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**Te Tautiaki i nga tini a Tangaroa**

**Characterisation of the commercial flatfish, grey mullet, and rig  
fisheries in the Kaipara Harbour**

**B. Hartill**

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## EXECUTIVE SUMMARY

Hartill, B. (2004). Characterisation of the commercial flatfish, grey mullet, and rig fisheries in the Kaipara Harbour.

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This report provides a characterisation of the commercial flatfish, grey mullet, and rig fisheries in the Kaipara Harbour. The largest fishery in the Kaipara Harbour is that targeting flatfish by setnet. Two methods are used to target grey mullet, setnetting and ring netting, and a highly seasonal setnet fishery, targeting rig, also operates in summer. These fisheries should be regarded holistically however, as shifts between them appear to take place on a seasonal basis with about half of the fleet participating in two or more fisheries.

Data from Ministry of Fisheries catch effort databases relating to setnet and ring net fishing events in the Kaipara Harbour were extracted and groomed for apparent errors. Detailed examination of chronologically sorted catch effort data from each vessel highlighted an undesirable variety, and, for some vessels, quantity of errors. Where possible, these have been rectified in the light of the fishing history of the vessels concerned. Corrections for most apparent errors were usually, but not always, obvious. There are likely to be many errors which went undetected grooming, but these are less likely to result in misleading interpretation as they did not stand out as unusual, and may therefore be closer to the true value.

Only data relating to the period 1989–90 to 2000–01 were examined, as previous studies have found pre-1989 Fisheries Statistics Unit (FSU) data of doubtful consistency with more recent data given their summarised form. Late FSU and early CELR data are not considered representative, as the transition between the two reporting systems was gradual and some fishing activity probably went unreported.

Fishing fleets targeting different species were divided into two groups, "local" and "non-local", although the criterion for this separation was arbitrary, and does not necessarily describe any vessel's historical commitment to a fishery. Despite the narrow criterion used to define local vessels (at least 90% of reported fishing events occurring in the Kaipara Harbour), by far the majority of effort and landed catch has been made by the local fleet.

Trends in fishing effort though time by these two fleets were similar for the flatfish and rig setnet fisheries, but some differences were evident in the grey mullet setnet fishery as local fleet fishing effort decreased while non-local effort remained steady. This decline in setnet effort by the local fleet may merely reflect a shift towards ring netting by local fishers, who account for most days fished using this method. In the last decade, fishing effort has generally increased in the flatfish and rig fisheries, but these increases were not solely attributable to either the local or non-local fleet.

Annual landed catches of flatfish have increased in recent years, largely by the non-local fleet, which still lands less than 25% of the total catch. Annual landings of grey mullet by the setnet fleet have fluctuated, and fallen substantially in recent years, but there has been a marked corresponding increase in ring net catches. When catches by both methods are combined, however, a decline in total grey mullet landings is evident in recent years. The annual rig catch has increased through time, with local catches increasing markedly in 1994–95 and non-local catches increasing markedly in 1998–99.

Catch rates of all three species peaked in the mid 1990s, but have declined in recent years, yet an increasing proportion of landings from each species Quota Management Area comes from the Kaipara Harbour. Fishing effort may therefore be shifting to the Kaipara Harbour from other areas, and this, in conjunction with increased effort by local fishers, may result in localised depletion.

## 1. INTRODUCTION

Increasing levels of setnet fishing effort and declining catch rates in some Kaipara Harbour setnet fisheries have led to concerns about sustainability by local fishers and the wider community and to the formation of the "Kaipara Harbour Sustainable Fishing Study Group", which consists of representatives from local iwi and commercial and recreational fishers. This study was undertaken to provide background information on the major setnet fisheries in the harbour. These setnet fisheries should not be regarded individually, due to the involvement by many fishers in two or more fisheries and their seasonal nature.

A large component of the North Island setnet fleet is trailer borne, and fishes many areas in a transient manner in response to weather conditions and catch rates. In the Kaipara Harbour, however, many launch-type vessels participate in these fisheries, and these are unable to respond to falling catch rates by shifting fishing effort elsewhere. In this study, a "local" fleet was identified, to give some insight into the extent to which effort had shifted from other harbours/fisheries through time. Further, by identifying these vessels, a core of experienced fishers was identified whose catch rates are more likely to reflect the underlying abundance of the species examined.

## 2. LITERATURE REVIEW

Information on some Kaipara Harbour fisheries is included in studies of wider ranging fisheries characterised in recent years. Standardised and unstandardised CPUE indices for grey mullet targeted in the Kaipara, using setnets, were derived from a description of catch rates in GMU 1 between 1983 and 1996 (J. McKenzie 1996, NIWA, Unpublished results). Only those indices calculated for 1989-96 were considered useful, however, as some doubt was expressed about the quality and consistency of the pre-1989 Fishery Statistics Unit (FSU) data.

In a characterisation of the New Zealand school shark fishery, Paul & Sanders (2001) described trends in the Kaipara Harbour longline fishery between 1989 and 1999, which is a comparatively small and seasonal component of the overall fishery. Information on rig setnet catch and effort in the Kaipara since 1989 is included in a characterisation of the SPO 1 fishery (Paul 2003). While these studies describe some, but not all, of the fisheries operating in the Kaipara, which they have not been examined holistically over a common period.

## 3. METHODS

Data from the Ministry of Fisheries Catch Effort Landing Return (CELR) databases relating to vessels reporting setnet (SN) or ring net (RN) effort in statistical reporting area 044 (Kaipara Harbour, Figure 1) between 1 October 1989 and 30 September 2001 were extracted. These data (60 258 fishing events) were subsequently used to identify further records relating to fishing effort in statistical reporting areas 001, 004, and 009, which were thought to have actually occurred in 044. The inclusion of these data (1278 records) was based on the reported landing location. Only data relating to the period 1989-90 to 2000-01 were examined, as previous studies have found pre-1989 (FSU) data of doubtful consistency with more recent data, given their summarised form. Late FSU and early CELR data are thought to be incomplete, as the transition between the two reporting systems was gradual.

In order to holistically examine these data for potential errors, fishing effort data were linked to estimates of catch by fishing event, and these data were then in turn linked to the landed catch of each trip, where each trip comprised one or more fishing events. These records were then sorted chronologically by vessel, and examined for errors given the recent reported fishing history. This approach highlighted an undesirable variety, and, for some vessels, quantity of errors. Where possible, these have been rectified, in the light of the fishing history of the vessels concerned. Corrections for most apparent errors were usually, but not always, obvious. There are likely to be many errors which went

undetected during grooming, but these are less likely to result in misleading interpretation, as they did not stand out as unusual, and may therefore be closer to the true value.

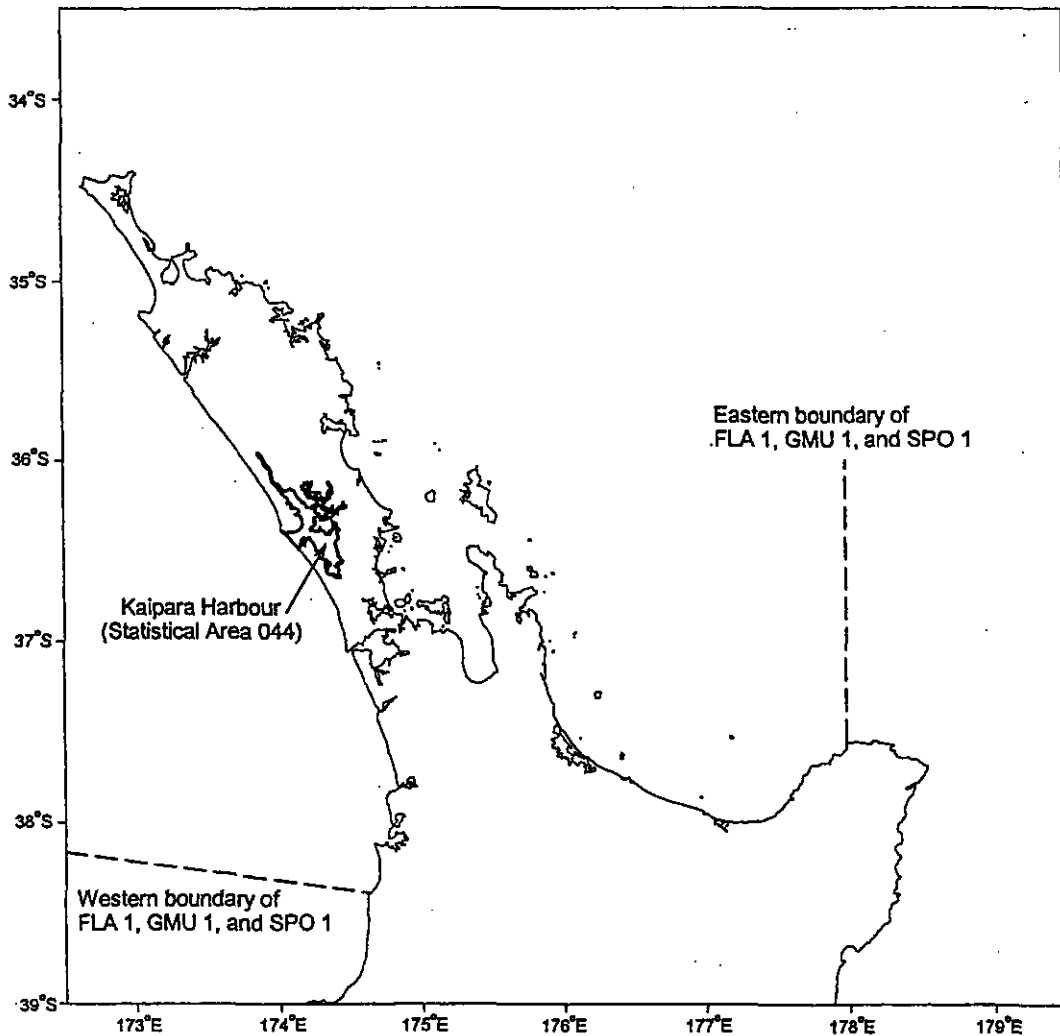


Figure 1: Kaipara Harbour and the common boundaries of FLA 1, GMU 1, and SPO 1.

Only fishing effort relating to setnet length was groomed for errors. In the small percentage of records where no estimate of net length was available, the median value of recent estimates was used. cursory examination of the reported number of sets per day, soak time, and mesh sizes used suggested that these data were not reliable due to both the high proportion of missing values, and the apparent inconsistency of those values which were recorded.

Fisheries have been characterised on the basis of the reported target species. As the species code FLA is generic to many species, records relating the targeting or catch of all flatfish species have been reclassified as FLA to overcome any inconsistencies in reporting practice. In some instances, illegible handwriting or mispunching of species codes appears to have resulted in reported targeting or catches of species which are unlikely to be caught by setnet, but have spelling similar to more commonly caught species. These have also been reclassified. The following species codes have therefore been classified as FLA: FLA (32 079 targeted fishing events), YBF (8221), SFL (23), FLO (1), ESO (no target events, but in reported catch). Reclassified species codes relating to rig (SPO) are: SPO (3373), SPD (28), SPI (2) and SDO (1). No reclassification of species codes was necessary for grey mullet (GMU).

For each fishing trip, misreported, misrecorded, or mispunched catch estimates or landed catch weights were identified on a species by species basis by comparing the landed catch weight for that trip with the total of the estimated catches from all fishing events occurring during that trip. When marked differences between a trip's estimated and landed catches were apparent, the estimated catch weight was used only in preference to the landed catch weight if the landed catch weight appeared implausible given the amount of fishing effort used. Usually, however, the landed catch weight was used where possible, as it was considered more accurate than estimated catch weights, which are often only crude estimates, and not measured weights. For rig, the difference between estimated and landed catch weights suggested that some fishers recorded processed weights and not greenweights in the estimated catch section of the CELR. In some instances the landed catch was adjusted but still used, when the total estimated catch and fishing effort suggested an obvious punching error, such as the double punching of a numeral. When no landed catch weight was available, the fisher's estimates of catch were used.

This approach resulted in a best catch estimate of the landed weight of FLA, GMU, and SPO from each reported fishing trip. When a "best catch estimate" was not available for any of these species, the trip was not used in the characterisation, as the lack of catch data generally appeared to occur as a result of mismatches in the database. The incidence of these zero catch fishing trips was low, however, and omission of these records is unlikely to influence any of the trends observed. It is acknowledged that zero catch trips are possible and may have occurred.

For 57% of trips examined, only one fishing event took place during a trip, and the estimated weight of the five top species caught generally matched the landed catch weights. When multiple fishing events occurred during a trip, and the same species was targeted using the same method in all events, catch and effort were summed for the trip and used to generate unstandardised catch per unit effort (CPUE) estimates. When more than one species was targeted, or more than one method was used during a fishing trip, the landed catch from a trip was apportioned between fishing events on the basis of catch estimates from each event. It was not always possible to do this reliably, however, as catch estimates were not recorded in some instances.

Two data sets were therefore used to generate catch, effort, and CPUE estimates for each species: all fishing events where the species was targeted ("Target") and only those trips where one fishing method was used to target one species ("1 method, 1 target").

As CPUE is partially influenced by a fisher's local knowledge and experience, a fleet of local vessels was identified. Local vessels were deemed to be those with at least 90% of their fishing events occurring within the Kaipara Harbour. Data from another Ministry of Fisheries project (MOF3001\_03M), containing records relating to any vessel which had reported at least one setnet event during its entire fishing history was used to identify these vessels. Two fleets are therefore characterised in this report, a "local" fleet, described above, and all other vessels, called the "non-local" fleet. The selection of the criterion for dividing these fleets is, however, arbitrary, and is not intended to classify any fisher's commitment to the fishery.

A further subset of the local fleet, with prolonged experience in the Kaipara Harbour setnet and ring net fisheries, was identified ("index vessels"). For the setnet fisheries, these were vessels with at least 500 events reported in the Kaipara Harbour over at least 5 years, and for the ring net fishery, these were vessels with at least 100 events reported over at least 3 years.

Four estimates of annual catch, effort, and CPUE of increasing putative representativeness of abundance were therefore generated using combinations of trip datasets and fleet descriptors.

- Target – all fishing events reported by all vessels, where the species was targeted.
- 1 method, 1 target – trips where one method was used to target one species.
- Local 1 method, 1 target – trips reported by those vessels with over 90% of reported fishing events occurring in the Kaipara Harbour, where one method was used to target one species.

- Index 1 method, 1 target – trips reported by those vessels with over 90% of reported fishing events occurring in the Kaipara Harbour which had a prolonged fishing history, where one method was used to target one species.

For each of these datasets, the sum of the catch (“best catch estimates”) was divided by the sum of the effort (net lengths), to provide estimates of CPUE. Estimates of effort, and hence CPUE, were not calculated for the grey mullet ring net fishery, as no meaningful measure of fishing effort reported in a consistent manner was available.

## 4. RESULTS

### 4.1 Predominant fisheries

The predominant setnet fisheries operating in the Kaipara Harbour between 1989–90 and 2000–01 were those targeting flatfish species (FLA 1), grey mullet (GMU 1), and rig (SPO 1) (Figures 1 & 2). A smaller ring net fishery has also been operating, which targeted grey mullet only. Other fishing methods are used in the Kaipara Harbour, such as fyke netting for eels and longlining for school shark (see Paul & Sanders 2001 for description), but the level of effort in these fisheries is far lower than in the setnet and ring net fisheries.

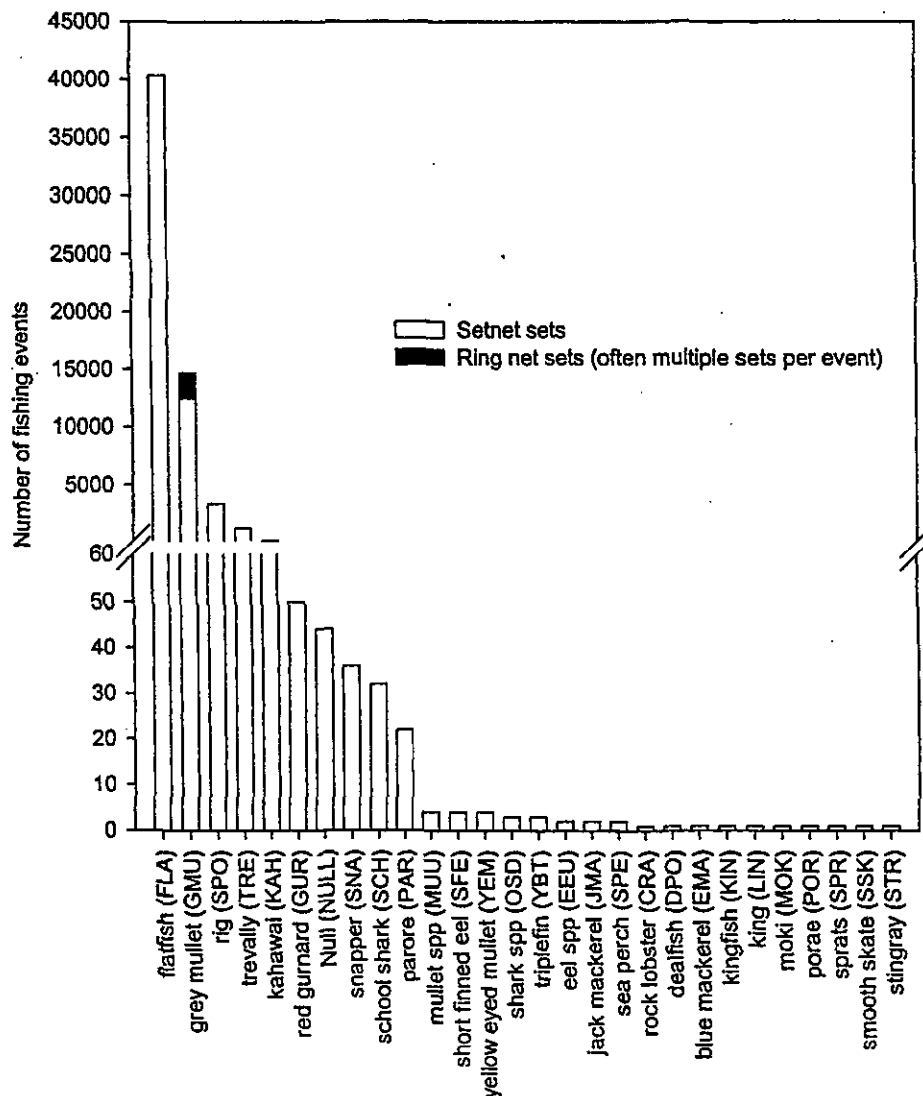


Figure 2: Frequency of setnet and ring net fishing events by target species.



Some fishers appear to have switched setnet fishing effort from one target species to another as the fishing year progressed. When the monthly setnet effort targeting flatfish, grey mullet, and rig for the period 1/10/89 to 30/9/01 is compared, fleet-wide trends are apparent. Effort targeting rig peaked at the beginning of the fishing year, probably in response to an inshore movement of females after pupping (Francis & Mace 1980). Setnetting for flatfish peaked in summer and autumn and declined as targeting for grey mullet increased during the winter months. Targeting of some species late in the fishing year may have occurred in response to the availability of unfished quota, but seasonal availability of these species and resulting catch rates are likely to have had a marked influence on fisher behaviour. The Total Allowable Commercial Catch (TACC) of all three species has been consistently undercaught since the early 1990s (Annala et al. 2002).

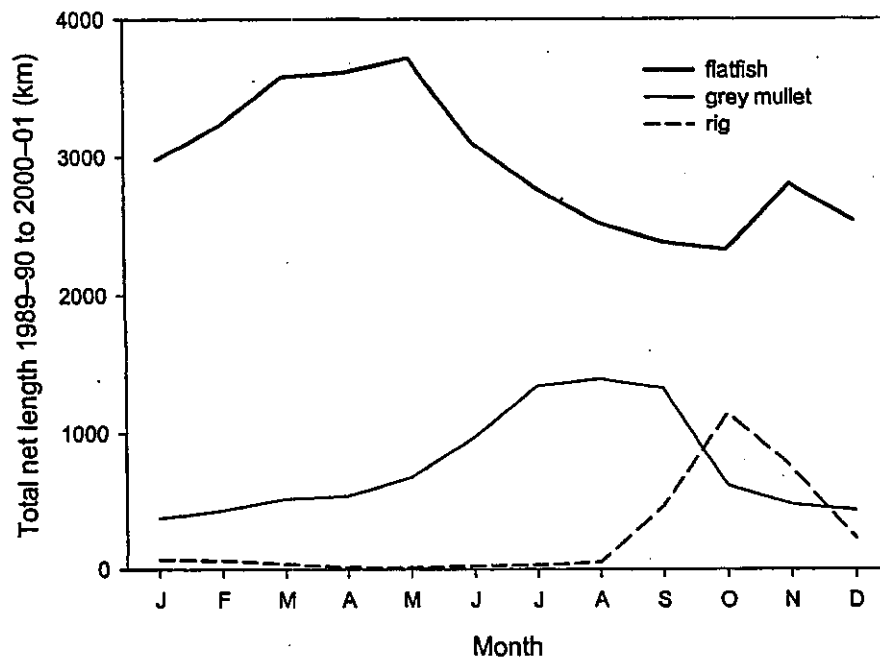


Figure 3: Total length of setnets targeting flatfish, grey mullet, and rig for the period 1/10/89 to 30/9/01, by month.

#### 4.2 Setnet fishery targeting flatfish

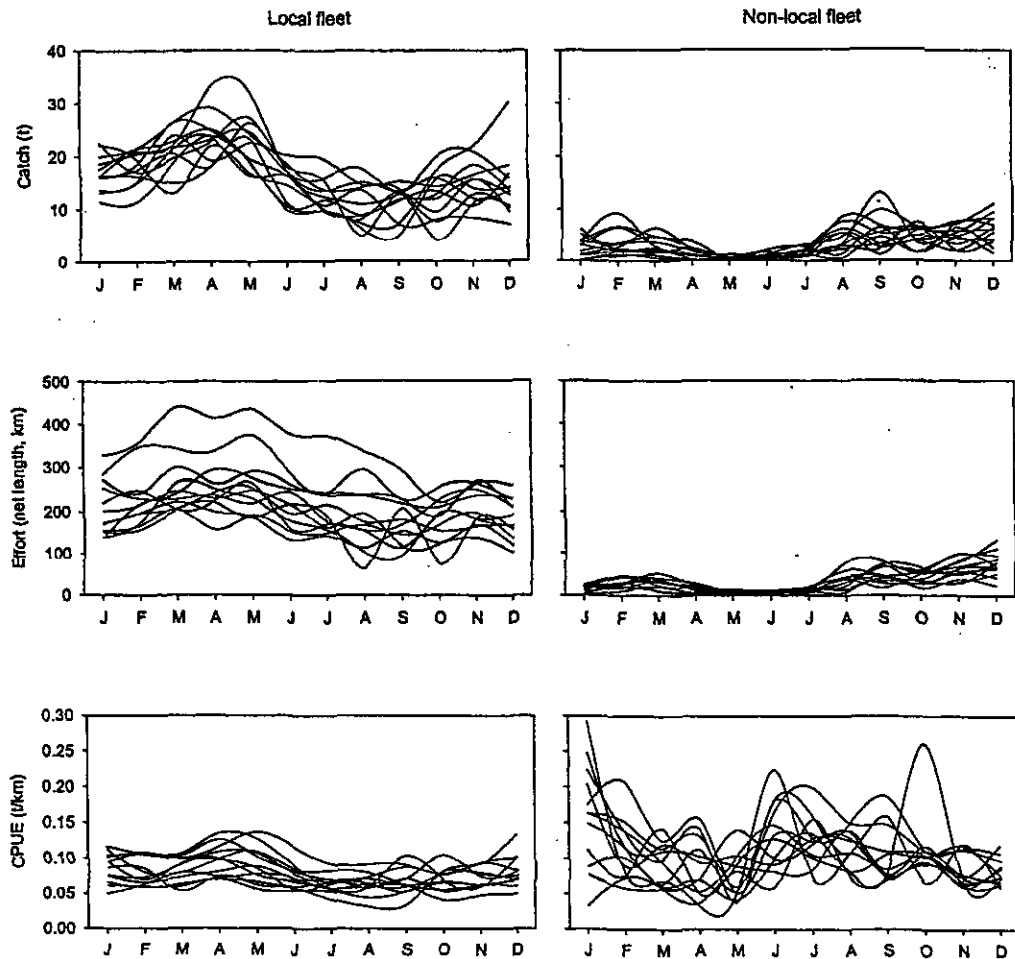
The largest setnet fishery in the Kaipara Harbour was that targeting flatfish species, in terms of both effort and catch (Figure 3, Appendices 1 to 4). The Kaipara Harbour setnet flatfish fishery has accounted for an increasingly sizable proportion of FLA 1 landings in recent years, and almost totally comprised targeted landings (Table 1).

Substantial targeting of flatfish occurs throughout the year (Figure 4). With the local fleet, both effort and catch peaked in autumn (March to May), although catch rates increased only slightly during this period. The local fleet generally accounted for at least 60% of all vessels, and over 80% of fishing events in any given fishing year (Appendix 1a). In contrast to the local fleet, most fishing effort by the non-local fleet occurred between August and December. Catch rates of non-local vessels fluctuated markedly during the year, although there are insufficient data available from this fleet to draw any strong conclusions.

**Table 1: Annual setnet landings and targeted landings of flatfish in the Kaipara Harbour relative to the total landed catch and TACC for the whole of FLA 1.**

Fishing year	FLA 1 TACC (t)	FLA 1 landings (t)	Kaipara setnet (t)	% of FLA 1 landings (t)	Targeted Kaipara (t)	% of FLA 1 landings (t)
1989-90	1 184	791	221	27.9	220	27.8
1990-91	1 187	849	216	25.4	215	25.3
1991-92	1 187	940	213	22.7	211	22.4
1992-93	1 187	1 106	199	18.0	198	17.9
1993-94	1 187	1 136	165	14.5	163	14.3
1994-95	1 187	964	216	22.4	215	22.3
1995-96	1 187	628	206	32.8	203	32.3
1996-97	1 187	741	276	37.2	271	36.6
1997-98	1 187	728	270	37.1	265	36.4
1998-99	1 187	690	249	36.1	243	35.2
1999-00	1 187	751	293	39.0	292	38.9
2000-01	1 187	792	316	39.9	315	39.8

Since 1995-96 there has been a marked increase in fishing effort by both the local and non-local fishing fleets (Figure 5). This is likely to be in response to a combination of decreasing catch rates and increased port prices (Bob Drey, Ministry of Fisheries, pers comm.). Landed catches have increased gradually since 1993-94, with the greatest proportional increase associated with non-local vessels. Flatfish catch rates peaked in the mid 1990s, and have steadily declined since (Figure 6).



**Figure 4: Seasonality of targeted flatfish setnet catch, effort and CPUE, by the local fleet (left panels) and the non-local fleet (right panels). Smoothed monthly values for the fishing years 1989-90 to 2000-01.**

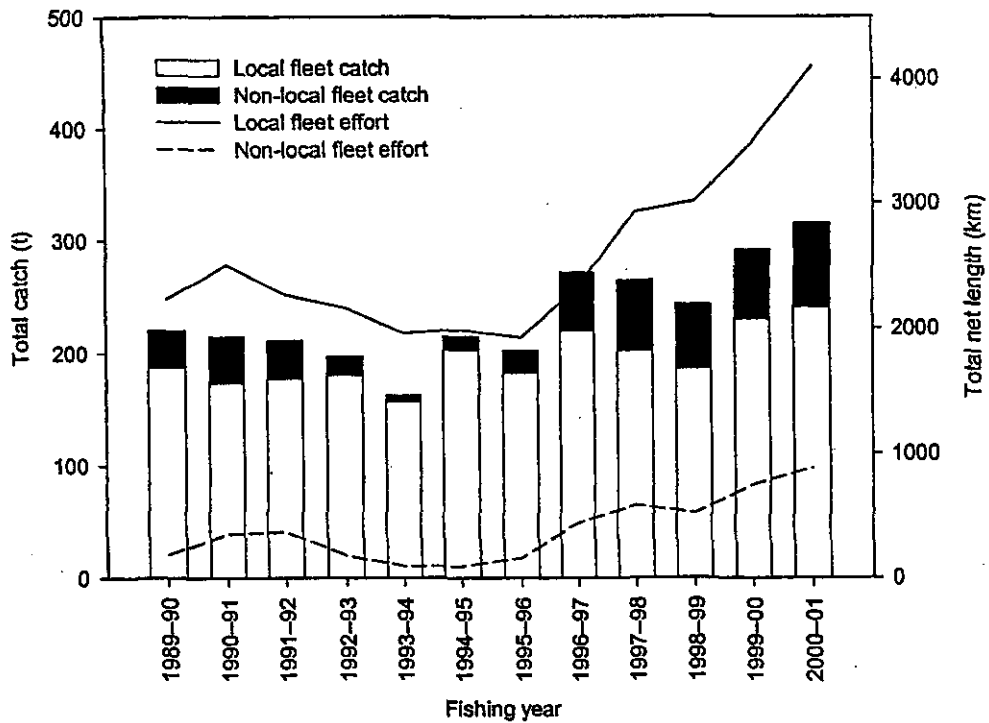


Figure 5: Total catch and setnet effort by local and non-local fishing fleets when targeting flatfish by fishing year.

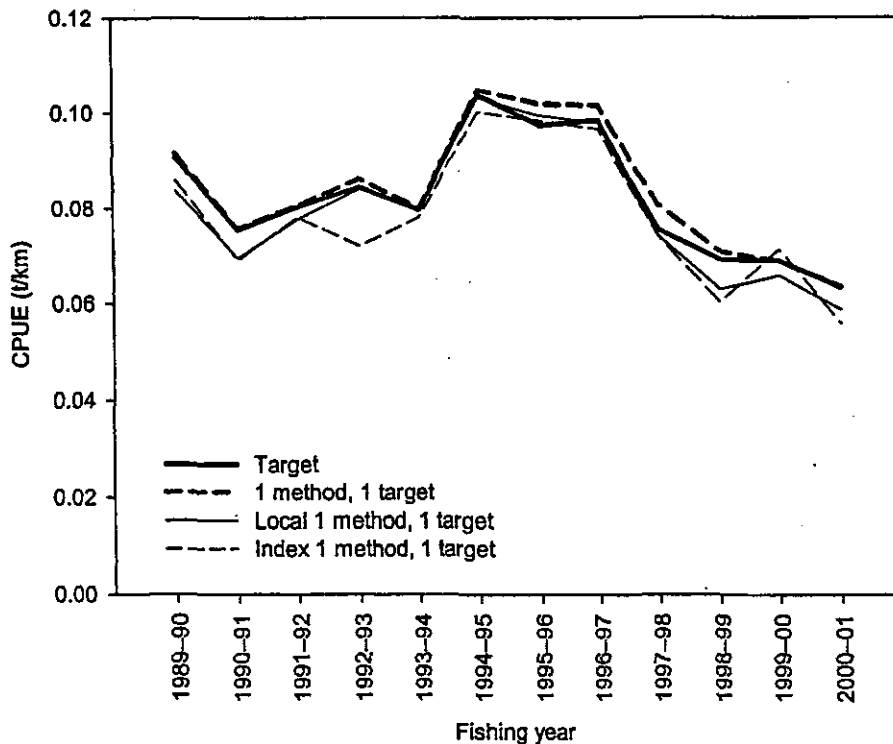


Figure 6: Indices of unstandardised catch rate for setnet trips where flatfish was targeted, by fishing year. Target, all fishing events reported by all vessels, where flatfish was targeted; 1 method, 1 target, trips where one method was used to target one species; Local 1 method, 1 target, trips reported by those vessels with over 90% of reported fishing events occurring in the Kaipara harbour, where one method was used to target flatfish; Index 1 method, 1 target, trips reported by those vessels with over 90% of reported fishing events occurring in the Kaipara Harbour which had a prolonged fishing history, where one method was used to target flatfish.

### 4.3 Fisheries targeting grey mullet

In the early 1990s, the main method used to target grey mullet was by setnet, but in recent years most of the catch has been caught by ring netting (Table 2). These two fisheries will be discussed separately, but combined landings by these methods suggest that the Kaipara Harbour grey mullet fishery is one of, if not, the largest in GMU 1. When annual landings from the setnet and ring net fisheries are combined, it is evident that grey mullet landings from the Kaipara Harbour peaked in 1996–97, and have since declined to to about half this level (Appendices 2a & 3a).

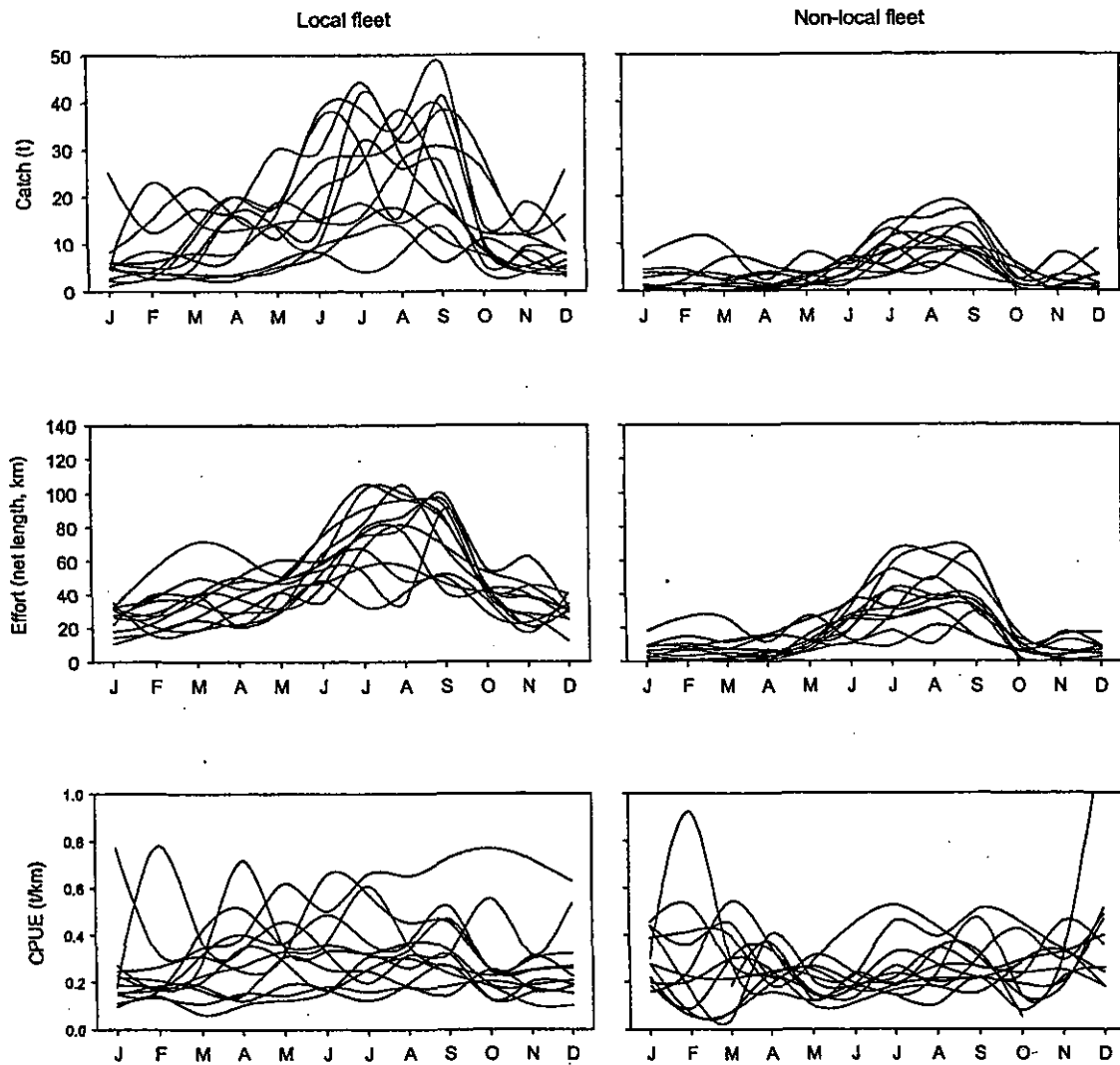
**Table 2: Annual setnet and ring net landings and targeted landings of grey mullet in the Kaipara Harbour relative to the landed catch and TACC for the whole of GMU 1.**

Fishing year	GMU 1 TACC (t)	GMU 1 landings (t)	Kaipara setnet (t)	Kaipara ring net (t)	Kaipara as % of GMU 1	Targeted Kaipara set net (t)	Targeted Kaipara ring net (t)	Targeted as % of GMU 1
1989–90	990	907	330	7	37.2	324	7	36.5
1990–91	994	875	251	18	30.7	246	18	30.2
1991–92	1 006	848	211	12	26.3	205	12	25.6
1992–93	1 006	711	223	15	33.5	219	15	32.9
1993–94	1 006	743	193	20	28.7	192	20	28.5
1994–95	1 006	776	260	31	37.5	256	31	37.0
1995–96	1 006	866	286	51	38.9	280	51	38.2
1996–97	1 006	870	385	76	53.0	375	76	51.8
1997–98	1 006	730	268	72	46.6	258	72	45.2
1998–99	925	750	116	197	41.7	110	197	40.9
1999–00	925	749	115	196	41.5	109	196	40.7
2000–01	925	797	103	142	30.7	98	142	30.1

#### 4.3.1 Setnet fishery targeting grey mullet

The grey mullet setnet fishery operates throughout the fishing year, but fishing effort increases substantially from July to September (Figure 7). Although both the local and non-local fleets exhibited similar activity patterns, the local fleet generally accounted for over 70% of fishing events (Appendix 2a). There was no seasonal pattern in catch rates, however, which were highly variable within any given fishing year.

Almost all grey mullet landed by setnet is caught as a result of targeting the species (Table 2). Annual landings of grey mullet have declined markedly in recent years, as has local fleet effort to a lesser degree (Figure 8). Catch and effort by the non-local fleet have fluctuated over the last 10 years, but no long-term trends are evident for these vessels.



**Figure 7: Seasonality of targeted grey mullet setnet catch, effort, and CPUE by the local fleet (left panels) and the non-local fleet (right panels). Smoothed monthly values for the fishing years 1989-90 to 2000-01.**

All four catch rate indices show very similar trends. Between 1991-92 and 1996-97, CPUE steadily increased, but fell sharply in the next two fishing years to the lowest level seen since 1989-90 (Figure 9). Since then there has been little change in catch rates. These trends are similar to a standardised catch rate index previously calculated for the period 1989-90 to 1995-96 (McKenzie, Unpublished results). Catch rates calculated for the index fleet accounted for 61% of the targeted catch, 56% of the total length of all nets set, and 18% of the vessels participating in this fishery since 1989-90.

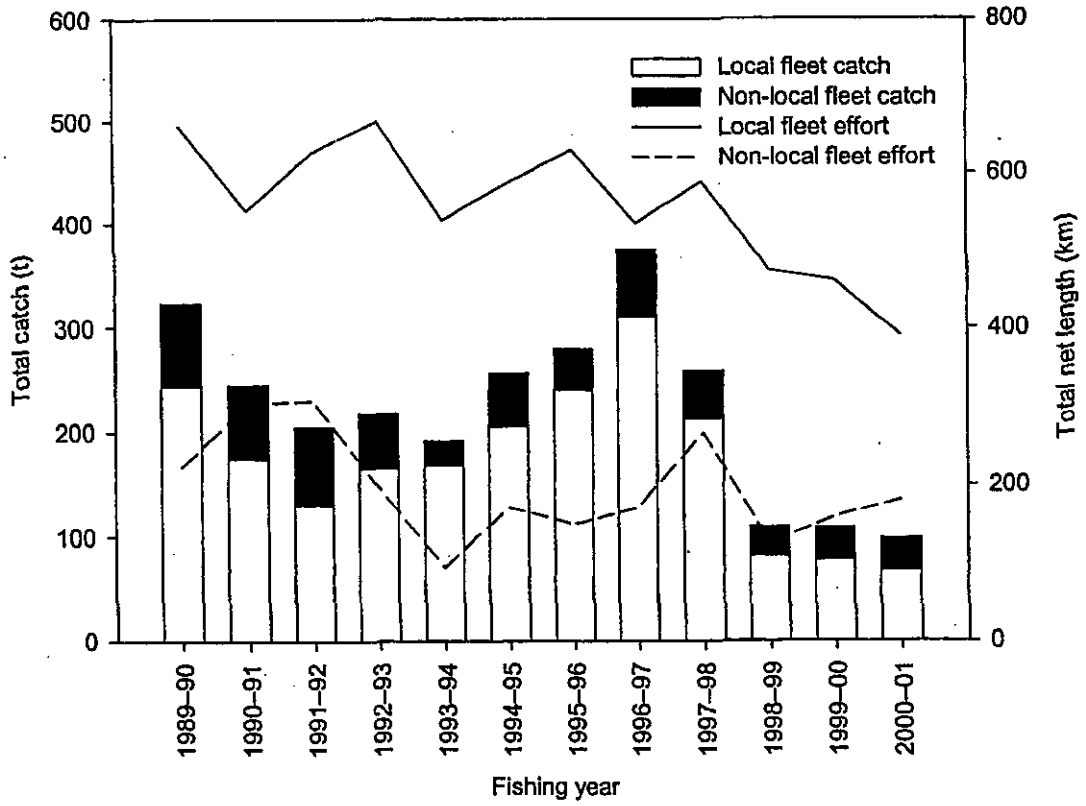


Figure 8: Total catch and setnet effort by local and non-local fishing fleets when targeting grey mullet by fishing year.

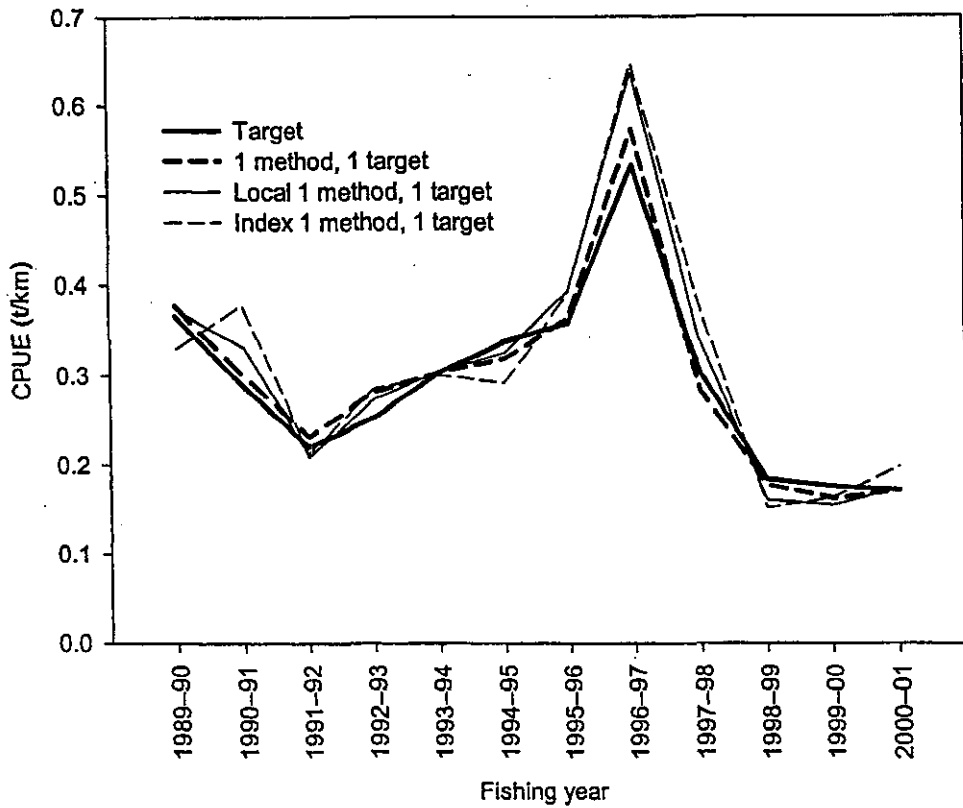


Figure 9: Indices of unstandardised catch rate for setnet trips where grey mullet was targeted, by fishing year. Conventions as per Figure 5.

### 4.3.2 Ring net fishery targeting grey mullet

In the last 10 years the reported number of ring net days increased substantially, although local vessels increased their effort only in the last 6 years (Appendix 3a). Landed catches have increased correspondingly, and most of the catch is now caught by local vessels (Appendix 3b). Ring netting is used only to target grey mullet, and hence all grey mullet catch by this method is the result of targeting (Table 2). Examination of the data suggests that there is no reliable measure of effort with which to generate CPUE indices. The reported number of sets per day was highly variable and frequently went unreported. Net length estimates per set were reported, but as the number of sets per day was not considered reliable, it was not possible to relate total catch to total net length.

Ring netting for grey mullet occurred throughout the fishing year, but in some years was higher during winter and spring (Figure 10). Annual landed catches have generally increased since 1991–92, but fell noticeably in 2000–01 (Figure 11). Between 1994–95 and 1996–97, most of the ring net catch was landed by non-local vessels, but subsequently, local vessel catch increased substantially while non-local landings decreased.

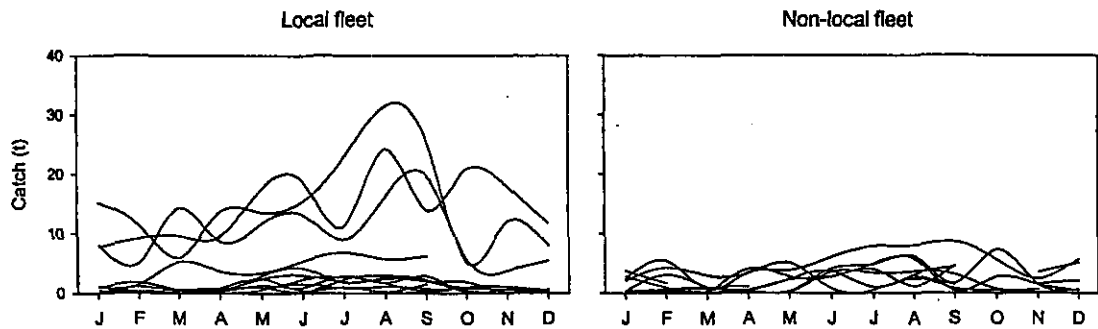


Figure 10: Seasonality of targeted grey mullet ring net catch by the local fleet (left panels) and the non-local fleet (right panels). Smoothed monthly values for the fishing years 1989–90 to 2000–01.

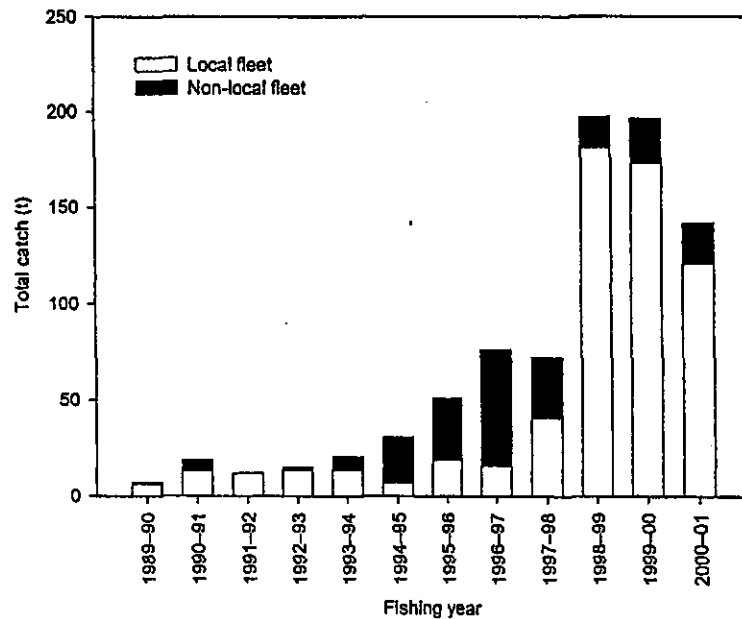


Figure 11: Total catch by ring net by local and non-local fishing fleets when targeting grey mullet by fishing year.

#### 4.4 Setnet fishery targeting rig

Almost all rig landed from the Kaipara Harbour is caught as a result of targeting (Table 3). Landings from SPO 1 have decreased only slightly since 1989–90, but increasing catches from the Kaipara Harbour, where annual landings have increased substantially.

**Table 3: Annual setnet landings and targeted landings of rig in the Kaipara Harbour relative to the total landed catch and TACC for the whole of SPO 1.**

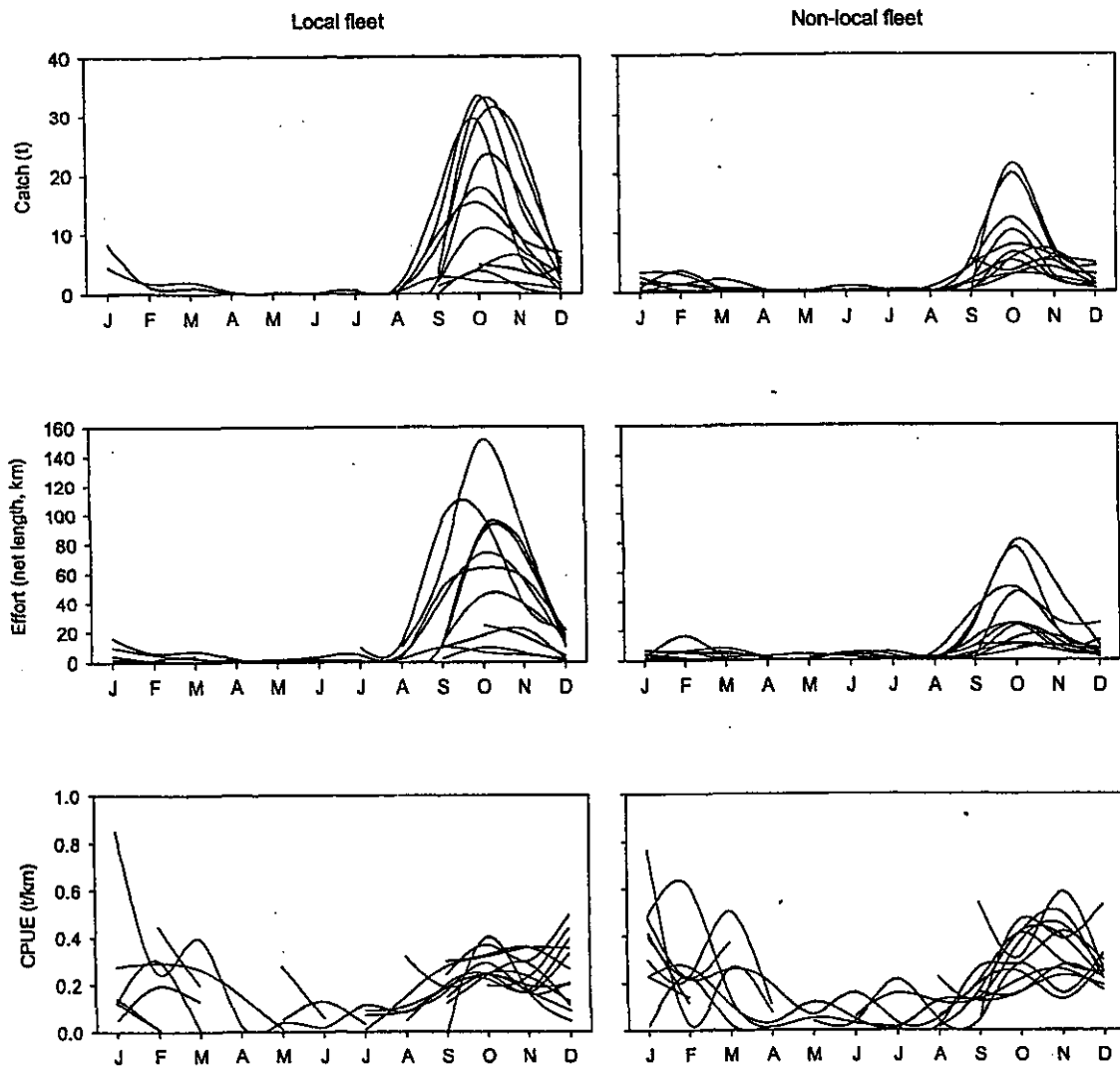
Fishing year	SPO 1 TACC (t)	SPO 1 landings (t)	Kaipara setnet (t)	% of SPO 1 landings (t)	Targeted Kaipara (t)	% of SPO 1 landings (t)
1989–90	687	689	29	4.2	24	3.5
1990–91	688	656	32	4.9	25	3.8
1991–92	825	878	57	6.5	46	5.2
1992–93	825	719	36	5.0	30	4.2
1993–94	829	631	38	6.0	33	5.2
1994–95	829	666	77	11.6	73	11.0
1995–96	829	603	76	12.6	72	11.9
1996–97	829	681	65	9.5	60	8.8
1997–98	692	621	58	9.3	49	7.9
1998–99	692	553	89	16.1	81	14.6
1999–00	692	608	120	19.7	109	17.9
2000–01	692	554	105	19.0	100	18.1

In the mid 1990s, local fleet participation in the rig setnet fishery peaked at about 80% of the total fleet and 90% of fishing events. Local involvement has now fallen to about 60% and 65% respectively (Appendix 4a). The fishery was highly seasonal, beginning in September and finishing in December, which corresponds to the inshore movement of rig which mate in shallow waters after offshore pupping by females in deeper waters (Figure 12). Sporadic sets targeting rig were reported in the off-season, but contributed little to the annual landed catch. Seasonal catch rates peaked over spring and summer, but were probably poorly described in the off-season.

Local fleet fishing effort has steadily increased since 1989–90 as has non-local fleet effort in more recent years (Figure 13). Total annual catches by the local fleet were about of 10 to 15 tonnes in the early 1990s, but in 1994–95 the annual catch of this fleet tripled, and has since fluctuated at around this level. Non-local vessels caught most of the targeted rig in the early 1990s, with annual catches declining in the mid 1990s and subsequently increasing in later years. The combination of these fleet catch histories has been a fluctuating, but generally increasing, trend of extraction of rig by ring netting from the Kaipara Harbour.

Conversely, rig catch rates have fluctuated, but generally fallen since 1989–90 (Figure 14). Catch rates calculated from different datasets vary in their magnitude, but all show the same trend. A CPUE index given in Paul (2003) demonstrates a similar trend, although the magnitude of annual estimates is generally lower than those calculated from this study.





**Figure 12: Seasonality of targeted rig setnet catch, effort, and CPUE by the local fleet (left panels) and the non-local fleet (right panels). Smoothed monthly values for the fishing years 1989–90 to 2000–01.**

Differences between these studies originate from the nature of catch estimates used. This study uses catch weights, based predominantly, but not exclusively, on landed catch weights, whereas the index derived from Paul's study is based upon estimates of catch made by the fisher. Differences can therefore arise when fishers make poor estimates of their catch, or report processed weights in the estimated catch section of the CELR. The latter explanation is supported by the generally higher levels of CPUE generated from this study, as landed catch weights should exceed estimated catch weights when estimated processed weights are recorded by fishers. In Paul's database, annual landing totals (which were very similar to those generated from this study) generally exceed annual estimated catch totals. Landed catch data were used in this study, as they were considered more accurate than estimated catch weights, and less likely to be influenced by the misreporting of estimated greenweights, as estimated processed weights.

Regardless of the measure used, however, the trends in fishing success are generally the same, suggesting a decline in rig abundance. Paul (2003), found that the largest declines in rig CPUE have been in the west coast harbours during the summer.

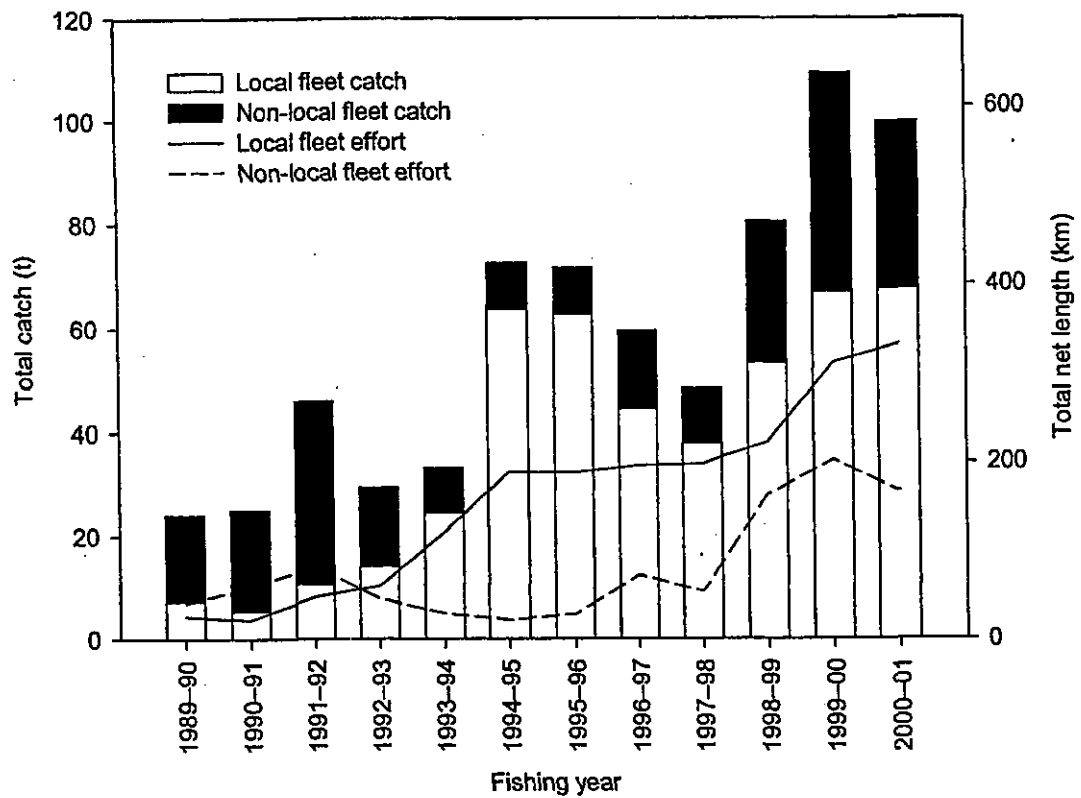


Figure 13: Total catch and setnet effort by local and non-local fishing fleets when targeting rig by fishing year.

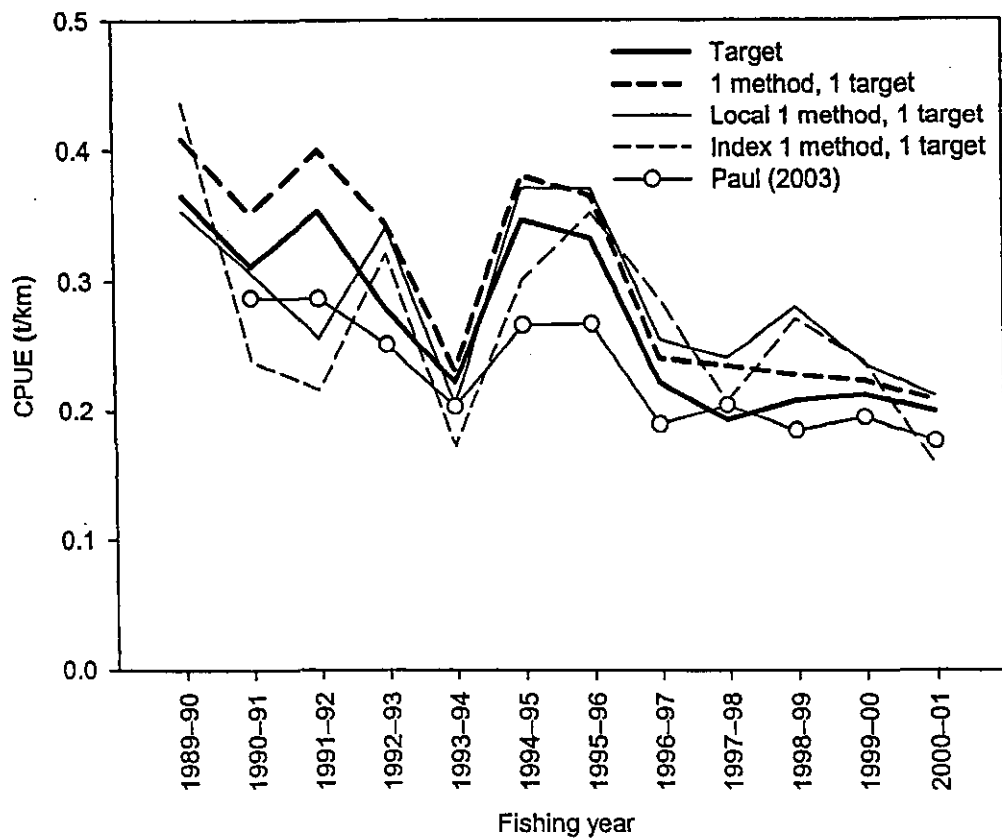


Figure 14: Indices of unstandardised catch rate for setnet trips where rig was targeted, by fishing year. Conventions as per Figure 5.

## 5. DISCUSSION

Increasing levels of setnet fishing effort and declining catch rates in some Kaipara Harbour setnet fisheries have led to concerns about sustainability by local fishers and the wider community. The predominant fisheries in the Kaipara Harbour are those targeting flatfish, grey mullet, and rig, which should be regarded holistically, as shifts between these fisheries appear to take place on a seasonal basis with about half the fleet participating in two or more fisheries.

All the species examined are managed under the Quota Management System, which attempts to constrain catches to sustainable levels. The Quota Management Areas used are essentially confederations of localised fisheries, which are not managed individually. Localised depletion may therefore occur in two ways. Local fishers may fish at unsustainable levels, and/or fishing effort may shift between harbours, which commonly occurs in setnet fisheries where many of the vessels are trailer borne dories. The Kaipara Harbour setnet fisheries include many launch-type vessels, which are unable to respond to falling catch rates by shifting fishing effort to elsewhere. In this study, a "local" fleet was identified, to give some insight into the extent to which effort had shifted from other harbours/fisheries through time. Further, by identifying these vessels, a core of experienced fishers were identified, whose catch rates are more likely to reflect the underlying abundance of the species examined.

*In the past decade, fishing effort for all three species has generally increased. Annual totals of net lengths set by both local and non-local fleets targeting flatfish and rig have increased, but these increases were not solely attributable to either the local or non-local fleets. While setnet effort targeting grey mullet has fallen markedly in recent years, a switch to ring netting appears to have occurred, and, overall, fishing effort appears to have increased, which is largely attributable to local fishers.*

Annual landed catches of flatfish have increased in recent years, largely by the non-local fleet, which still lands less than 25% of the total catch. Annual landings of grey mullet by the setnet fleet have fluctuated, but fallen substantially in recent years, but there has been a marked corresponding increase in ring net catches. When catches by both methods are combined, however, a recent decline in total grey mullet landings is evident. The annual rig catch has increased through time, with local catches increasing markedly in 1994–95 and non-local catches increasing markedly in 1998–99.

Catch rates of all three species peaked in the mid 1990s, but have declined in recent years, yet an increasing proportion of landings from each species Quota Management Area comes from the Kaipara Harbour. Fishing effort may therefore be shifting to the Kaipara Harbour from other areas, and this, in conjunction with increased effort by local fishers, may result in localised depletion, as declining catch rates suggest.

## 6. ACKNOWLEDGMENTS

Thanks are due to Larry Paul for numerous helpful discussions about setnet fisheries, with which he is far more familiar than I. This study was funded through the Ministry of Fisheries contract MOF200203C. Thanks are also due to Mike Beardsell, for his editorial advice.

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**Appendix 1a: Number of fishing vessels targeting flatfish and fishing events fished when setnetting was the reported method, by fishing year.**  
 "Total fleet", all vessels fishing in the Kaipara Harbour; "Local fleet", vessels with at least 90% of all reported fishing events in the Kaipara Harbour; "Index vessels", "local" vessels which reported at least 500 days of fishing over at least 5 fishing years.

Fishing year	Number of fishing vessels				Fishing events			
	Total fleet	Local fleet	% local	Index vessels	Total fleet	Local fleet	% local	Index vessels
1989-90	55	40	73	15	2 464	2 173	88	1 317
1990-91	57	39	68	15	2 953	2 469	84	1 474
1991-92	51	35	69	18	2 747	2 205	80	1 577
1992-93	59	41	69	20	2 466	2 157	87	1 666
1993-94	47	38	81	22	2 337	2 154	92	1 830
1994-95	49	38	78	23	2 402	2 259	94	2 078
1995-96	53	38	72	25	2 461	2 213	90	1 968
1996-97	62	48	77	22	3 315	2 730	82	2 416
1997-98	61	37	61	22	4 144	3 364	81	2 459
1998-99	56	39	70	21	4 231	3 506	83	2 368
1999-00	66	40	61	20	5 123	4 112	80	1 974
2000-01	63	39	62	19	5 681	4 563	80	2 468

**Appendix 1b: flatfish catch, setnet effort and CPUE by fishing years.** "Target", all fishing events reported by all vessels, where flatfish was targeted; "1 method, 1 target", trips where one method was used to target one species; "Local 1 method, 1 target", trips reported by those vessels with over 90% of reported fishing events occurring in the Kaipara harbour, where one method was used to target flatfish; "Index 1 method, 1 target", trips reported by those vessels with over 90% of reported fishing events occurring in the Kaipara harbour which had a prolonged fishing history, where one method was used to target flatfish.

Fishing year	Catch (t)					Effort (net length, km)				CPUE (t/km)			
	Total	Target	Local		Index	Target	Local			Target	Index		
			1 method	1 method	1 method		1 method	1 method	1 method		1 method		
1989-90	221	220	208	177	103	2 422	2 267	2 116	1 194	0.09	0.09	0.08	0.09
1990-91	216	215	195	159	88	2 852	2 577	2 293	1 281	0.08	0.08	0.07	0.07
1991-92	213	211	191	162	104	2 633	2 367	2 087	1 336	0.08	0.08	0.08	0.08
1992-93	199	198	183	169	114	2 336	2 119	2 004	1 587	0.08	0.09	0.08	0.07
1993-94	165	163	143	140	118	2 049	1 787	1 750	1 512	0.08	0.08	0.08	0.08
1994-95	216	215	197	185	167	2 076	1 879	1 797	1 672	0.10	0.10	0.10	0.10
1995-96	206	203	187	167	149	2 083	1 838	1 682	1 515	0.10	0.10	0.10	0.10
1996-97	276	271	253	205	184	2 759	2 498	2 099	1 907	0.10	0.10	0.10	0.10
1997-98	270	265	242	183	134	3 511	3 000	2 463	1 810	0.08	0.08	0.07	0.07
1998-99	249	243	224	168	108	3 524	3 171	2 673	1 800	0.07	0.07	0.06	0.06
1999-00	293	292	267	208	108	4 238	3 894	3 166	1 520	0.07	0.07	0.07	0.07
2000-01	316	315	297	225	125	4 981	4 691	3 839	2 239	0.06	0.06	0.06	0.06

Appendix 2a: Number of fishing vessels targeting grey mullet and fishing events fished when set netting was the reported method, by fishing year. "Total fleet", all vessels fishing in the Kaipara Harbour; "Local fleet", vessels with at least 90% of all reported fishing events in the Kaipara Harbour; "Index vessels", "local" vessels which reported at least 500 days of fishing over at least 5 fishing years.

Fishing year	Number of fishing vessels			Fishing events		
	Total	Local	% Index	Total	Local	% Index
1989-90	37	21	57	980	685	70
1990-91	43	27	63	1113	761	68
1991-92	44	24	55	1170	752	64
1992-93	44	27	61	1073	755	70
1993-94	38	27	71	891	706	79
1994-95	42	29	69	1009	771	76
1995-96	46	31	67	1043	850	81
1996-97	40	24	60	991	718	72
1997-98	49	28	57	1385	995	72
1998-99	42	30	71	893	709	79
1999-00	43	27	63	1003	767	76
2000-01	31	18	58	901	628	70

Appendix 2b: Grey mullet catch, set net effort and CPUE by fishing years. "Target", all fishing events reported by all vessels, where grey mullet was targeted; "Local", trips where one method was used to target one species; "Index", trips where one method was used to target grey mullet; those vessels with over 90% of reported fishing events occurring in the Kaipara Harbour, where one method was used to target grey mullet; "Index", trips reported by those vessels with over 90% of reported fishing events occurring in the Kaipara Harbour which had a prolonged fishing history, where one method was used to target grey mullet.

Fishing year	Catch (t)			Effort (net length, km)			CPUE (t/km)		
	Total	Local	% Index	Total	Local	% Index	Total	Local	% Index
1989-90	330	283	214	883	750	572	263	0.37	0.38
1990-91	251	246	204	855	680	428	279	0.29	0.33
1991-92	211	205	164	933	708	478	398	0.22	0.23
1992-93	223	219	180	863	641	509	453	0.25	0.28
1993-94	193	192	123	632	404	348	327	0.30	0.30
1994-95	260	256	188	757	587	453	398	0.34	0.33
1995-96	286	280	216	779	595	456	395	0.36	0.36
1996-97	385	375	266	704	463	337	304	0.53	0.57
1997-98	268	258	170	854	603	400	315	0.30	0.28
1998-99	116	110	82	598	464	358	148	0.18	0.18
1999-00	115	109	73	619	452	330	164	0.18	0.16
2000-01	103	98	71	572	417	280	114	0.17	0.17

Appendix 3a: Number of fishing vessels targeting grey mullet and fishing events fished when ring netting was the reported method, by fishing year. "Total fleet", all vessels fishing in the Kaipara Harbour; "Local fleet", vessels with at least 90% of all reported fishing events in the Kaipara Harbour; "index vessels", "local" vessels which reported at least 100 days of fishing over at least 3 fishing years.

Fishing year	Number of fishing vessels				Days fished			
	Total fleet	Local fleet	% local	Index vessels	Total fleet	Local fleet	% local	Index vessels
1989-90	3	2	67	1	54	52	96	15
1990-91	4	3	75	2	109	91	83	86
1991-92	3	3	100	1	49	49	100	48
1992-93	9	5	56	2	49	43	88	35
1993-94	8	2	25	2	53	34	64	34
1994-95	9	2	22	2	122	29	24	29
1995-96	9	2	22	2	172	83	48	83
1996-97	16	4	25	3	265	64	24	53
1997-98	13	4	31	3	282	156	55	154
1998-99	16	6	38	4	396	324	82	196
1999-00	13	3	23	3	397	266	67	266
2000-01	16	5	31	3	291	209	72	145

Appendix 3b: grey mullet catch, set net effort and CPUE by fishing years. "Target", all fishing events reported by all vessels, where grey mullet was targeted; "1 method, 1 target", trips where one method was used to target one species; "Local 1 method, 1 target", trips reported by those vessels with over 90% of reported fishing events occurring in the Kaipara harbour, where one method was used to target grey mullet; "Index 1 method, 1 target", trips reported by those vessels with over 90% of reported fishing events occurring in the Kaipara harbour which had a prolonged fishing history, where one method was used to target grey mullet.

Fishing year	Catch (t)					Effort	CPUE
	Total	Local Target	Local 1 method 1 target	Index 1 method 1 target	Index 1 method 1 target		
1989-90	7	7	5	4	0		
1990-91	18	18	14	9	8		
1991-92	12	12	8	8	8		
1992-93	15	15	12	10	8		
1993-94	20	20	17	10	10	No reliable measure of effort available	No reliable measure of effort available
1994-95	31	31	29	6	6		
1995-96	51	51	50	18	18		
1996-97	76	76	71	14	12		
1997-98	72	72	67	37	37		
1998-99	197	197	156	140	52		
1999-00	196	196	131	109	108		
2000-01	142	142	112	93	66		

Appendix 4a: Number of fishing vessels targeting rig and fishing events fished when setnetting was the reported method, by fishing year. "Total fleet", all vessels fishing in the Kaipara Harbour; "Local fleet", vessels with at least 90% of all reported fishing events in the Kaipara Harbour; "index vessels", "local" vessels which reported at least 500 days of fishing over at least 5 fishing years.

Fishing year	Number of fishing vessels				Fishing events			
	Total fleet	Local fleet	% local	Index vessels	Total fleet	Local fleet	% local	Index vessels
1989-90	12	7	58	4	88	45	51	38
1990-91	19	10	53	5	101	33	33	21
1991-92	16	7	44	5	141	55	39	49
1992-93	13	10	77	6	130	74	57	62
1993-94	17	14	82	9	182	145	80	120
1994-95	18	14	78	9	241	216	90	144
1995-96	18	14	78	10	229	199	87	132
1996-97	30	16	53	10	326	222	68	136
1997-98	26	17	65	8	311	229	74	109
1998-99	27	15	56	7	435	262	60	110
1999-00	27	17	63	6	580	367	63	107
2000-01	28	16	57	6	640	442	69	111

Appendix 4b: rig catch, setnet effort and CPUE by fishing years. "Target", all fishing events reported by all vessels, where rig was targeted; "1 method, 1 target", trips where one method was used to target one species; "Local 1 method, 1 target", trips reported by those vessels with over 90% of reported fishing events occurring in the Kaipara harbour, where one method was used to target rig; "Index 1 method, 1 target", trips reported by those vessels with over 90% of reported fishing events occurring in the Kaipara harbour which had a prolonged fishing history, where one method was used to target rig.

Fishing year	Catch (t)					Effort (net length, km)				CPUE (t/km)			
	Total	Target	Local		Index	Target	Local		Index	Target	Local		Index
			1 method 1 target	1 method 1 target	1 method 1 target		1 method 1 target	1 method 1 target	1 method 1 target		1 method 1 target		
1989-90	29	24	20	4	4	66	48	13	9	0.37	0.41	0.35	0.44
1990-91	32	25	18	3	1	81	50	9	3	0.31	0.35	0.31	0.24
1991-92	57	46	39	5	4	131	97	19	18	0.35	0.40	0.26	0.22
1992-93	36	30	20	9	7	107	58	26	22	0.28	0.34	0.34	0.32
1993-94	38	33	26	17	12	149	111	85	68	0.22	0.23	0.21	0.17
1994-95	77	73	58	49	25	210	152	131	83	0.35	0.38	0.37	0.30
1995-96	76	72	65	56	32	216	178	152	91	0.33	0.36	0.37	0.35
1996-97	65	60	53	41	23	268	219	159	80	0.22	0.24	0.26	0.29
1997-98	58	49	41	33	13	252	175	138	62	0.19	0.24	0.24	0.21
1998-99	89	81	76	49	15	387	332	175	56	0.21	0.23	0.28	0.27
1999-00	120	109	96	57	15	513	429	241	63	0.21	0.22	0.24	0.24
2000-01	105	100	93	63	10	500	447	297	66	0.20	0.21	0.21	0.16