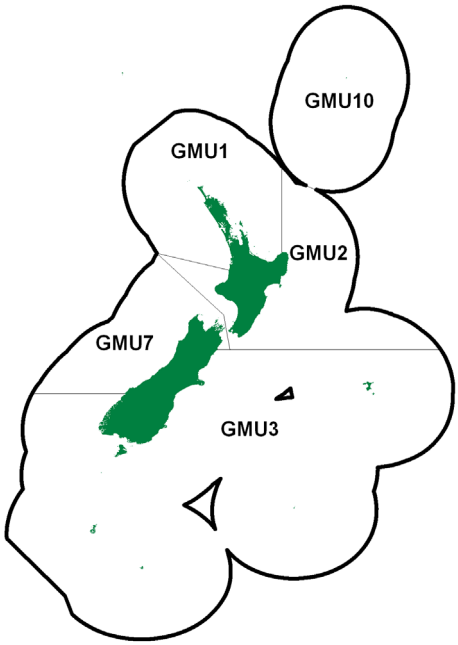
GREY MULLET (GMU)

(*Mugil cephalus*)
Kanae, Hopuhopu



1. FISHERY SUMMARY

1.1 Commercial fisheries

Commercial fishing for grey mullet occurs predominantly in GMU 1, where annual landings increased from approximately 128 t in 1931 to a maximum of 1142 t in 1983–84 (Table 1; 2). 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 and 2013–14 (Table 2).

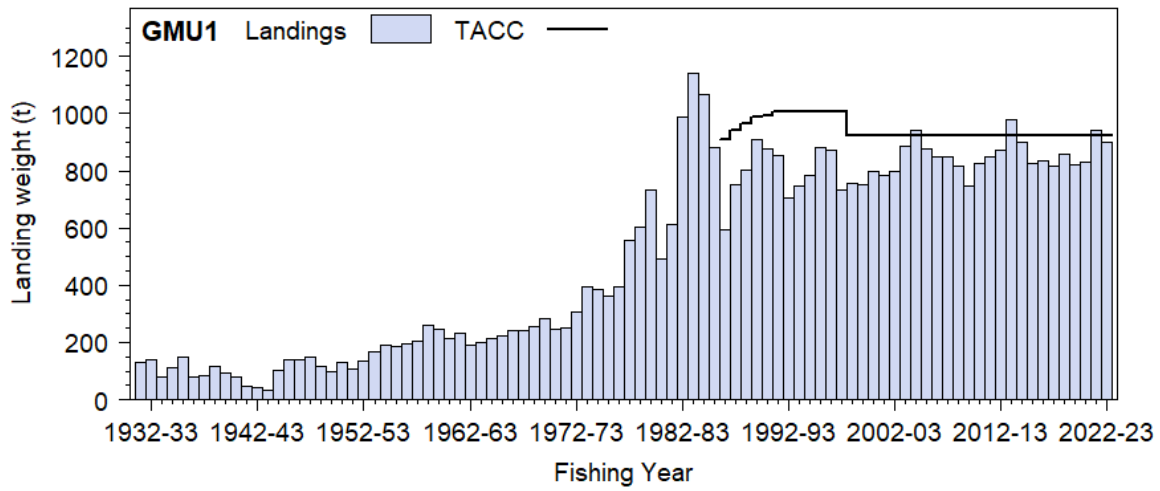


Figure 1: Reported commercial landings and TACC for the main GMU stock; GMU 1 (Auckland).

Table 1: Reported landings (t) for the main QMAs from 1931 to 1990.

Year	GMU 1	GMU 2	GMU 3	GMU 7	Year	GMU 1	GMU 2	GMU 3	GMU7
1931–32	128	0	0	0	1957	204	1	0	0
1932–33	138	0	0	0	1958	262	0	0	0
1933–34	78	0	0	0	1959	244	0	0	0
1934–35	111	0	0	0	1960	213	0	0	0
1935–36	147	0	0	0	1961	230	0	0	0
1936–37	80	0	0	0	1962	191	0	0	0
1937–38	82	0	0	0	1963	199	0	0	0
1938–39	117	1	0	1	1964	214	0	0	0
1939–40	91	0	0	0	1965	222	2	3	0
1940–41	77	0	0	0	1966	240	0	0	0
1941–42	48	2	0	0	1967	243	0	0	0
1942–43	44	2	0	0	1968	256	0	0	0
1943–44	35	0	0	0	1969	283	1	1	0
1944	104	0	0	0	1970	248	1	0	0
1945	138	0	0	0	1971	253	1	0	0
1946	141	0	0	0	1972	305	0	1	0
1947	151	0	0	0	1973	393	1	4	2
1948	114	0	0	0	1974	386	0	0	0
1949	100	0	0	0	1975	360	0	0	0
1950	129	0	0	0	1976	394	0	0	0
1951	108	0	0	0	1977	557	0	0	0
1952	136	0	0	0	1978	604	0	0	0
1953	166	0	0	0	1979	735	0	0	0
1954	190	0	0	0	1980	494	0	0	0
1955	188	0	0	0	1981	612	0	0	0
1956	193	0	0	0	1982	990	0	8	2

Notes:

1. The 1931–1943 years are April–March but from 1944 onwards are calendar years.
2. Data up to 1985 are from fishing returns: Data from 1986 to 1990 are from Quota Management Reports.
3. Data for the period 1931 to 1982 are based on reported landings by harbour and are likely to be underestimated as a result of under-reporting and discarding practices. Data includes both foreign and domestic landings.

Table 2: Reported landings (t) of grey mullet by Fishstock from 1983–84 to present and actual TACCs (t) for 1986–87 to present. QMS data from 1986-present. There have been no report landings for GMU 10. *FSU data. [Continued on next page]

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	TACC	Landings	TACC
1983–84*	1 142	-	6	-	5	-	7	-	-	1 160	-
1984–85*	1 069	-	5	-	0	-	15	-	-	1 089	-
1985–86*	881	-	10	-	0	-	10	-	-	901	-
1986–87	595	910	3	20	< 1	30	0	20	10	598	990
1987–88	751	941	3	20	0	30	0	20	10	754	1 021
1988–89	792	963	3	20	0	30	0	20	10	795	1 043
1989–90	907	990	2	20	0	30	4	20	10	913	1 070
1990–91	875	994	2	20	1	30	< 1	20	10	879	1 073
1991–92	848	1 006	1	20	2	30	1	20	10	852	1 086
1992–93	711	1 006	< 1	20	< 1	30	0	20	10	712	1 086
1993–94	743	1 006	< 1	20	< 1	30	0	20	10	706	1 086
1994–95	776	1 006	0	20	< 1	30	10	20	10	787	1 086
1995–96	866	1 006	0	20	< 1	30	< 1	20	10	866	1 086
1996–97	870	1 006	< 1	20	1	30	< 1	20	10	872	1 086
1997–98	730	1 006	< 1	20	< 1	30	< 1	20	10	730	1 086
1998–99	750	925	< 1	20	< 1	30	< 1	20	10	750	1 005
1999–00	749	925	< 1	20	0	30	< 1	20	10	750	1 005
2000–01	797	925	1	20	0	30	< 1	20	10	798	1 005
2001–02	782	926	2	20	< 1	30	< 1	20	10	784	1 005
2002–03	797	926	1	20	< 1	30	0	20	10	798	1 005
2003–04	886	926	< 1	20	0	30	< 1	20	10	796	1 005
2004–05	941	926	< 1	20	0	30	0	20	10	941	1 005
2005–06	878	926	< 1	20	< 1	30	0	20	10	878	1 005
2006–07	847	926	1	20	0	30	< 1	20	10	845	1 005
2007–08	848	926	1	20	< 1	30	< 1	20	10	849	1 005
2008–09	814	926	1	20	0	30	0	20	10	815	1 005
2009–10	746	926	< 1	20	0	30	0	20	10	746	1 005
2010–11	825	926	< 1	20	< 1	30	< 1	20	10	826	1 006
2011–12	848	926	< 1	20	< 1	30	< 1	20	10	848	1 006
2012–13	871	926	< 1	20	< 1	30	< 1	20	10	871	1 006
2013–14	981	926	< 1	20	0	30	0	20	10	981	1 006
2014–15	900	926	< 1	20	0	30	< 1	20	10	901	1 006
2015–16	827	926	< 1	20	0	30	0	20	10	827	1 006
2016–17	835	926	< 1	20	0	30	0	20	10	836	1 006
2017–18	817	926	0	20	0	30	3	20	10	820	1 006
2018–19	857	926	< 1	20	< 1	30	0	20	10	857	1 006

Table 2 [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	TACC	Landings	TACC
2019–20	821	926	< 1	20	0	30	< 1	20	10	821	1 006
2020–21	829	926	< 1	20	0	30	< 1	20	10	829	1 006
2021–22	940	926	< 1	20	0	30	0	20	10	941	1 006
2022–23	901	926	< 1	20	0	30	< 1	20	10	901	1 006

1.2 Recreational fisheries

Grey mullet is 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.

Telephone-diary surveys is 1993–94 (Teirney et al 1997), 1996 (Bradford 1998), and 2000 (Boyd et al 2004) were used to estimate the annual recreational catch from GMU 1 as 150, 106, and 100 t, respectively (Table 3). The Minister of Fisheries provided an allowance for customary harvest of 100 t beginning in 1998–99.

The harvest estimates provided by telephone-diary surveys between 1993 and 2001 are no longer considered reliable for various reasons. A Recreational Technical Working Group concluded that these harvest estimates 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. In response to these problems and the cost and scale challenges associated with onsite methods, a National Panel Survey was conducted for the first time throughout the 2011–12 fishing year. The panel survey used face-to-face interviews of a random sample of 30 390 New Zealand households to recruit a panel of fishers and non-fishers for a full year (Wynne-Jones et al 2014). The panel members were contacted regularly about their fishing activities and harvest information collected in standardised phone interviews. The national panel survey was repeated during the 2017–18 and 2022–23 fishing years using very similar methods to produce directly comparable results (Wynne-Jones et al 2019; Heinemann & Gray, in prep). Recreational catch estimates from the three national panel surveys are given in Table 3. Note that national panel survey estimates do not include recreational harvest taken on charter vessel trips or under s111 general approvals.

Table 3: Estimated number of grey mullet harvested by recreational fishers by Fishstock and survey year (Wynne-Jones et al 2014, 2019, Heinemann & Gray, in prep for panel surveys), and the estimated Fishstock harvest (using mean weights from Hartill & Davey 2015, Davey et al 2019; Davey et al in prep).

Survey	Fishstock	Number	CV	Harvest range (t)	Harvest estimate (t)
1994 telephone-diary	GMU 1	170 000	0.19	90–210	150
1996 telephone-diary	GMU 1	110 000	0.25	80–130	106
2000 telephone-diary	GMU 1	110 000	0.33	68–136	102
2011–12 panel survey	GMU 1	29 563	0.41	-	27.3
2011–12 panel survey	GMU 2	3 062	0.55	-	2.8
2011–12 panel survey	GMU 3	5 252	0.93	-	4.8
2011–12 panel survey	GMU 7	191	0.73	-	0.2
2017–18 panel survey	GMU 1	56 358	0.43	-	44.2
2017–18 panel survey	GMU 2	6 917	0.54	-	5.4
2017–18 panel survey	GMU 3	25	1	-	<0.1
2017–18 panel survey	GMU 7	300	0.74	-	0.2
2022–23 panel survey	GMU 1	24 303	0.44	-	19.9
2022–23 panel survey	GMU 2	479	1.01	-	0.4
2022–23 panel survey	GMU 3	-	-	-	-
2022–23 panel survey	GMU 7	1 089	0.94	-	0.9

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 worldwide 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 making up 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 to 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 4.

Table 4: 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)^b (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 net level of movement cannot be ascertained. There is evidence in the CPUE data that GMU 1 may be comprised of six populations with low to moderate mixing between them (McKenzie 1997).

GMU 1 has been divided into two sub-stocks (east coast and west coast) for the purposes of fisheries stock assessment. 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 (McKenzie & Vaughan 2008), and updated to 2010–11 (Kendrick & Bentley 2012). However, internal and anecdotal evidence suggest that method is being misreported in these fisheries and that standardized CPUE is unlikely to reflect relative abundance for GMU. CPUE was therefore rejected as an index of relative abundance for all sub-areas within GMU 1.

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 Yield estimates and projections

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 5. *MCY* cannot be estimated for the other fish stocks.

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

Fishstock	QMA	Y_{AV}	*MCY*
GMU 1	Auckland 1 & 9	1 030	825

The level of risk to the stock by harvesting the population at the estimated *MCY* level cannot be determined. No estimates of current biomass, fishing mortality, or other information are available which would permit the estimation of *CAY*.

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 (Fisheries New Zealand 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 a hundred 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 of GMU.

Characterisation shows an overall trend away from set netting towards ring netting, and, within the nominal setnet method, a trend towards shorter nets; a trend that is not seen in flatfish setnet fisheries in the same areas. This suggests there have been systematic changes in fishing strategy that are not captured by the CELR form. Anecdotal information from interviews of net fishers suggests that fishers use the various net method codes interchangeably, and that the methods describe differences in strategy rather than in gear, from passive fishing to spotting and encircling schools of fish. While the passive form of set netting is an appropriate sampling tool, any contamination by ring net or similarly 'directed' fishing could mask trends in the abundance of the underlying population.

The Working Group agreed that given the misreporting issues and its consequences, that standardized CPUE is unlikely to reflect relative abundance for GMU.

5. STATUS OF THE STOCKS

For all Fishstocks there is insufficient information to estimate current stock status.

Given the misreporting of method and its consequences, standardised CPUE is unlikely to reflect relative abundance for GMU. CPUE was therefore rejected as an index of relative abundance for all sub-areas within GMU 1.

6. FOR FURTHER INFORMATION

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