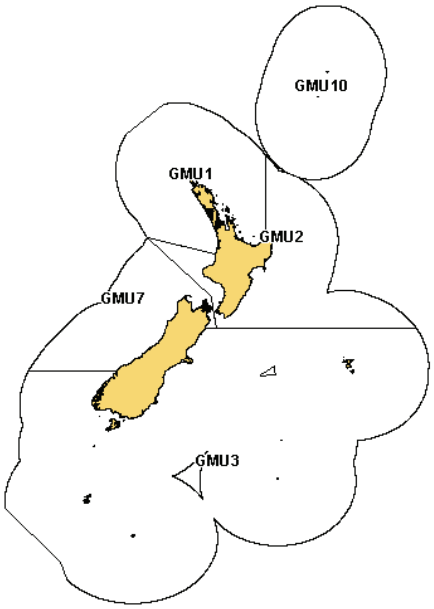
GREY MULLET (GMU)

(*Mugil cephalus*)
Kanae, Hopuhopu



1. FISHERY SUMMARY

1.1 Commercial fisheries

Commercial fishing for grey mullet occurs predominantly in the GMU 1, where annual landings increased from approximately 420 t in 1974 to a maximum of 1142 t in 1983–84. Marked changes in fishing effort occurred during this period through the development of more efficient fishing techniques and an increase in the market demand for this species. Before the introduction of the QMS, total domestic catches declined from the maximum (1160 t) in 1983–84 to 901 t in 1985–86. The TACC was consistently under caught after GMU 1 was introduced into the QMS (Figure 1). The Minister of Fisheries therefore reduced the TACC for GMU 1 to 925 t, beginning in 1998–99. The reduction in TACC had little effect on the annual catches, and it has only ever been reached in GMU 1 in 2004–05 (Table 1).

Table 1: Reported landings (t) of grey mullet by Fishstock from 1983–84 to 2007–08 and actual TACCs (t) for 1986–87 to 2007–08. QMS data from 1986–present.

Fishstock	GMU 1		GMU 2		GMU 3		GMU 7		GMU 10			
QMA (s)	1 & 9		2 & 8		3, 4, 5 & 6		7		10		Total	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1983–84*	1 142	–	6	–	5	–	7	–	0	–	1 160	–
1984–85*	1 069	–	5	–	0	–	15	–	0	–	1 089	–
1985–86*	881	–	10	–	0	–	10	–	0	–	901	–
1986–87	595	910	3	20	<1	30	0	20	0	10	598	990
1987–88	751	941	3	20	0	30	0	20	0	10	754	1 021
1988–89	792	963	3	20	0	30	0	20	0	10	795	1 043
1989–90	907	990	2	20	0	30	4	20	0	10	913	1 070
1990–91	875	994	2	20	1	30	<1	20	0	10	879	1 073
1991–92	848	1 006	1	20	2	30	1	20	0	10	852	1 086
1992–93	711	1 006	<1	20	<1	30	0	20	0	10	712	1 086
1993–94	743	1 006	<1	20	<1	30	0	20	0	10	706	1 086
1994–95	776	1 006	0	20	<1	30	10	20	0	10	787	1 086
1995–96	866	1 006	0	20	< 1	30	< 1	20	0	10	866	1 086
1996–97	870	1 006	< 1	20	1	30	< 1	20	0	10	872	1 086
1997–98	730	1 006	< 1	20	< 1	30	< 1	20	0	10	730	1 086
1998–99	750	925	< 1	20	< 1	30	< 1	20	0	10	750	1 005
1999–00	749	925	< 1	20	0	30	< 1	20	0	10	750	1 005
2000–01	797	925	1	20	0	30	< 1	20	0	10	798	1 005
2001–02	782	925	2	20	< 1	30	< 1	20	0	10	784	1 005

Table 1 continued:

Fishstock	GMU 1		GMU 2		GMU 3		GMU 7		GMU 10			
QMA (s)	1 & 9		2 & 8		3, 4, 5 & 6		7		10		Total	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
2002–03	797	925	1	20	< 1	30	0	20	0	10	798	1 005
2003–04	886	925	< 1	20	0	30	< 1	20	0	10	796	1 005
2004–05	941	925	< 1	20	0	30	0	20	0	10	941	1 005
2005–06	878	925	< 1	20	< 1	30	0	20	0	10	878	1 005
2006–07	844	925	< 1	20	0	30	< 1	20	0	10	845	1 005
2007–08	848	925	< 1	20	< 1	30	< 1	20	0	10	849	1 005

* FSU data.

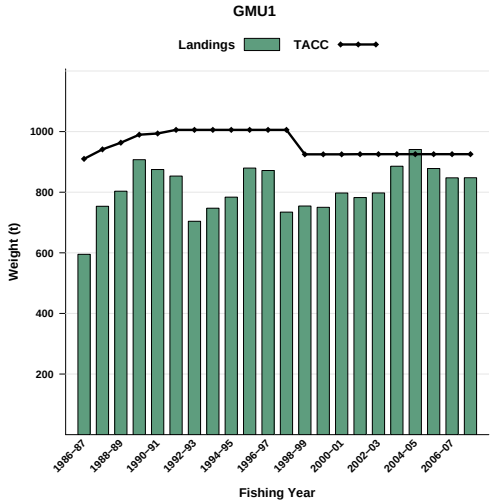


Figure 1: Historical landings and TACC for the main GMU stock; GMU 1 (Auckland). Note that this figure does not show data prior to entry into the QMS.

1.2 Recreational fisheries

Grey mullet are a popular recreational species particularly in the Auckland FMA. Information is available on the relative levels of commercial and amateur catch of this species in the Manukau Harbour and the lower Waikato River based on limited tagging work undertaken in 1987. Of the number of tags returned 38% were from amateur fishers, suggesting that recreational use of the resource was relatively high.

The 1993–94 North Region Recreational Fishing Survey (Teirney *et al*. 1997) estimated the annual recreational catch from GMU 1 at 150 t (Table 2). This represents 17% of the total landings from GMU 1 in 1993–94. The 1996 National Recreational Fishing Survey (Bradford, 1998) estimated the annual recreational catch from GMU 1 in the 1996 fishing year at 106 t (Table 2). The 2000 National Recreational Fishing Survey (Boyd *et al*. 2000) fishing survey provided an estimate of 102 t (Table 2). Results from the three recreational surveys are relatively consistent; it is likely the annual level of recreational extraction from GMU 1 is in the order of 100–150 t. The Minister of Fisheries provided an allowance for customary harvest of 100 t beginning in 1998–99.

Table 2: Estimated number of grey mullet harvested by recreational fishers by Fishstock and survey year, the corresponding estimated survey harvest, and the estimated Fishstock harvest.

		Total			
Fishstock	Survey year	Number	CV	Estimated harvest range (t)	Point estimate (t)
GMU 1	1993–94	170 000	19%	90–210	150
GMU 1	1996	110 000	25%	80–130	106
GMU 1	2000	110 000	33%	68–136	102

The RTWG recommends that the harvest estimates from the diary surveys should be used only with the following qualifications: a) they may be very inaccurate; b) the 1996 and earlier surveys contain a methodological error; and, c) the 2000 and 2001 estimates are implausibly high for many important fisheries. Relative comparisons may be possible between stocks within these surveys.

1.3 Customary non-commercial fisheries

No quantitative information is available on the current level of customary non-commercial take. The Minister of Fisheries provided an allowance for customary harvest of 100 t per annum beginning in 1998–99.

1.4 Illegal catch

Estimates of illegal catch are unknown but anecdotal evidence suggests 10–20% under-reporting is plausible. In the latest stock assessment, an annual under-reporting of 20% was assumed for the period before 1986 and 10% thereafter.

1.5 Other sources of mortality

No quantitative estimates are available regarding the impact of other sources of mortality on grey mullet stocks. Grey mullet principally occur in sheltered harbours and estuarine ecosystems. Some of these habitats are known to have suffered environmental degradation.

2. BIOLOGY

Grey mullet has a world wide distribution, occurring commonly along coasts, in estuaries, and in lower river systems between latitudes of 42° N and 42° S. Overseas and New Zealand tagging studies indicate that movement patterns of adult grey mullet are complex. Some schools remain in one locality, while others appear to be on the move almost continuously. Recorded movements of tagged grey mullet of 160 km within a few weeks of release are not uncommon.

Females grow faster than males and attain a larger size. Both sexes mature at 3 years of age at an average size of 33 cm fork length (FL) for males and 35 cm FL for females. Maximum ages appear to be 12 to 14 years, with ages 4-8 comprises the bulk of the commercial fishery.

Natural mortality was estimated from the equation $M = \log_e 100/\text{maximum age}$, where maximum age is the age to which 1% of the population survives in an unexploited stock. Using 15 years for the maximum age results in an estimate of $M = 0.33$. (Note: the maximum age of 15 years was obtained from an exploited population, so M is likely to be less than 0.33).

Grey mullet commonly occur in schools, which generally become larger and more prevalent in the spawning season. Spawning in northern New Zealand occurs during November through February. Females are highly fecund and may release up to 1 million eggs in a spawning event. It is likely that grey mullet spawn at sea, because running-ripe females have only been caught off coastal beaches or in offshore waters, and eggs and larvae are a component of the offshore coastal plankton at certain times of the year. Small post-larval grey mullet occur seasonally in estuaries, which serve as nursery grounds for juveniles.

Adult grey mullet typically feed on diatom algae and small invertebrates which are gulped along with surface scum or with detrital ooze and sifted by fine teeth and gill-rakers.

Biological parameters relevant to stock assessment are shown in Table 3.

Table 3: Estimates of biological parameters of grey mullet.

Fishstock	Estimate	Source
1. Natural mortality (M)		
GMU 1	0.33	NIWA (unpubl. data)

2. Weight = a(length) (Weight in g, length in cm fork length).

	Both Sexes		
	a	b	
GMU 1	0.04236	2.826	Breen & McKenzie (unpublished)

3. Von Bertalanffy growth parameters

	Females			Males			
	L_∞	k	t_0	L_∞	k	t_0	
GMU 1	40.1	0.587	1.3469	37.0	0.619	1.3257	Breen & McKenzie (unpublished)

3. STOCKS AND AREAS

There is little biological data to determine the level of sub stock separation within GMU 1. Results from a small scale tagging program in the Manukau Harbour and the Lower Waikato River indicated that there is fish movement between these two localities and also north along the west coast but the level of net movement cannot be ascertained. There is evidence in the CPUE data that GMU 1 may be comprised of 6 populations with low to moderate mixing between them (McKenzie 1997).

GMU 1 has been divided into two substocks for the purposes of fisheries stock assessment: east cost substock; west coast substock. The boundary between the two sub-stocks is assumed to be due north from North Cape.

4. STOCK ASSESSMENT

4.1 Estimates of fishery parameters and abundance

Standardised CPUE analyses were undertaken for the six largest catching areas in GMU 1. The analysis was based on setnet catch and effort data for the years 1990-91 to 2005-06 (data for 1989-90 was not included due to potential problems relating to ring net catches). The response variable for the analyses was the log of the daily grey mullet catch with net length and set duration offered as covariates (McKenzie and Vaughan *in prep*.).

CPUE in the Kaipara Harbour, Manukau Harbour, and east Northland (which collectively account for over 80% of the GMU 1 catch (Figure 2)) have increased since 2002 (Figures 3 and 4). CPUE in the less important areas, though more variable, are similar to 2002 levels. While increases have been observed in the key areas, that the different CPUE series exhibit different trends and do not correlate well. The implication being that the major GMU 1 harbours and embayment's are home to relatively distinct sub-populations of grey mullet.

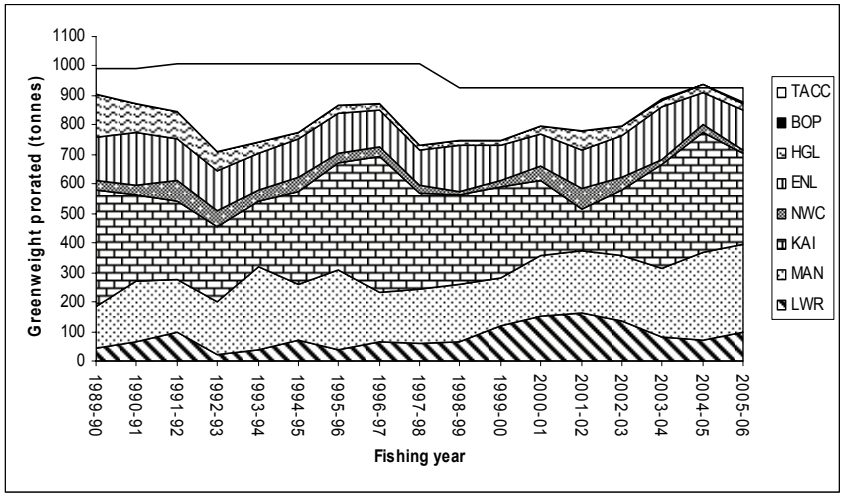


Figure 2: Recorded trip green weights in each zone (t) (groomed data scaled to annual catch).

4.2 Biomass estimates

West coast GMU 1

A stock assessment was undertaken for the west GMU 1 substock using a stochastic dynamic age-structured observation-error time series model (Breen & McKenzie 1998), but this did not prove to be robust and the results were rejected by the Working Group.

4.3 Estimation of Maximum Constant Yield (MCY)

There is insufficient information with which to revise the yield estimates of either the West or East coast GMU 1 substocks. The MCY estimate derived in 1986 using the equation MCY = cY_{AV} (Method 4) remains the accepted yield estimate for GMU 1.

Annual landings of grey mullet in the Auckland QMA for the period 1974–84 showed an increasing trend to a maximum in 1984. There were some fluctuations throughout this period. A general increase in fishing effort occurred during this time. Fishing effort between 1983–84 and 1985–86 appeared relatively constant, and catches during these years were averaged to estimate Y_{AV}. The constant 'c' was set at 0.8. This is not consistent with the maximum observed age of 14 years, which equates with an estimate of $M = 0.33$ and c = 0.7. However, it is believed that they live to older ages in unexploited populations. Therefore, the accuracy of MCY derived for grey mullet is uncertain. The estimate of MCY for GMU 1 is shown in Table 4. MCY cannot be estimated for the other fish stocks.

Table 4: Estimate of MCY (t) rounded to the nearest 5 t.

Fishstock	QMA	Y_{AV}	MCY
GMU 1	Auckland 1 & 9	1030	825

The level of risk to the stock by harvesting the population at the estimated MCY level cannot be determined.

4.4 Estimation of Current Annual Yield (CAY)

No estimates of current biomass, fishing mortality, or other information are available which would permit the estimation of CAY.

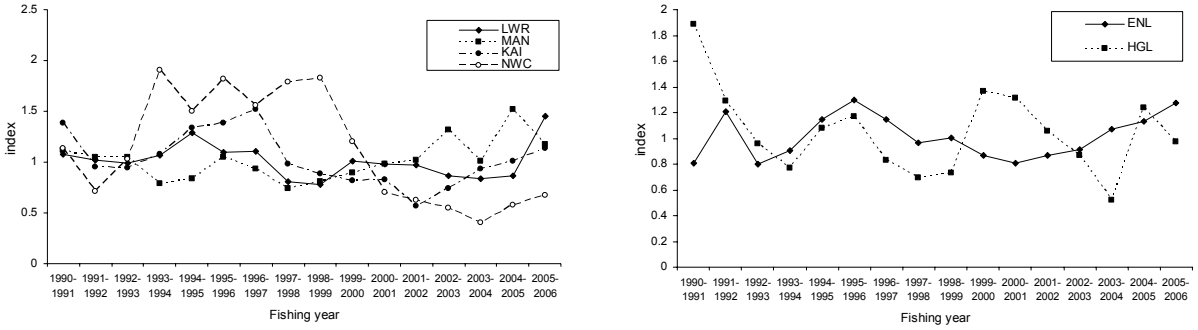


Figure 3: Standardised CPUE for the western (left) and eastern (right) areas. See Figure 4 for details of the areas.

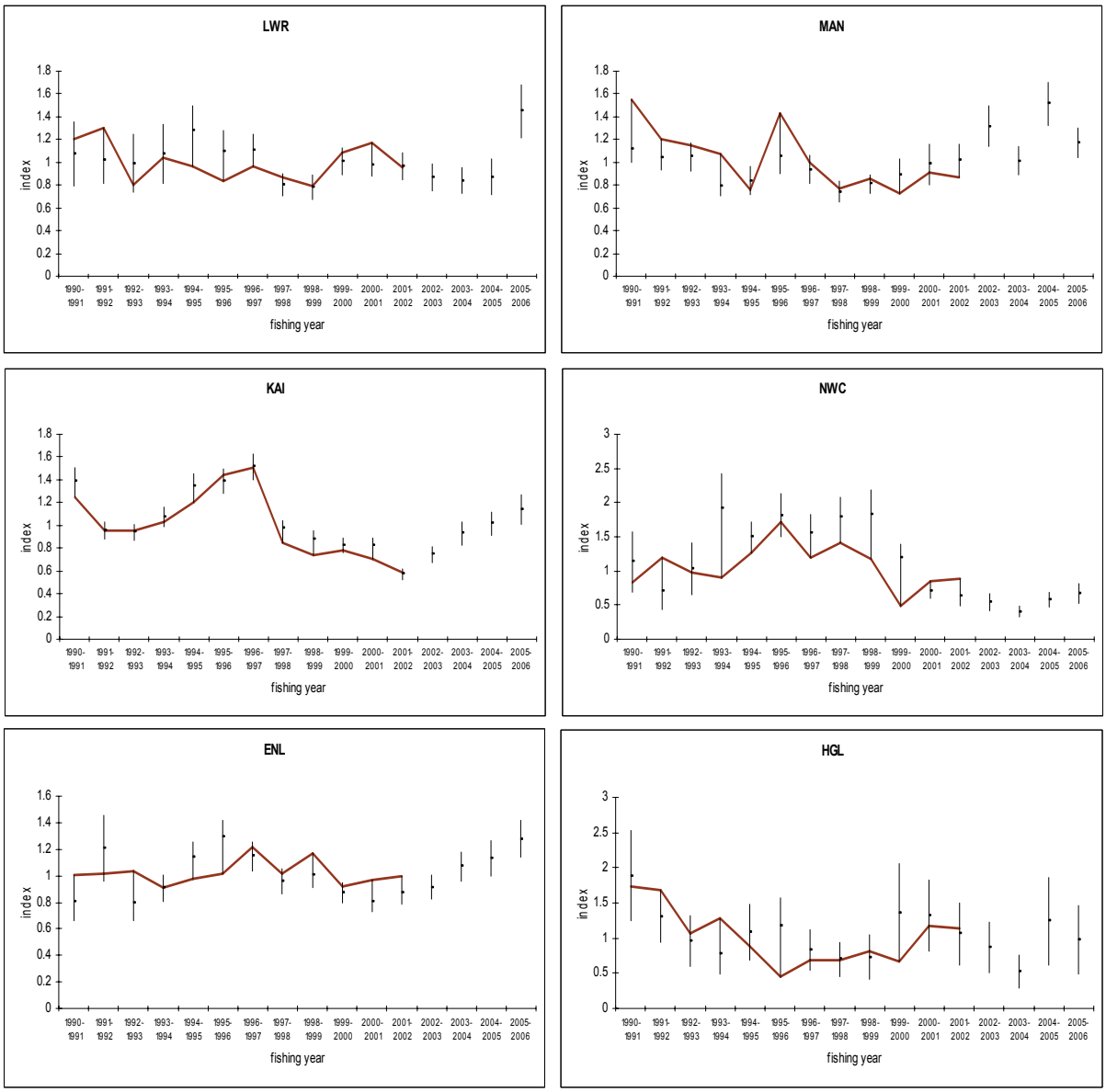


Figure 4: Standardised CPUE for the important GMU areas (points with error bars) and the previous CPUE series from Watson *et al.* (2005) (solid line). Error bars represent the 95% lognormal confidence intervals about each canonical index. LWR – lower Waikato River; MAN – Manukau Harbour; KAI – Kaipara Harbour; NWC – Northwest coast and harbours; ENL – east Northland; and HGL – Hauraki Gulf.

4.5 Other Factors

The minimum legal mesh size for use in the grey mullet fishery is 89 mm. However, fishers typically use mesh larger than 89 mm when fishing for grey mullet (MFish data). There are no data available to compare the selectivity characteristics of different mesh sizes. It is possible that a significant fraction of the grey mullet stock comprising larger older fish is poorly selected by the fishery. If this is true then the von Bertalanffy parameter estimates, which are based on random samples from the 1997–98 setnet landings, are likely to be biased: L_∞ will be biased low, K biased high.

Grey mullet have been exploited by customary, commercial, and recreational fishers for over 100 years. They are found predominantly in harbours and these environments have undergone considerable change over this period due to a range of anthropogenic sources. The impact of these changes on potential carry-capacity and productivity are not understood and this potentially has impacts on the yields for GMU.

5. STATUS OF THE STOCKS

Grey mullet have been exploited by customary, commercial, and recreational fishers for over 100 years. They are found predominantly in harbours and these environments have undergone considerable change over this period due to a range of anthropogenic sources. The impact of these changes on potential carrying capacity and productivity are not understood and this potentially has impacts on the yields for GMU.

GMU 1 is currently assessed using CPUE data and these analyses suggest that the GMU 1 fishery is composed of a number of spatially distinct substocks and tagging data suggest low to moderate mixing between them. CPUE analyses using data up to 2005–06 have found that the CPUE in the Kaipara Harbour, Manukau Harbour, and east Northland (which collectively account for over 80% of the GMU 1 catch) have increased since 2002. Therefore catches in these areas appear to be sustainable in the short-term. The status of GMU1 relative to B_{MSY} is unknown.

Yields, TACCs and reported landings are summarised in Table 5.

Table 5: Summary of yields (t), TACCs (t), and reported landings (t) of grey mullet for the most recent fishing year.

Fishstock	QMA	MCY	2007–08 Actual TACC	2007–08 Reported landings
GMU 1	Auckland (East) (West) 1 & 9	825	925	848
GMU 2	Central (East) (West) 2 & 8	–	20	< 1
GMU 3	South–East (Coast) (Chatham) 3, 4, Southland and Sub–Antarctic 5 & 6	–	30	< 1
GMU 7	Challenger 7	–	20	< 1
GMU 10	Kermadec 10	_	10	0
Total		–	1 005	849

6. FOR FURTHER INFORMATION

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