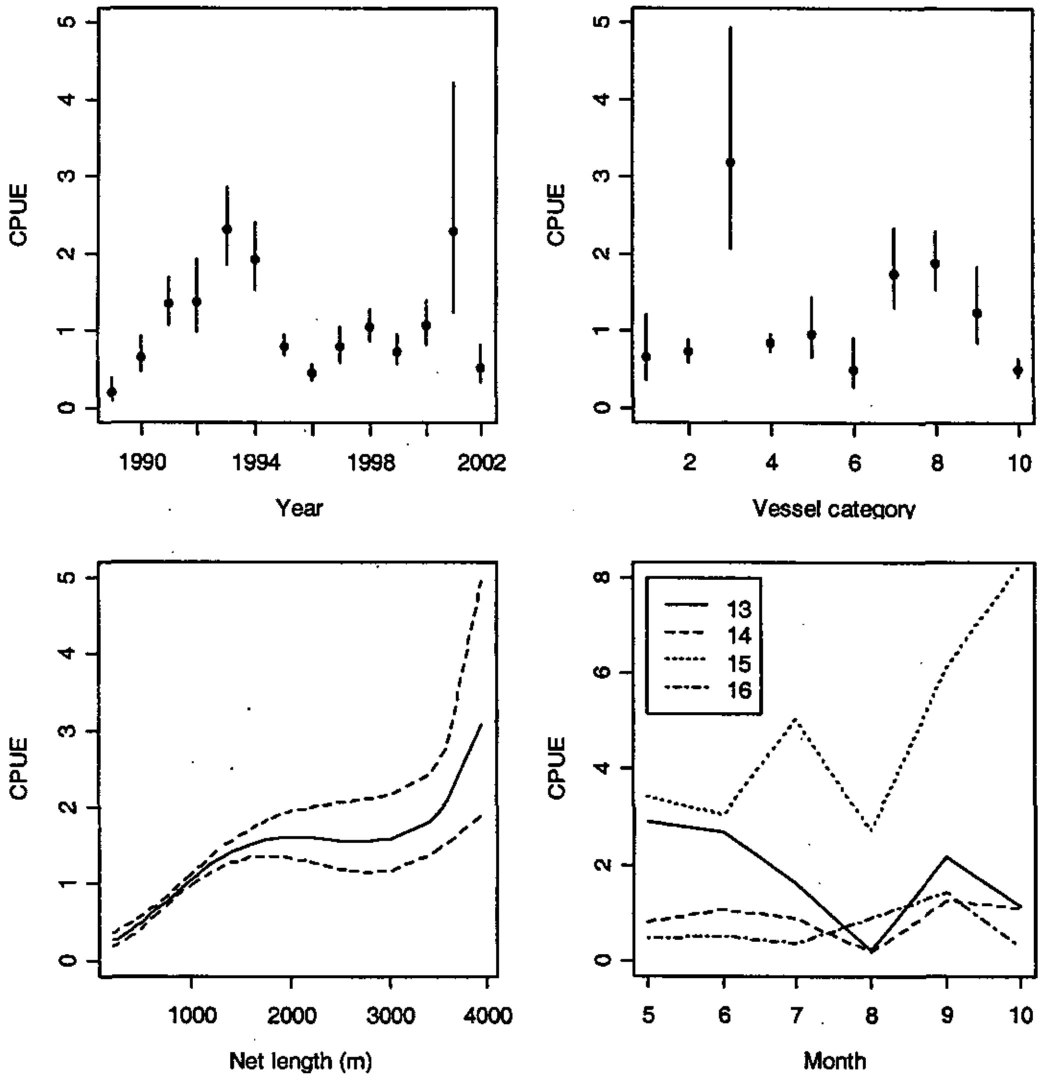


Figure 22: The predicted relationship between blue moki catch and the significant variables included in the WAR target loglinear CPUE model. The confidence intervals represent +/- 2 standard error. The month effects are plotted for each statistical area included in the month*statistical area interaction term.

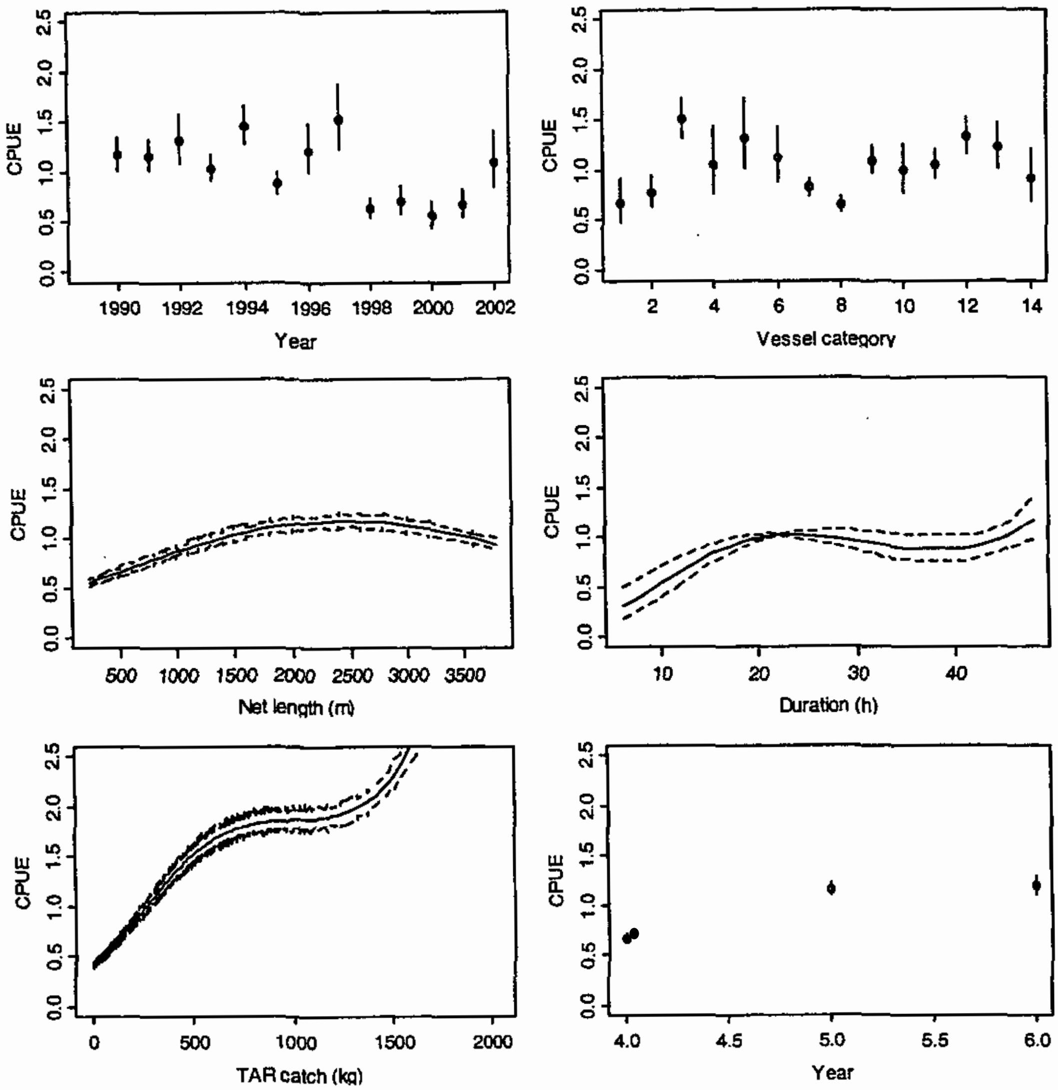


Figure 23: The predicted relationship between blue moki catch and the significant variables included in the TAR SN loglinear CPUE model. The confidence intervals represent +/- 2 standard error.

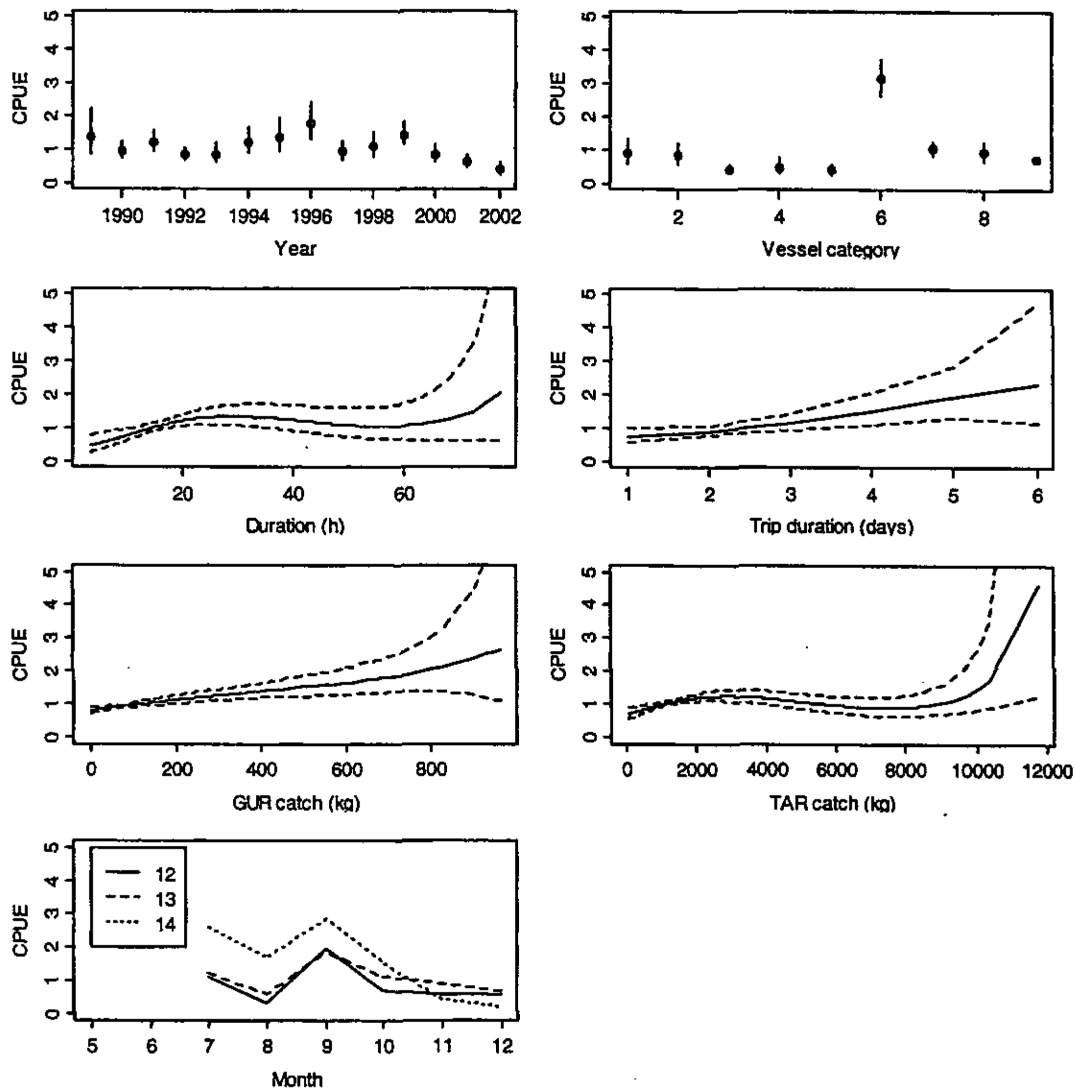


Figure 24: The predicted relationship between blue moki catch and the significant variables included in the TAR BT loglinear CPUE model. The confidence intervals represent +/- 2 standard error. The month effects are plotted for each statistical area included in the month*statistical area interaction term.

Appendix A. Individual model fits

Table A1: Variables included in the stepwise regression of the loglinear MOK target CPUE model.

Variable	% R^2 at iteration				
	1	2	3	4	5
Duration	11.16	46.28	48.33	50.11	51.21
Net length	3.29	46.79	49.18	51.19	
WAR catch	0.76	45.48	48.32	50.40	51.54
Statistical area	29.56				
Month	11.20				
Stat. Area*month	45.21				
Year	15.73	46.97	50.10		
Vessel category	31.10	48.14			
Percent improvement		6.47	4.08	2.19	NS

Table A2: Variables included in the stepwise regression of the loglinear WAR target CPUE model.

Variable	% R^2 at iteration				
	1	2	3	4	5
Duration	6.42	22.80	34.43	41.76	45.70
Net length	7.27	27.04	36.76	45.52	
WAR catch	2.56	23.48	34.95	42.36	45.85
Statistical area	1.59				
Month	15.04				
Stat. Area*month	18.88				
Year	10.55	26.50	41.53		
Vessel category	17.38	34.30			
Percent improvement		81.70	21.06	9.61	NS

Table A3: Variables included in the stepwise regression of the negative binomial WAR target CPUE model.

Variable	% of null deviance at iteration				
	1	2	3	4	5
Duration	2.57	7.91	10.26	12.09	
Net length	5.20	9.82			
WAR catch	0.24	7.05	10.02	12.03	12.37
Statistical area	5.41				
Month	4.52				
Stat. Area*month	6.99				
Year	3.68	8.38	11.77		
Vessel category	4.33	8.34	8.96	10.04	10.06
Percent improvement		40.58	19.90	2.71	2.26

Table A4: Variables included in the stepwise regression of the loglinear TAR SN CPUE model.

Variable	% R^2 at iteration					
	1	2	3	4	5	6
Duration	1.14	21.80	31.91	36.19	40.43	
Net length	10.56	23.73	31.78	35.83	40.71	41.45
WAR catch	20.91					
Month	6.08	24.92	34.99	39.56		
Year	7.52	28.76	35.24			
Vessel category	17.38	30.90				
Percent improvement		47.75	14.05	12.26	2.89	1.82

Table A5: Variables included in the stepwise regression of the negative binomial TAR SN CPUE model.

Variable	% of null deviance at iteration					
	1	2	3	4	5	6
Duration	0.06	2.50	6.29	9.43	9.99	10.20
Net length	0.48	2.69	7.24	9.66	10.20	
WAR catch	2.61	5.08	9.41			
Month	0.88	4.01	7.23	9.99		
Year	2.92	6.21				
Vessel category	2.49					
Percent improvement		112.86	51.57	6.13	2.15	NS

Table A6: Variables included in the stepwise regression of the loglinear TAR BT CPUE model.

Variable	% R^2 at iteration							
	1	2	3	4	5	6	7	8
Number of trawls	11.81	27.53	28.57	35.58	39.54	41.43	42.15	43.04
Number of days	9.91	27.40	28.76	36.05	40.09	41.99		
Total trawl duration	9.69	27.80						
GUR est.	6.42	23.13	30.56	37.57	40.95			
TAR land	11.04	22.10	28.89	35.77	39.69	42.00	42.91	
WAR land	1.42	18.37	28.89	35.40	39.33			
Month	5.40	22.58	34.77	34.77	34.77	41.57	42.46	43.30
Statistical area	1.29	15.79	27.84	34.79	39.06	41.25	42.33	43.27
Year	6.21	21.13	32.41	38.77				
Vessel category	15.69							
Percent improvement		77.15	25.05	11.51	5.64	2.56	2.16	NS

Table A7: Variables included in the stepwise regression of the negative binomial TAR BT CPUE model.

Variable	% of null deviance at iteration							
	1	2	3	4	5	6	7	8
Number of trawls	2.02	7.97	10.35	12.71	13.13	13.33	13.56	
Number of days	1.62	7.72	10.12	12.48	12.96	13.42		
Total trawl duration	1.65	8.20	10.51	12.82	13.23			
GUR est.	0.37	7.54	9.99	12.34	12:91	13.26	13.45	13.59
TAR land	2.74	8.15	10.42	12.80	13.23	13.31	13.54	13.66
WAR land	1.46	8.28	10.54	12.84				
Month	1.14	8.77						
Statistical area	0.18	7.42						
Stat. Area*month	2.88	9.84						
Year	3:19	9.63	12.24					
Vessel category	7.40							
Percent improvement		32.98	24.38	4.94	3.03	1.44	1.03	NS

Table A8: Variables included in the stepwise regression of the loglinear FSU MOK CPUE model.

Variable	% R^2 at iteration		
	1	2	3
Stat. Area*month	44.71		
Statistical area	37.63		
Month	3.38		
Year	7.82	47.39	
WAR catch	0.78	44.83	47.51
Percent improvement		5.99	NS

Appendix 2a. Copy of CELR form without template (Source: Ministry of Fisheries Catch Effort reference library).

Catch, Effort and Landing Return

Trip Data

First day of trip	Last day of trip (if different from first day of trip)	Landing date	Vessel registration number	Vessel name	Vessel registration number of other vessel (if pair fishing)	Point of landing	Page	of
/ /	/ /	/ /						

Catch/Effort Data

No. A 2173154

Day and month	Method code	Position: Lat. Long or Stat area	Effort data: Time hours mins	A	B	C	D	Target species Total (kg)	Species code Weight (kg)	Species code Weight (kg)	Species code Weight (kg)	Species code Weight (kg)	Species code Weight (kg)
/													
/													
/													
/													
/													

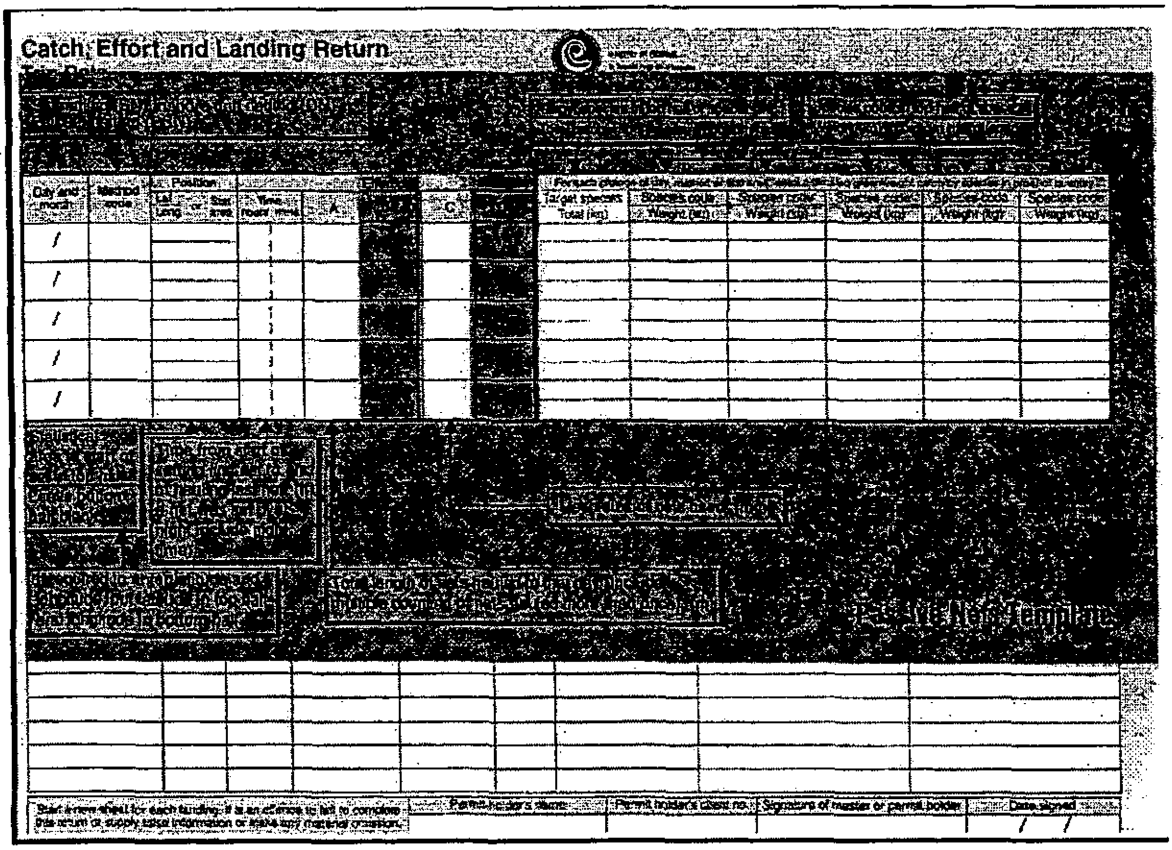
For each change of day, method or stat area, enter estimated greenweight catch by species in order of quantity

Catch Landing Data

Fishstock (Species/Area)	Landed state	Container: Number	Container: Type	Container: Content weight	Destination: Type	Destination: LFR no. or vessel reg. no.	Greenweight (kilograms)	Purchase tax invoice number from LFR

Start a new sheet for each landing. It is an offence to fail to complete this return or supply false information or make any material omission.	Permit holder's name	Permit holder's client no.	Signature of master or permit holder	Date signed
				/ /

Appendix 2b. Copy of CELR form with passive nets template (Source: Ministry of Fisheries Catch Effort reference library).



Appendix C. Trawl catch rates by month, depth, and statistical area.

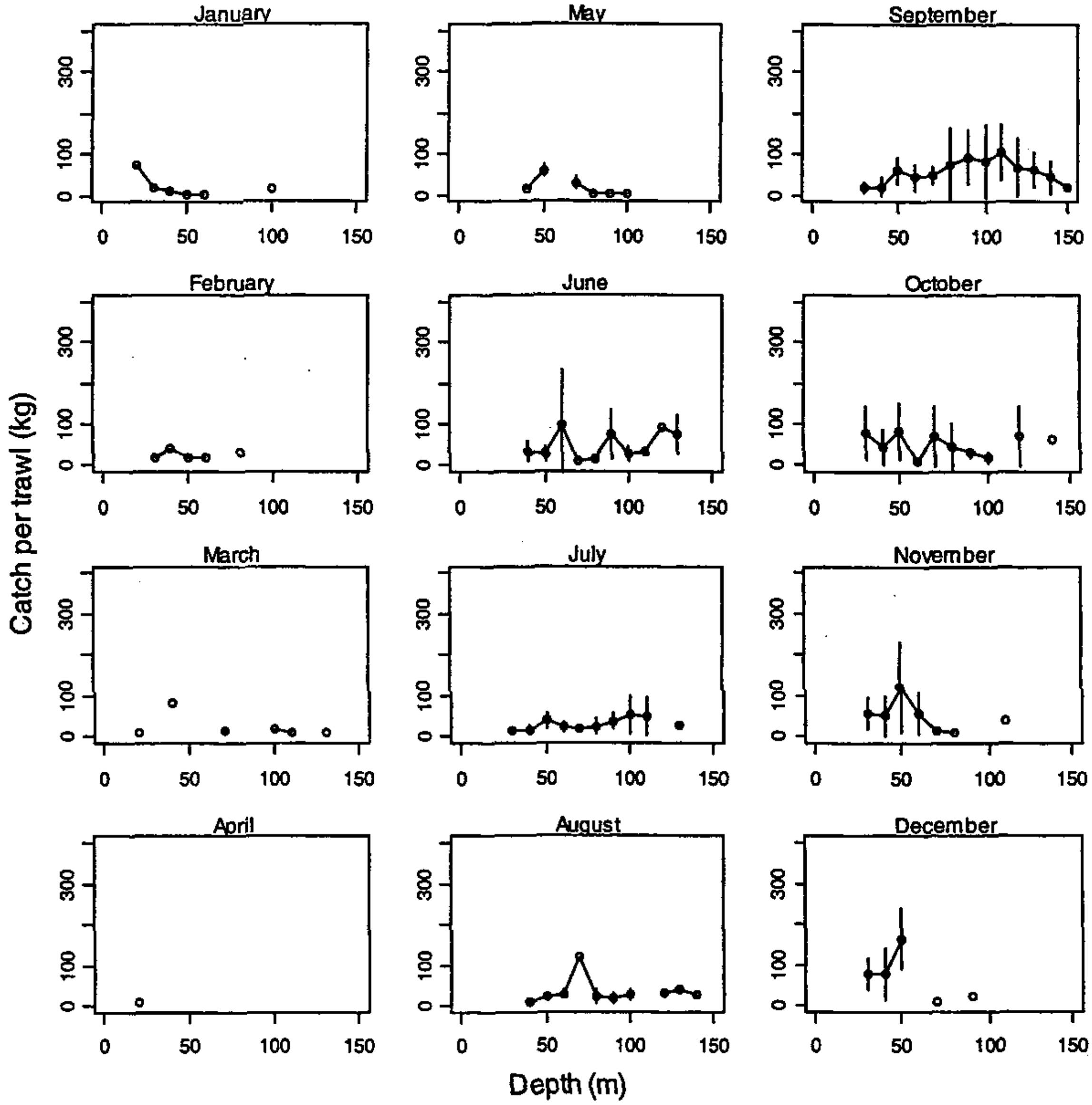


Figure C1: Catch rates (kg per trawl) of blue moki by depth and month from all trawl fisheries operating in statistical area 012 for all years combined (source: MFish TCEPR data). The confidence intervals represent one standard deviation.

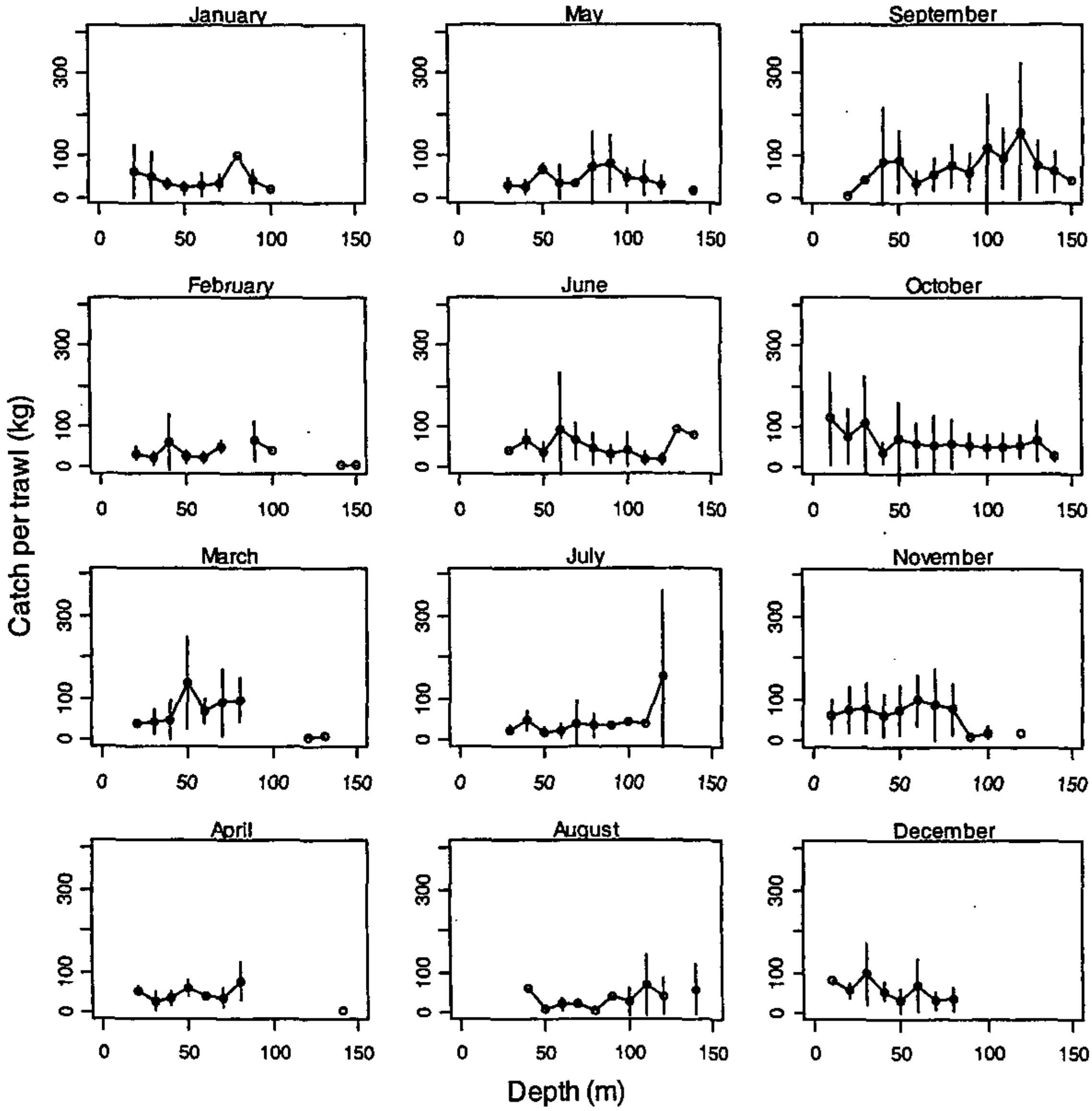


Figure C2: Catch rates (kg per trawl) of blue moki by depth and month from all trawl fisheries operating in statistical area 013 for all years combined (source: MFish TCEPR data). The confidence intervals represent one standard deviation.

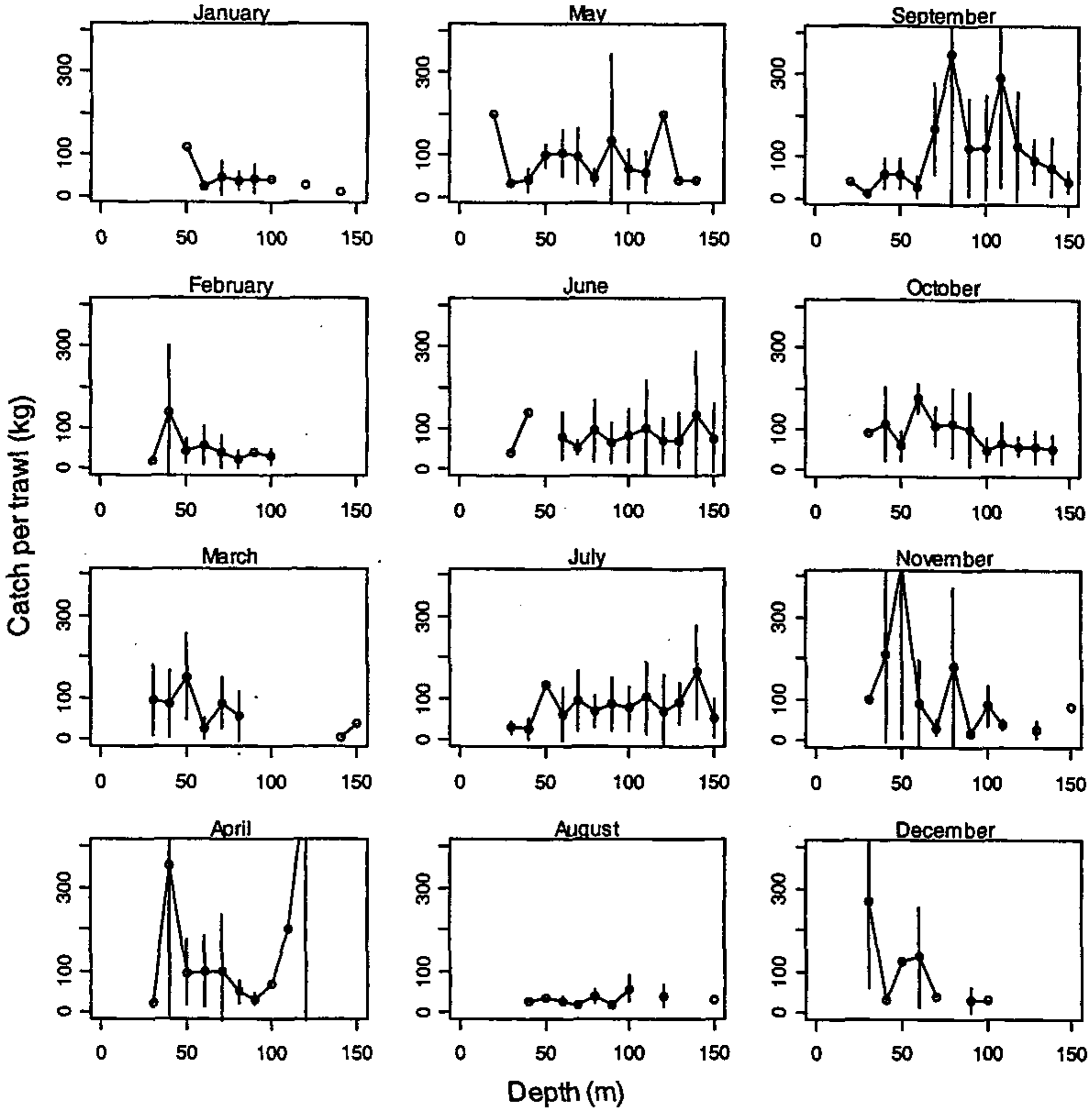


Figure C3: Catch rates (kg per trawl) of blue moki by depth and month from all trawl fisheries operating in statistical area 014 for all years combined (source: MFish TCEPR data). The confidence intervals represent one standard deviation.

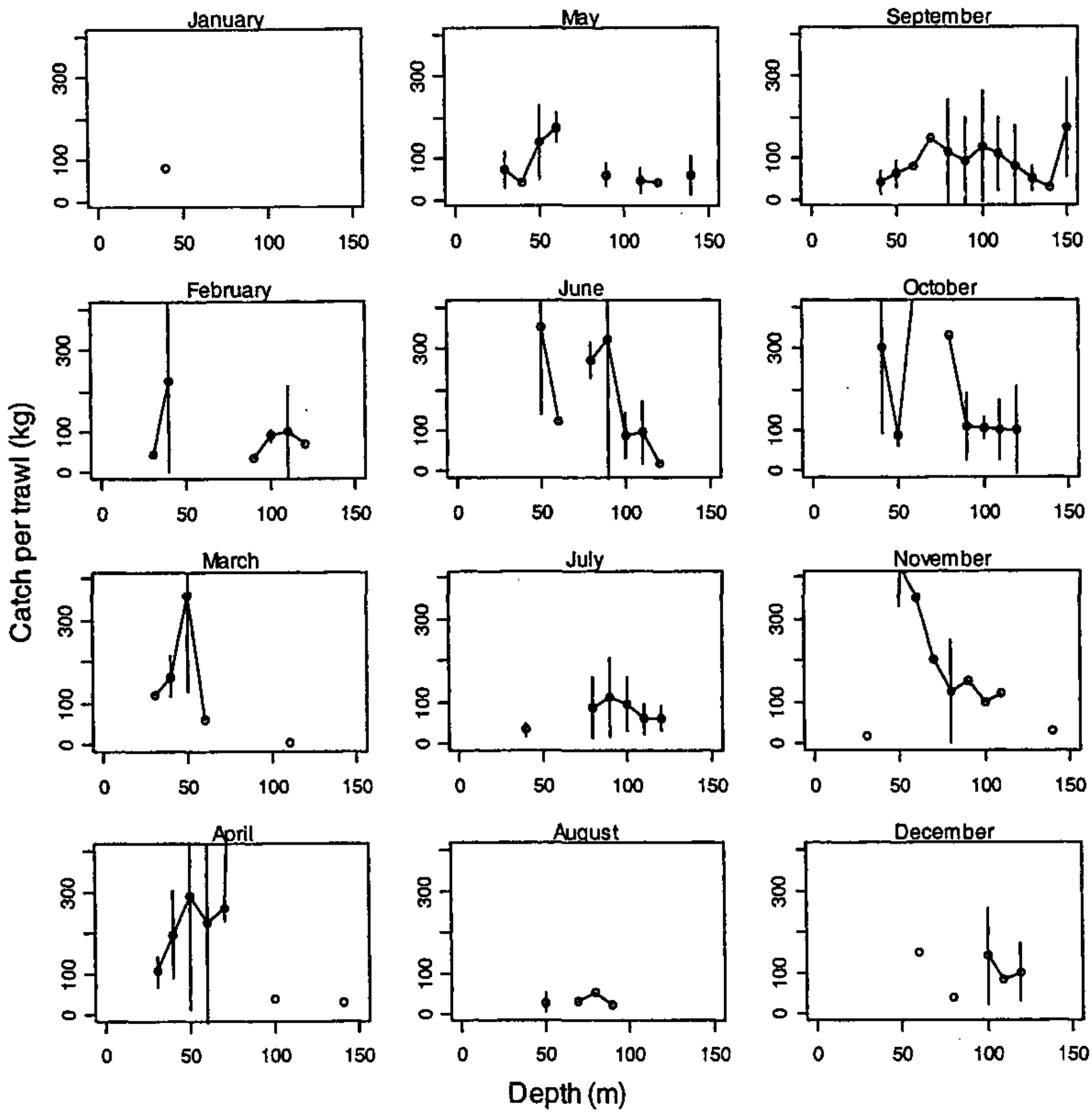


Figure C4: Catch rates (kg per trawl) of blue moki by depth and month from all trawl fisheries operating in statistical area 015 for all years combined (source: MFish TCEPR data). The confidence intervals represent one standard deviation.

Appendix Da. Interview questions

Name, Contact detail, Company

Vessel: Name, Length, Number of crews

Gear used: Size of net, Mesh size

(Setnet: length and depth of panel)

Fishing plan

What do you target? Where? When?

Targetting

How do you define what is declared as the target species? What affects this? ACE availability? Catchability? Demand from processors? Amount caught?

Do you setnets/trawl on known ground or based on marks on the fishfinder?
Can you distinguish between species on the sounder?
Are these species found in separate schools or mixed in with other species?

To what extent can skippers target or exclude individual species?
When/where could you guarantee catching MOK? In the top five species?
When/where would MOK not be in the top five species caught?

Setnet/Trawl

To what extent do you use the deemed value scheme and bycatch trade off scheme to cover MOK 1 catch (over and above quota)?
To what extent (if any) did you discard (illegal) any MOK 1 when no quota was available?

Setnet

Is there any difference in depth fished when you are targeting different species?
How many times do you typically set the net in a day?
What time do you set the net?
What is the usual soak time?

Trawl

What is the main depth range fished when targeting TAR in July-December (when most MOK is caught)?

Distribution

How variable is the distribution of the species?
Is there variation between years/season?
What are the depth ranges for each species?

MOK
TAR
GUR
WAR (blue)

Have you noticed any seasonal patterns in the abundance of MOK?
Have the depths/grounds that you target the fish changed?
Has the distribution of the species changed?

Sizes

What is the size range of the fish caught? Does this change with area/year/season?
Is there any difference in distribution between the large and small fish?
Do you see big year classes coming through?

Changes to fishing practices

Have there been any changes to gear, nets, technology that would affect the catch rates or bycatch levels?
Have there been any changes in the meshsize/gear regulations?

Catch rates

What affects the catch rates of MOK/TAR/WAR/GUR?

Water temp? Prevailing wind direction? El Nino? Food?

What factors are important in determining catch rate? Tide? Time of the moon?

What contributed to the increase in catch of MOK in the late 1990's?

Market
Where is MOK sold?
In what state is it sold?
For what price?
Is the market stable? Has it changed in the last 10 years?
Any size limits from the processors?

Appendix Db. Individual interviews

Ivan Bennett
"Surfrider 2", "Valiant 2", "Samalla 2"
Fishery sector: Operator in the MOK and WAR setnet fishery
Phone interview

Ivan has been involved in the setnet fishery for 20 years and has three boats beach launched from Pourerere Beach, *Surfrider 2*, *Valiant 2*, and *Samalla 2*, ranging in size from 6.5 to 7.5 m. These vessels operate from Blackhead Point to Mangakuri Beach.

Vessel's target choice is based on the availability of quota from the processing sheds: over the last few years he has been mainly targeting MOK, WAR and CRA. He sets 3–4 nets up to 400 m long, twice per day, once in the morning and again in the afternoon.

Ivan said there is a MFish regulation that limits the soak time of a net to 19 hours, this stops people from leaving nets out for weeks and killing a lot of fish that goes to waste.

Ivan targets moki as they run north up the coast from May to July, and also for a 10 day period in September as they run back south.

This year has been one of the worst for moki, certainly worse than 5 years ago, while they are still highly abundant there was a lack of the good quality larger fish. Moki caught in previous years have weighed 4–5 kg, but early in this year's run the moki weighed around 3 kg. Some fishermen think that the moki may be running in deeper waters, but Ivan is not convinced.

Ivan thinks that there may be a link between the poor fish quality and larger boats targeting moki in their spawning grounds off Gisborne. He thinks that spawning grounds should be left alone; if the fish are disturbed while spawning it may be a disaster for the fishery.

Fishing this year has also been affected greatly by adverse weather.

It costs Ivan $0.45/kg to lease moki quota and he receives $1.30/kg greenweight. Currently the deemed value for moki is $0.88/kg.

Ivan says that the resident fish along the coast tend to have blacker flesh while the moki running up to the spawning grounds normally have white flesh.

Ivan targets rock lobster between April and September, before fishing for wetfish again.

Ivan targets warehou during November using a 6.5 inch mesh net. There have not been very good catches for the last three years. There have been massive catches in the Wellington area in that time. They currently pay a lease of $0.40/kg and get $1.80/kg greenweight.

Ivan also targets butterfish with 4.5 inch mesh, gurnard with 5 inch mesh, and lemon sole with 6.5 inch mesh.

Ivan thought that the bycatch trade off provision worked well. He is not happy with how the system is working at the moment; the high deemed values on species with low quota are making some fishermen discard those species. Moki is a problem to some extent especially for the trawlers that have little available quota. Rig is a big problem with tonnes of it likely being dumped at sea. He thinks that kingfish must also be a huge problem as the quota allocated is nowhere near the recent catch levels, and there is no way to avoid catching it. The deemed value for kingfish is $4.45/kg while the fishermen are getting paid only $2.10/kg greenweight.

Wayne Phelps
Rambla
Fishery Sector: Operator in the MOK and WAR target setnet fishery
Phone interview

Wayne is based on the southern Wairarapa coast and has been fishing for 25 years in the area. He setnets from a 30 ft long vessel, *Rambla*. He was lucky when the QMS came in, as he could buy out quota from other local fishermen, as the quota allocations were much lower than what they had been fishing. He is currently leasing out his quota but fishes on behalf of Moana Pacific.

Wayne targets only moki in May, June; and July; he does not fish the rest of the year. He operates from Cape Palliser to White Rock. He sets two nets, each 300 m long, made of seven inch mesh. He usually sets the nets over the day, about 12–15 hours, hauling the net at 5–6 pm: if there are good conditions he may leave the net set overnight.

Wayne targets moki in depths of 30–60 fathoms, the moki does extend beyond this range but not in great abundance. He catches very little bycatch while targeting moki, for every 2 t of moki, he may catch 2–6 tarakihi, 4–6 hapuku, occasionally 1 or 2 kingfish (possibly once a week) and sometimes 2 to 3 bins of warehou.

The moki caught tend to be 4 kg and larger (60+ cm FL); the smaller moki can escape the 7 inch mesh used.

Wayne does not believe that improvements in gear technology have changed the catchability of moki. He says that the best nets (Jafoval) are now too expensive and not economical to use.

Wayne thinks that the best catch rates are not due to tides or moon phase, but merely the time of year, which determines when they are running up the coast. He did comment that he gets better catches during the day and in bigger swells there are more moki around, while the other fish disappear.

Wayne caught 42 t for Moana Pacific last year and can catch as much as they want; he has usually caught all they want before the peak of moki abundance at the end of July. All 42 t of the moki he caught had been sold on the Auckland market, rather than the Wellington market. He gets $2/kg from Moana Pacific, and pays $0.60/kg to lease the quota and $0.40 for resource rental.

Wayne would push for an increase in quota, as he thinks that the fishery is better than it used to be.

Colin Buschl
Boadicea
Fishery Sector: Setnet fisherman in 018 who targets tarakihi
Interviewed in Kaikoura

Colin has 18 years experience fishing in the Kaikoura area. He has an 11.5 m setnet vessel, *Boadicea*, which he operates from the Conway River to the Haumuri Bluffs, to the south of Kaikoura.

Colin catches 3–4 t of moki annually and 70 t of tarakihi (mostly in the summer). Hapuku are mainly caught from late May.

It is hard to know whether the moki are in separate schools or not, but Colin thinks that the schools are probably mixed.

He targets tarakihi, hapuku, and rig on known grounds. Tarakihi and rig are targeted in depths around 100 m, while hapuku is targeted in waters around 220 m deep. He uses 5–6 nets, which are 220 m long, in 15–18 hour soaks. Colin uses 5 inch mesh to target tarakihi and 7 inch mesh to target rig, both mesh sizes catch moki.

Moki are mostly about 60–70 cm FL

The moki run has not been as good over the last 3–4 years; he thinks that there are fewer moki around, rather than that they are somewhere else.

The only way to avoid catching moki is to stop fishing.

Colin sells his fish to Ngai Tahu Fisheries, who pay $1.00/kg greenweight and always take the fish.

Colin believes that there is a code of practice that states that each vessel may have 1000 m of mesh for each crew member. He is not sure whether this is still in use or how widely it was applied.

Royden Fearnley
Poseidon
Fishery Sector: Setnet fisherman in 018
Interviewed in Kaikoura

Royden Fearnley has a long fishing history of setnetting in the Kaikoura area. He started fishing in 1974 and now owns two setnet vessels, 26 and 38 ft long, that operate along the Kaikoura coast from the Conway river mouth to the Clarence river mouth. They target tarakihi (130 t per year), hapuku (40 t per year), and ling. Moki is caught as bycatch, usually 8–10 t annually. 7.7 t of moki was caught this year and he has 9 t of ACE available for the next fishing year.

Royden's vessels blind set on known grounds; they do not use marks on the sounder to determine where they setnets. They target hapuku in depths of 80–120 fathoms and tarakihi in depths of 35–60 fathoms. Most moki is caught in depths of 32–35 fathoms, and they can setnets deeper in order to avoid catching it.

Most moki is caught in May with a small amount caught in October.

Each of Royden's vessels sets six nets (5 inch mesh, 200 m long), each net is usually set once per day at 3a.m. Occasionally when catches are good the nets are lifted and reset at 4p.m. Mesh size on either side of 5 inches do not catch well.

Although large catches of moki were taken in the mid 1980s, catches of both tarakihi and moki have been relatively constant, with tarakihi having its best year the year before last.

Royden thinks that both water temperature and river flow affect the timing of the moki run and general fish abundance. With higher river flows, there are fewer fish around.

When moki or small hapuku are still alive when the nets are lifted, they release the live ones, as the market prices do not warrant keeping them.

Royden used to sell his fish to Wairau Fisheries, who sold to the Wellington market, before they were bought out by Pacifica. All of Royden's fish are now sold to Pacifica. Pacifica generally sells to the Christchurch or Nelson markets, and especially, for moki, these markets are not as good as the Wellington market. Royden gets $1.00/kg greenweight for moki, but this quickly drops to $0.50/kg greenweight if too much is caught; in this case it is sold as bait for lobster pots. Tarakihi is sold for $1.50/kg greenweight. In general, Royden believes that Kaikoura fishermen get the lowest prices in the country.

Royden did not use the bycatch tradeoff provision as he didn't like the system. He did say that if a fisherman didn't have quota to cover the catches, they would probably have to dump the moki, due to the low market value relative to the deemed value.

Robert Saunders
Streaker
Fishery sector: Kapiti coast trawl fishery
Phone interview

Robert operates *Streaker*, a 30 ft trawler from Paremata, and has been fishing is this area for 30 years. He targets tarakihi, moki, and snapper from Makara Beach to Kapiti Island, sometimes venturing north to Foxton Beach.

Robert catches about 27 t of tarakihi and 21 t of moki annually. He targets moki from November to May in depths of about 50 fathoms. He targets fish based on known grounds rather than targeting fish marks on the sounder.

Robert catches moki that are 50–70 cm FL. Moki in this area are resident fish, not run fish, with most of them having white flesh and only a few with black flesh. Someone at NIWA had suggested to him that this moki comes from the Cook Strait depending on the strength of the currents, but he doesn't think that is true.

Robert used the bycatch tradeoff system and has also paid deemed values. The deemed value is currently $0.88/kg. At the moment, fishermen are left with the choice of finding enough ACE by the end of the year or paying deemed values, so for some it must be tempting to discard species they have caught too much of already.

Robert sells his fish to Cook Strait Fisheries for $1.75/kg, and it is sold on the Wellington local market. The price has been constant over the last two years. If the processor has too much of one species they will often ask fishers to target something else for a while.

Robert thinks that if the water is too clear then he catches less moki, and there seem to be higher catch rates after a southerly front comes through. Robert said that there have been more moki around each year in his area.

Chris Robinson
Pacific Trawling
***Fishery sector:* Northern QMA 2 trawl fishery**
Interviewed in Napier

Five vessels ranging from 23 to 42 m in length, all trawlers, supply 90% of their fish to Cook Strait Seafood with some going to Starfish, Moana Pacific, and Gisborne Fisheries.

The two larger vessels target HOK, ORH, BYX, OEO, BNS
Three smaller vessels are mixed inshore/offshore:

Marine Star;	WAR, TAR, GUR
Challenger;	ORH, Chatham Islands inshore fishery
Sea Hawke;	TAR, GUR, SKI

Most of their moki is caught by the *Sea Hawke* and the *Marine Star*. These vessels target mainly gurnard (they have more gurnard quota than tarakihi) from East Cape to Wellington in depths of 15 to 110 m.

They target known grounds while in the inshore fishery and target marks on the sounder when offshore.

Moki are found mostly in shallow waters out to 110 m with not much in deeper waters. The depth range where most moki are caught changes with each year.

Chris said that setnetters target moki based on marks as the fish are migratory. They are caught in August and September as they travel north up the coast and in October as they return to the south.

For the Pacific Trawling vessels moki is a minor bycatch as they fish deeper than where the main concentrations of moki are found.

Moki used to migrate in large schools over the soft bottom and they got some big catches. Now they tend to catch a few mixed in with the rest of the catch, maybe only catching some lone fish. There appear to be less around than 3–4 years ago, unless they are in shallower waters around the rocks. Chris did notice a couple of years with higher moki abundance in the mid 1990s.

Chris does not think that moki are in schools, just going in the same direction, although they may clump as they go over shallow ground.

He believes that the increase in quota relieved the pressure on available quota. Moki are on an abundance cycle which, as with other species, is related to successful year classes, but independent of the abundance cycles of other fish species.

Chris considers that the moon phase, current, and food abundance determines the abundance. Weather conditions greatly affect how much they catch: in easterly conditions catches are very poor, and in northwest conditions there are very good catches.

Moki are only sold to the local market for fish and chips. Chris gets $1.50/kg for unprocessed fish. All sizes are OK, but they have trouble selling larger catches as the market cannot handle the volume.

Changes in gear technology have had no effect on the catch of MOK.

Mike Claudatos
Star Fish
Fishery sector: Processor
Interviewed in Napier

Star Fish contracts 4–10 vessels to fish for them, mainly trawlers ranging in size from 13 to 40 m, with one setnet vessel contracted at the moment.

These vessels target gurnard, tarakihi, flatfish, hoki, warehou, and ling. They do not target moki, as when the quota was increased in the early 1990s they made an agreement not to target moki in order to get the quota increase. Mike was not sure how some people now are able to target moki.

Setnetters often fish on marks from the sounder and have a reasonable idea of what is down there. Trawlers target known grounds and it is impossible for them to avoid catching moki, which are found in mixed schools with tarakihi.

Depth ranges of species: GUR and flatfish 0-40 fathoms, TAR >40 fathoms, MOK in all depths 0–100 m, WAR around rocky reefs over 10 m.

Moki run throughout August, September and October.

Bycatch tradeoff was used a lot but they were also paying deemed values.

Large moki are caught by trawlers (40–80 cm FL).

Setnetters targeting warehou use larger mesh, and Mike doesn't remember any changes to the mesh regulations.

There has been a large decrease in the number of setnetters, with 4–5 operating along the east coast of the North Island 10 years ago and only 2 remaining. This is likely due to the problems of catching too much shark and rig, for which they have to pay deemed values, as well as the lack of moki quota.

Moki are sold locally as fillets at a stable $5.50/kg, but can have problems selling it when the flesh gets black (possibly due to feeding on weed).

Terry Gittings
Moana Pacific
Fishery sector: Processor
Interviewed in Napier

Moana Pacific currently has 5–6 trawlers contracted to catch for them, and two setnetters. These are mostly 10 m long vessels with the setnetters being 20 ft beach boats.

Terry has been involved in the fishery for about 6 years.

Setnet
The setnetters are based on the southern Wairarapa coast and target moki as they run up the coast in July-September when the fish are in the best condition; they lose condition quickly as they continue their run. They tend to catch 50–70 cm FL fish weighing 3–4 kg (nice and fat).

Setnetters target based on markscombined with local knowledge; they generally know what fish they are seeing on the sounder.

One of his fishermen (from Ngawi) usually sets his nets twice a day (morning /afternoon) with 4 hour soak time. Nets are generally 30–400 metres long. They fish in depths up to 50 fathoms.

Trawl
Trawlers generally operate in 012–014 statistical areas, in Hawke Bay, mainly from Bare Island north to Portland Island. They target gurnard and tarakihi in 30–200 m, none target moki. None of his vessels target warehou as it is caught near Cape Palliser.

Terry believes that the newer design of trawl nets makes better catches.

Tarakihi are caught in depths of 30–200 m, and are so abundant at the moment they are having problems getting enough quota. There are plagues of tarakihi in FMA 1 and now it is starting in FMA 2.

General
Terry said that there always seem to be plenty of moki around with no bad years, and they always seem to be around the same size (50–70 cm FL). Moki are usually found in separate schools to other species.

Terry thinks that deemed values used to be relatively low, but now with the new deemed values, he thinks that discarding of moki might be more prevalent.

Easterly conditions hurt inshore fisheries, as poor catches occur in these conditions. The best catches are three days either side of the full moon.

Moki are sold as skinoff fillets to the local fish and chip market. They get $3/kg for green fish and $6.50/kg for the fillets. They limit the setnetter to catch 2 t per day as that is all they can find buyers for.

Winston Waititi
Kauaetangohia Marae Committee
Fishery sector: Maori
Interviewed at Otamaroa, Cape Runaway

Moki have considerable importance to Maori in the Whangaparaoa district, Cape Runaway. They feature in the history of the area prominently and this long interest has resulted in an area closed to any nets that encompasses traditional fishing grounds.

Their history, as described by Kuaha Waititi to the Whangaparaoa Maori School Jubilee Committee in 1966, details the involvement of moki in the history of the area, paraphrased here.

The great migration of canoes landed near Whangaparaoa, and while the others dispersed, the Tainui canoe landed on Whangaparaoa beach and the occupants settled there for a while. After a death during weapons practise one group took the Tainui canoe and headed west.

After living there for some considerable time, the chief Rua-moe-ngarara returned to Hawaiiki in order to bring back their relative, Pou. Pou decided to bring with him the fish with the protruding lip that was basking in the sun (moki). Rehua granted Pou the fish as long as they observed certain rites with regard to moki:

1) *It must not be cooked on the beach,*
2) *It must not be eaten raw,*
3) *It must not be killed with a stick,*
4) *The first moki caught must be sacrificed to the god of fish (Rehua or Tangaroa to some people).*

Rehua also gave Pou a special stick with which to catch crabs among the rocks, to use for bait in order to catch the moki. When Pou arrived in Aotearoa he remarked how alike it was to his home village in Hawaiiki, Whangaparaoa-mai-Tawhiti, and it was then known as Whangaparaoa. However as they arrived in the canoes, Pou's canoe capsized and the contents were spread along the coastline.

Pou told a priest as he was to leave for Motu that Autahi (the star Canopia) is the sign, when you can see Tautoru ma (Orion constellation) clearly, send Maru-papanui to investigate. The sign was seen and Maru-papanui went out to investigate, he dove into the sea and found many of Rehua's children (moki). He found several areas where many moki were seen, these are still known by these names:

Otamaroa – so deep only reached by man
Tuapapa – swimming above flat rock
Kokohura – churning up seaweed
Pakuru (full name; Te Pakarutanga o te toto ri te ihu o Maru-papanui) – the place where Maru-papanui's nose bled

The first moki caught in each year is hung by its tail from the rata tree which Pou tied a whale to.

The moki is not like any other fish, it pulls down on the line so the line is always taut. The moki season lasts from late May to the end of July, but it is more plentiful around 6– 7 June. When the moki disappears, Maori believe that it has returned to its parent Rehua.

The Cape Runaway area was always known as the best area for moki fishing among Maori, often with groups travelling through, stopping to pick up fish as the boats land.

Moki were traditionally fished using large hooks used specifically for moki and hapuku, and when monofilament nets became available Maori began to use them as well. However, as nets capture fish by the head, this was offensive to Maori due to the cultural significance of moki (especially the head) and didn't fit with what they were teaching to children. It was made known that it was not acceptable to use nets in the Cape Runaway area (from Oruaiti Beach to Pitikirua Point) in 1986. However there was some commercial netting still within this area.

When Maori were consulted about the proposed increase in MOK 1 quota for the 1995–96 fishing year, they wanted an area made a taiapure. In 1996 the closure, from Oruaiti Beach to Pitikirua Point and extending 2 miles out to sea, was made official by the Ministry of Fisheries.

Maori had large catches up to the early 1970s, but these declined after several years of fishing with nets. Recently catches have been patchy, as not enough boats have been out fishing at the same time. If there are 30–40 boats fishing with a lot of hooks in total, it increases the feeding of moki and increases the overall catches. The local Maori do not have enough confidence in boating to be out fishing. The moki are still there in the same abundance but may have shifted grounds slightly.