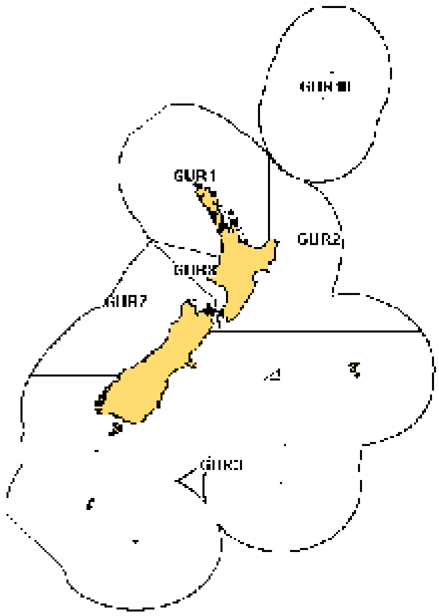
RED GURNARD (GUR)

(*Chelidonichthys kumu*)



1. FISHERY SUMMARY

(a) Commercial fisheries

Red gurnard are a major bycatch of inshore trawl fisheries in most areas of New Zealand, including fisheries for red cod in the southern regions, and flatfish on the west coast of the South Island and in Tasman Bay. They are also directly targeted in some areas. Some minor target fisheries for red gurnard are known in Pegasus Bay, off Mahia and off the west coast South Island. Red gurnard is also a minor bycatch in the jack mackerel trawl fishery in the South Taranaki Bight. Up to 15% of the total red gurnard catch is taken by longline and setnet.

The 1986 TACCs were based on 1984 landings for Southland and 1983 landings for other regions. TACCs for GUR 3 and 7 were increased by 76 t (14%) and 137 t (20%) respectively for the 1991–92 fishing year under the adaptive management scheme, to 600 t in GUR 3 and to 815 t in GUR 7. The TACC for GUR 7 was reduced by the amount of the AMP increase for the 1997–98 fishing year. The TACC for GUR 3 was again increased, by 300 t (50%), for the 1996–97 fishing year under the adaptive management scheme.

Recent reported landings and actual TACCs by Fishstock are shown in Table 1.

Annual landings of GUR 1 have been relatively stable since 1986–87, generally ranging between 900 and 1300t i.e. substantially lower than the 2287t TACC. About 60% of the GUR 1 total is taken from FMA 1, as a bycatch of a number of fisheries including inshore trawl fisheries for snapper, John dory and tarakihi. The remaining 40% is taken from FMA 9, mainly as a bycatch of the snapper and trevally inshore trawl fisheries.

GUR 2 landings have fluctuated within the range of 400–700 t since 1991–92, typically well below the TACC. In addition to the target fishery off Mahia, red gurnard are taken as a bycatch of the tarakihi, trevally and snapper inshore trawl fisheries.

Table 1: Reported landings (t) of red gurnard by Fishstock from 1983–84 to 2004–05 and actual TACCs (t) from 1986–87 to 2004–05.

Fishstock	GUR 1		GUR 2		GUR 3		GUR 7		GUR 8		GUR 10			
QMA (s)	1 & 9		2		3, 4, 5 & 6		7		8		10		Total	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1983–84*	2 099	–	782	–	366	–	468	–	251	–	0	–	3 966	–
1984–85*	1 531	–	665	–	272	–	332	–	247	–	0	–	3 047	–
1985–86*	1 760	–	495	–	272	–	239	–	163	–	0	–	2 929	–
1986–87†	1 021	2 010	592	610	210	480	421	610	159	510	0	10	2 403	4 230
1987–88†	1 139	2 081	596	657	386	486	806	629	194	518	0	10	3 121	4 381
1988–89†	1 039	2 198	536	698	528	489	479	669	167	532	0	10	2 749	4 596
1989–90†	916	2 283	451	720	694	501	511	678	173	538	0	10	2 745	4 730
1990–91†	1 123	2 284	490	723	661	524	442	678	150	543	0	10	2 866	4 762
1991–92†	1 294	2 284	663	723	539	600	704	815	189	543	0	10	3 390	4 975
1992–93†	1 629	2 284	618	725	484	601	761	815	208	543	0	10	3 700	4 978
1993–94†	1 153	2 284	635	725	711	601	469	815	174	543	0	10	3 142	4 978
1994–95†	1 054	2 287	559	725	685	601	455	815	217	543	0	10	2 969	4 982
1995–96†	1 163	2 287	567	725	633	601	382	815	182	543	0	10	2 927	4 982
1996–97†	1 055	2 287	503	725	641	900	378	815	219	543	0	10	2 796	5 281
1997–98†	1 015	2 287	482	725	477	900	309	678	249	543	0	10	2 532	5 143
1998–99†	927	2 287	469	725	395	900	323	678	170	543	0	10	2 284	5 143
1999-00†	944	2 287	521	725	411	900	331	678	222	543	0	10	2 429	5 143
2000-01†	1 294	2 287	623	725	569	900	571	678	291	543	0	10	3 348	5 143
2001-02†	1 109	2 287	619	725	717	900	686	678	302	543	0	10	3 429	5 143
2002-03†	1 256	2 287	552	725	888	750	793	678	342	543	0	10	3 831	4 993
2003-04†	1 225	2 287	512	725	725	750	717	678	329	543	0	10	3 508	4 993
2004-05†	1 349	2 287	708	725	854	750	686	678	370	543	0	10	3 967	4 993

* FSU data.
† QMS data.

GUR 3 landings regularly exceeded the TACC between 1988–89 and 1995–96. Ageing of fish collected during the east coast South Island trawl surveys suggests there were 1 or 2 relatively strong year classes moving through the fishery, which may help explain the overcatches. However, once the TACC in GUR 3 was increased to 900 t in the 1996–97 fishing year, landings declined to well below this quantum. In 2002-03, the TACC for GUR 3 was reduced by 150 t, to 750 t. The most recent TACC was overcaught with annual landings of >850t in both the 2002/03 and 2004/05 fishing years.

GUR 7 landings declined steadily from 761 t in 1992–93, to 309 t in 1997/98, but have since increased to the point that they have ranged between 686t and 793t since 2001/02, thereby exceeding the TACC. Landings in GUR 8 have remained well below the levels of the TACC since 1986–87, with a maximum catch of 370 t reported for the 2004–05 fishing year.

(b) Recreational fisheries

Red gurnard is, by virtue of its wide distribution in shallow coastal waters, an important recreational species. Vulnerable to recreational fishing methods, it is often taken by snapper and tarakihi anglers, particularly in the Northern Region.

Recreational harvest estimates have been obtained from national telephone diary surveys undertaken in 1996 and 2001. Regional diary surveys were undertaken from 1991 to 1994. A key component of the estimating recreational harvest from diary surveys is determining the proportion of the population that fish. The Recreational Working Group has concluded that the methodological framework used for telephone interviews produced incorrect eligibility figures for the 1996 and previous surveys. Consequently the harvest estimates derived from these surveys are considered to be considerably underestimated and not reliable. However relative comparisons can be made between stocks within these surveys. The Recreational Working Group considered that the 2000 survey using face-to-face interviews better estimated eligibility and that the derived recreational harvest estimates are believed to be more accurate. FMA2 catches are nevertheless considered to be over-estimate, probably because of an unrepresentative diarist sample. The 1999/2000 Harvest estimates for each Fishstock should be evaluated with reference to the coefficient of variation. Recreational catch estimates from surveys undertaken in the 1990s are given in Tables 2-4.

Table 2: Estimated number and weight of red gurnard harvested by recreational fishers by Fishstock and survey. Surveys were carried out in different years in the Ministry of Fisheries regions: South in 1991–92, Central in 1992–93 and North in 1993–94 (Teirney et al., 1997). The estimated Fishstock harvest is indicative and was made by combining estimates from the different years.

		Total		
Fishstock	**Survey**	**Number**	**c.v.(%)**	**Survey harvest (t)**
GUR 1	North	349 000	14	155–245
GUR 2	North	2 000	–	–
GUR 2	Central	156 000	31	50–125
GUR 7	Central	21 000	23	5–20
GUR 8	Central	157 000	37	50–110

Table 3: Results of a national diary survey of recreational fishers in 1996. Estimated number of red gurnard harvested by recreational fishers by Fishstock and the corresponding harvest tonnage. The mean weights used to convert numbers to catch weight are considered the best available estimates. Estimated harvest is presented as a range to reflect the uncertainty in the estimates (from Bradford, 1998).

Fishstock	Number caught	c.v.(%)	Harvest Range (t)	Harvest Point Estimate (t)
GUR 1	262 000	7	100–120	108
GUR 2	38 000	18	10–20	16
GUR 3	1 000	–	–	–
GUR 7	26 000	15	10–15	12
GUR 8	67 000	15	25–35	28

Table 4: Results of the 1999/2000 national diary survey of recreational fishers (Dec 1999 – Nov 2000). Estimated number of red gurnard harvested by recreational fishers by Fishstock and the corresponding harvest tonnage. Estimated harvest is presented as a range to reflect the uncertainty in the estimates (Boyd and Reilly 2002).

Fishstock	Number caught	c.v.(%)	Harvest Range(t)	Harvest Point estimate(t)
GUR 1	465 000	16	188-256	223
GUR 2	209 000	37	80-173	127
GUR 3	11 000	70	2-9	5
GUR 7	36 000	23	9-14	11
GUR 8	99 000	36	26-55	40

(c) Maori customary fisheries

Red gurnard is an important species for Maori fishing interests, by virtue of its wide distribution in shallow coastal waters. However, no quantitative estimates of Maori customary take are currently available.

(d) Illegal catch

No quantitative information is available.

(e) Other sources of mortality

No quantitative information is available.

2. BIOLOGY

Red gurnard reach sexual maturity at an age of 2–3 years and a fork length (FL) of about 23 cm, after which the growth rate slows. Growth rate varies with location, and females grow faster and are usually larger than males. Maximum age is about 16 years and maximum size is 55+ cm.

M was estimated using the equation M = $\log_e$100/maximum age, where maximum age is the age to which 1% of the population survives in an unexploited stock. ECSI samples suggested an A_{max} of about 16 years for males and 13 years for females, giving estimates for M of 0.29 and 0.35 respectively. WCSI samples indicate an A_{max} of about 15 years for both sexes, giving an estimate of 0.31 for M. These samples were not from virgin populations, so M may be slightly overestimated.

Red gurnard have a long spawning period which extends through spring and summer with a peak in early summer. In the Hauraki Gulf, ripe adults can be found throughout the year. Spawning grounds appear to be widespread, although perhaps localised over the inner and central shelf. Egg and larval development takes place in surface waters, and there is a period of at least 8 days before feeding starts. Small juveniles (< 15 cm FL) are often caught in shallow harbours, but rarely in commercial trawls.

Biological parameters relevant to the stock assessment are shown in Table 5.

Table 5: Estimates of biological parameters for red gurnard.

Fishstock	Estimate						Source
1. Weight = a (length)^{b} (Weight in g, length in cm fork length)							
Combined sexes	**a**	**b**					
GUR 1	0.00998	2.99					Elder (1976)
GUR 1W & 1E	0.026	2.775					Stevenson (2000)
GUR 2	0.0053	3.19					Stevenson (2000)
2. von Bertalanffy growth parameters							
		Females			**Males**		
	K	**t_0**	**L_∞**	**K**	**t_0**	**L_∞**	
GUR 1	0.641	0.189	36.4	0.569	-0.552	28.8	Elder (1976)
GUR1W	0.25	-0.88	45.3	0.45	-0.30	36.5	Stevenson (2000)
GUR1E	0.28	-0.76	44.5	0.49	-0.24	35.2	Stevenson (2000)
		Females			**Males**		
	K	**t_0**	**L_∞**	**K**	**t_0**	**L_∞**	
GUR 3	0.44	0.1	48.2	0.49	-0.26	42.2	Sutton (1997)
		Females			**Males**		
	K	**t_0**	**L_∞**	**K**	**t_0**	**L_∞**	
GUR 7	0.40	-0.36	45.7	0.37	-0.96	40.3	Sutton (1997)
3. Natural mortality estimates							
		Females			**Males**		
GUR 1W & 1E		0.30			0.35		Stevenson (2000)
GUR 3		0.29			0.35		Sutton (1997)
GUR 7		0.31			0.31		Sutton (1997)

3. STOCKS AND AREAS

There are no new data that would alter the stock boundaries given in previous assessment documents. No information is available on stock separation of red gurnard.

4. STOCK ASSESSMENT

Stock reduction analyses were undertaken for GUR 1W, GUR 1E and GUR 2 using MIAEL estimation (Cordue, 1998). The MIAEL model uses a two-stage process. All input data are used in the first stage to obtain least squares estimates of year class strengths and trawl survey selectivities. The second stage of the model produces the least squares and MIAEL estimates of biomass. The MIAEL procedure produces a performance index for each estimate which, if it is low, indicates that the parameter is not well estimated within its bounds. Estimates of MCY and CAY are presented for all three stocks, based on the MIAEL method.

There are no new data which would alter the yield estimates given for the other GUR stocks in the 1997 Plenary Report. Those yield estimates were based on commercial landings data only and have not changed since the 1992 Plenary Report.

(a) Estimates of fishery parameters and abundance

GUR 1

Catch histories for GUR 1W and GUR 1E were collated for the period 1931 to 1997–98 (Table 6). The catch history for GUR 1 was divided into east and west of North Cape. The catches were split on the basis of port of landing up until 1984 and since then at a 60:40 ratio based on logbook data. Other model input parameters are given in Tables 5 and 7.

Table 6: Catch histories (t) for GUR 1W and GUR 1E for the period 1931 to 1997–98 used in the modelling.

Year	GUR 1 West	GUR 1 East	Year	GUR 1 West	GUR 1 East
1931	–	66	1966	561	557
1932	–	41	1967	549	455
1933	–	66	1968	651	443
1934	–	50	1969	794	502
1935	–	74	1970	832	581
1936	–	113	1971	670	468
1937	–	203	1972	340	401
1938	–	107	1973	677	577
1939	–	118	1974	512	355
1940	–	122	1975	386	294
1941	–	105	1976	610	427
1942	–	121	1977	690	569
1943	–	125	1978	833	696
1944	–	232	1979	1 119	767
1945	–	353	1980	1 153	664
1946	–	418	1981	1 499	810
1947	–	368	1982	1 021	987
1948	–	222	1983	629	1 139
1949	–	362	1984	624	1 029
1950	–	298	1984–85	612	919
1951	–	211	1985–86	704	1 056
1952	8	376	1986–87	408	613
1953	83	392	1987–88	456	683
1954	106	371	1988–89	416	623
1955	126	354	1989–90	366	550
1956	178	244	1990–91	449	674
1957	182	294	1991–92	518	776
1958	117	301	1992–93	652	977
1959	109	335	1993–94	461	692
1960	203	267	1994–95	422	632
1961	261	278	1995–96	465	698
1962	207	279	1996–97	422	633
1963	238	303	1997–98	406	609
1964	320	627			
1965	508	750			

Table 7: Input parameters used for the MIAEL modelling for the base case and sensitivity analysis for all stocks unless specified.

Parameter	Estimate	Sensitivity
Steepness	0.9	–
Recruitment variability	0.6	–
Natural mortality males	0.35	±0.05
Natural mortality females	0.3	±0.05
Maximum exploitation (r_{max}) pre-spawning, spawning	0.5	0.3
Minimum exploitation rate when largest catch (r_{mmx})	0.01	–

Maturity ogive	**Age**	**1**	**2**	**3**	**4**	**5**	**≥6**
GUR 1W & 1E	Male	0.00	0.75	1.00	1.00	1.00	1.00
	Female	0.00	0.25	1.00	1.00	1.00	1.00
Trawl survey selectivity							
GUR 1W	Male	0.25	1.00	1.00	1.00	1.00	1.00
	Female	0.10	0.40	1.00	1.00	1.00	1.00
GUR 1E	Male	0.10	1.00	1.00	1.00	1.00	1.00
	Female	0.10	0.30	1.00	1.00	1.00	1.00

Table 7: (*Continued*)

Fishing selectivity	**Age**	**1**	**2**	**3**	**4**	**5**	**³6**
GUR 1W	Male	0.10	0.35	0.60	0.80	0.90	1.00
	Female	0.10	0.35	0.65	0.85	1.00	1.00
Fishing selectivity							
GUR 1E	Male	0.10	0.35	0.60	0.80	0.90	1.00
	Female	0.10	0.35	0.70	1.00	1.00	1.00

Standardised CPUE indices for GUR 1W, GUR 1E and GUR 2 are shown in Table 7. The indices are based on an analysis of gurnard CPUE from inshore trawl fisheries where gurnard was either the target species or one of the important bycatch species (Stevenson, 2000). Log-linear and combined models showed similar trends and only the log-linear results are presented here.

Table 8: Relative year effects from the linear model of log (catch per day) for GUR 1W, GUR 1E and GUR 2.

Year	**GUR 1W**	**GUR 1E**	**GUR 2**
1989–90	1.00	1.00	1.00
1990–91	0.90	0.90	0.93
1991–92	0.97	0.85	0.91
1992–93	1.35	0.81	0.88
1993–94	1.20	0.64	0.80
1994–95	1.46	0.62	0.76
1995–96	1.20	0.50	0.83
1996–97	1.04	0.43	0.73

The input data sets and the *c.v.*'s used for those series in the modelling are listed in Table 9. For the base case all trawl survey indices and proportion at age data were fitted in the model. Sensitivity runs were carried out without fitting the age data or 1+ indices, and fitting the CPUE indices instead. Estimated year class strengths from base case model runs are given in Table 10.

Table 9: Coefficients of variation (c.v.) applied in the model to the series of relative abundance indices. BoP, Bay of Plenty. HG, Hauraki Gulf. NF, not fitted.

Fishstock	**Data series**	**Base case c.v. (%)**	**Sensitivity c.v. (%)**
GUR 1W	Trawl survey adults (*Kaharoa*, Oct/Nov)	25	
	Trawl survey 1+ (*Kaharoa*, Oct/Nov)	25	NF
	Trawl survey proportion-at-age (1994, 1996)	25	NF
	CPUE	NF	35
GUR 1E	Trawl survey adults BOP (*Kaharoa*, Feb) (excl. 1985 & 1987)	25	
	Trawl survey adults HG (*Kaharoa*, Nov–Dec) (excl. 1985)	25	
	Trawl survey 1+ BOP (*Kaharoa*, Feb) (excl. 1985 & 1987)	25	NF
	Trawl survey 1+ HG (*Kaharoa*, Nov–Dec) (excl. 1985)	25	NF
	Trawl survey proportion-at-age HG (1992, 1994)	25	NF
	CPUE	NF	35

Table 10: Estimates of year class strengths from model runs incorporating age data. –, not estimated.

Year class	**GUR 1W**	**GUR 1E**
1984	–	0.01
1985	0.95	0.42
1986	0.85	0.37
1987	0.01	0.82
1988	0.22	0.61
1989	0.72	1.04
1990	0.29	0.13
1991	2.56	1.44
1992	3.13	0.13
1993	0.92	2.45
1994	2.11	0.29
1995	1.59	0.01
1996	–	2.45
1997	–	0.13

GUR 2

Standardised CPUE analyses (using a lognormal non-zero catch model) were undertaken for red gurnard caught in three separate target fisheries, GUR 2, FLA 2, and TAR 2, each of which catch significant amounts of red gurnard and appear to exploit a different age-sex component of the red gurnard population (Kendrick & Walker, 2003). Red gurnard is generally targeted in waters 50-100m, whereas flatfish are targeted in waters less than 50 m and tarakihi is targeted in deeper waters between 100 and 200 m. The target fishery accounts for 50-70% of the annual catch of GUR2, and on account of the depth range fished is thought to provide a more reliable index of abundance. The standardized index for this fishery declined by 35% during the 1989/90 to 2000/01 period (Figure 1).

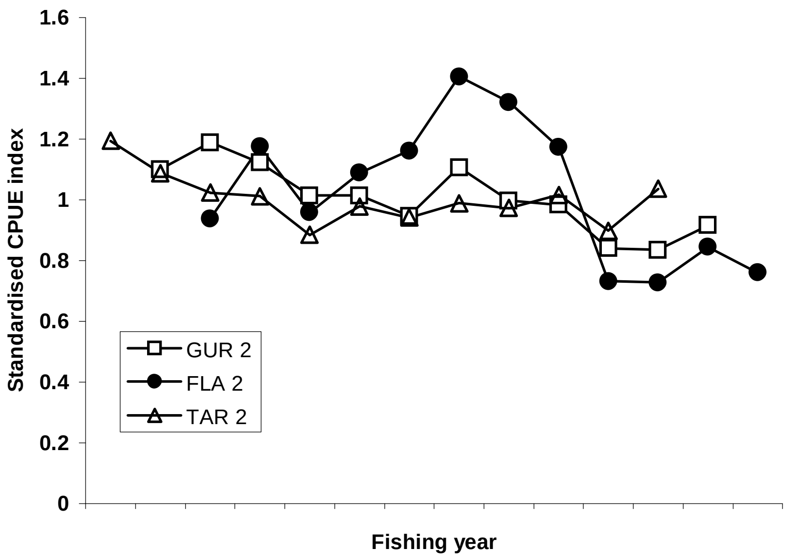


Figure 1: Standardised CPUE indices derived from a lognormal non-zero model on gurnard abundance from the flatfish (FLA 2) target fishery, the gurnard (GUR 2) target fishery (lagged one year), and the tarakihi (TAR 2) target fishery (lagged 2 years). The first year of each index is 1989-90 (Kendrick & Walker, 2003).

GUR 3

Further CPUE analyses have been carried out by the SeaFIC (2002, 2005) as part of the monitoring programme for adaptive management stocks. In 2002, the Plenary agreed that the CPUE indices resulting from the FLA fishery appeared to be more stable than those for the RCO bycatch. Therefore, the FLA bycatch regression analysis is now being used to monitor abundance in GUR 3 (Figure 2).

Winter trawl surveys were conducted annually off the South Island east coast (GUR 3) between 1991 and 1996 (Table 10); however, the biomass estimates are highly variable between surveys and are unlikely to monitor the abundance of red gurnard (the trawl surveys were optimised to sample red cod and, consequently, neither the survey depth range or areal stratification are appropriate to survey the red gurnard population). Five summer surveys, which were optimised for red gurnard, were carried out annually between 1996–97 and 2000–01. There has been a downward trend in the indices since 1996–97, but this may have been due to changing catchability for this species. In 2001, the Inshore FAWG recommended that the summer east coast South Island trawl survey be discontinued due to the extreme variability in the catchability of the target species.

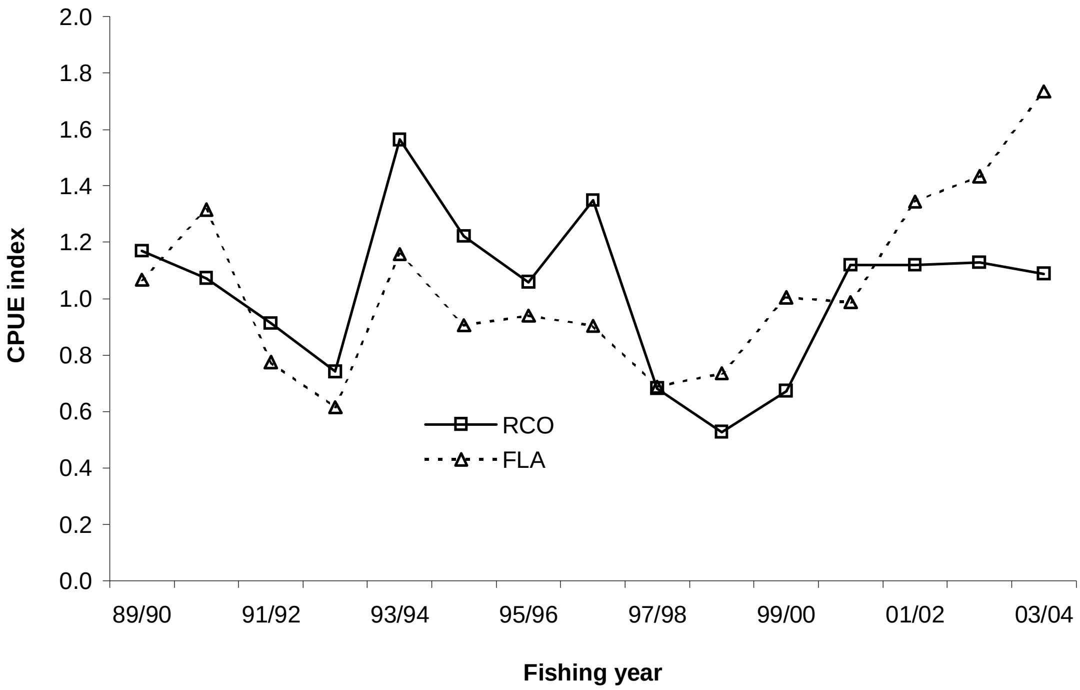


Figure 2: Comparison of indices from the combined models (lognormal standardization of non zero catches and binomial standardization of zero catchs) for GUR 3 in bottom trawl fisheries targeting red cod (RCO) and flatfish (FLA) (SeaFIC 2005).

GUR 7

Biomass indices derived from the raw CPUE (kg of gurnard/trawl) of vessels bottom trawling for barracouta, gurnard and flatfish in FMA 7 were developed in support of a proposal to introduce GUR 7 into the adaptive management programme (Challenger Finfish Management Company 2003). The annual indices declined from 1991/92 to 1994/95, were relatively stable until 1989/99 and then increased sharply to 2002/03. Trawl surveys, on the other hand, indicate that the relative biomass of red gurnard declined gradually from 1992 to 2003 on the west coast of the South Island, and, the relative biomass declined sharply in 2003 in Tasman and Golden Bays. On account of the low CVs and low inter-annual variability, WCSI trawl surveys have been thought to reflect biomass trends of the gurnard and other target species.

Relative abundance indices have been obtained from trawl surveys of the Bay of Plenty, west coast North Island and Hauraki Gulf within the GUR 1 Fishstock and the South Island west coast and Tasman/Golden Bays (GUR 7) (Table 11).

Table 11: Estimates of red gurnard biomass (t) from *Kaharoa* trawl surveys.

Year	Trip Code	Biomass	c.v. (%)
Bay of Plenty			
1983	KAH8303	380	23
1985	KAH8506	57	17
1987	KAH8711	410	28
1990	KAH9004	432	12
1992	KAH9202	290	9
1996	KAH9601	332	14
1999	KAH9902	364	14
North Island west coast (QMA 9)			
1986	KAH8612	1 763	16
1987	KAH8715	2 022	24
1989	KAH8918	1 013	12
1991	KAH9111	1 846	23
1994	KAH9410	2 498	30
1996	KAH9615	1 820	14
North Island west coast (QMA 8)			
1989	KAH8918	628	15
1991	KAH9111	817	9
1994	KAH9410	685	22
1996	KAH9615	370	37
1999	KAH9915	(QMAs 8 & 9 combined) 2 099	13
Hauraki Gulf			
1984	KAH8421	595	15
1985	KAH8517	49	44
1986	KAH8613	426	36
1987	KAH8716	255	15
1988	KAH8810	749	19
1989	KAH8917	105	29
1990	KAH9016	141	16
1992	KAH9212	330	9
1993	KAH9311	177	17
1994	KAH9411	247	19
1997	KAH9720	242	14
2000	KAH0012	24	46
South Island west coast and Tasman/Golden Bays			
1992	KAH9204	572	15
1994	KAH9404	559	15
1995	KAH9504	584	19
1997	KAH9704	471	13
2000	KAH0004	301	23
2003	KAH0304	270	20
2005	KAH0503	442	17
North Island east coast			
1993	KAH9304	439	44
1994	KAH9402	871	16
1995	KAH9502	178	26
1996	KAH9605	708	29
South Island east coast (winter)			
1991	KAH9105	763	40
1992	KAH9205	142	30
1993	KAH9306	576	31
1994	KAH9406	112	34
1996	KAH9606	505	27
South Island east coast (summer)			
1996/97	KAH9618	765	13
1997/98	KAH9704	317	16
1998/99	KAH9809	493	13
1999/00	KAH9917	202	20
2000/01	KAH0014	146	34

(b) Biomass estimates

Bounded estimates of mid-spawning season virgin (B_0, assumed to exist in 1931) and mid-spawning season current (B_{mid}) biomass, and estimates of next season's beginning of year total biomass (B_{beg}) were obtained using the least squares and MIAEL estimation techniques of Cordue (1998) (Table 11 and Figure 2). The model was run using the parameters from Tables 4 and 6, catch histories from Table 5, and biomass indices from Tables 7 and 10.

West coast North Island GUR 1W (QMA 9)

The MIAEL estimate of B_0 for GUR 1W is about 27000 t (range 5090 to 101930), with a low performance index of 10% (Table 11). This estimate is substantially higher than the sensitivity runs without age data, although the bounds and performance indices are virtually unchanged. The MIAEL estimate of B_{mid99} is about 80% of B_0 (range 40–147%) (Figure 2), but has a low performance index of only 3%. This estimate is slightly higher than the sensitivity runs without age data. However, the bounds were generally narrower and the performance indices higher for the sensitivity runs. The assessment for GUR 1W suggests that the stock has been only lightly exploited. Even if the stock were at B_{min}, the current biomass would still be greater than B_{may}, and the current level of catches would be sustainable, as indicated by the increasing stock trajectory (Figure 2).

North-east coast North Island GUR 1E (QMA 1)

The MIAEL estimate of B_0 for GUR 1E is about 31100 t (range 6290 to 94490), with a low performance index of 14% (Table 12). This estimate is substantially higher than the sensitivity runs without age data. The MIAEL estimate of B_{mid99} is about 59% of B_0 (range 9–83%), and has a high performance index of 58%. This estimate is considerably higher than the sensitivity runs without age data. The assessment for GUR 1E suggests that the stock has been low to moderately exploited. Current biomass appears to be greater than B_{may}, and the current level of catches appear to be sustainable.

Table 12: Estimates of B_{min} and B_{max}, least squares (LS) estimates of biomass, and MIAEL estimates of *p*, biomass (MIAEL), and performance indices (Perf.), for the base case assessment and sensitivity runs for GUR 1W and GUR 1E. r_{max}, maximum exploitation rate; cpue, inclusion of cpue index; age data, inclusion of catch-at-age data. Biomass estimates are: mid-spawning season virgin biomass (B_0) in tonnes, and mid-spawning season mature biomass for 1998–99 (B_{mid99}) as a percentage of virgin biomass. All sensitivities tests should be compared to the no age data run.

Estimate	Run	B_{min}–B_{max}	LS	*p*	MIAEL	Perf. %
GUR 1W						
B_0	**Base case**	**5 090–101 930**	**101 930**	**0.128**	**27 050**	**9.5**
	No age data	5 020–101 980	15 680	0.131	15 860	10.7
	M +0.05	4 540–93 800	18 310	0.122	14 920	9.8
	M –0.05	5 880–110 420	14 930	0.133	17 790	10.5
	r_{max} = 0.3	6 160–101 900	15 680	0.078	18 190	4.3
	cpue	5 000–101 950	13 060	0.136	15 480	11.3
$B_{mid99(\%B0)}$	**Base case**	**40.0–147.2**	**147.2**	**0.111**	**79.9**	**2.6**
	No age data	36.7–98.0	76.3	0.645	69.7	58.6
	M +0.05	52.7–98.1	80.0	0.473	75.1	36.3
	M –0.05	38.1–97.8	72.9	0.585	67.1	49.5
	r_{max} = 0.3	65.5–98.0	79.7	0.237	79.6	11.5
	cpue	34.6–98.0	74.8	0.681	68.7	64.3
GUR 1E						
B_0	**Base case**	**6 290–94 490**	**94 490**	**0.169**	**31 140**	**13.5**
	No age data	5 000–76 920	76 920	–0.030	12 770	1.0
	M +0.05	4 310–70 680	70 680	–0.034	10 860	1.5
	M –0.05	5 930–83 630	83 630	–0.006	16 460	0.0
	r_{max} = 0.3	5 460–76 920	76 920	0.026	17 180	0.6
	cpue	5 000–76 920	76 920	–0.019	13 460	0.4
$B_{mid99(\%B0)}$	**Base case**	**8.7–82.6**	**82.6**	**0.619**	**59.4**	**58.4**
	No age data	11.2–96.1	96.1	–0.011	26.5	0.0
	M +0.05	10.8–96.4	96.4	–0.037	24.0	1.1
	M –0.05	13.6–95.7	95.7	0.031	32.9	0.5
	r_{max} = 0.3	31.0–96.1	96.1	0.124	57.3	4.1
	cpue	11.2–96.1	96.1	0.003	27.5	0.0

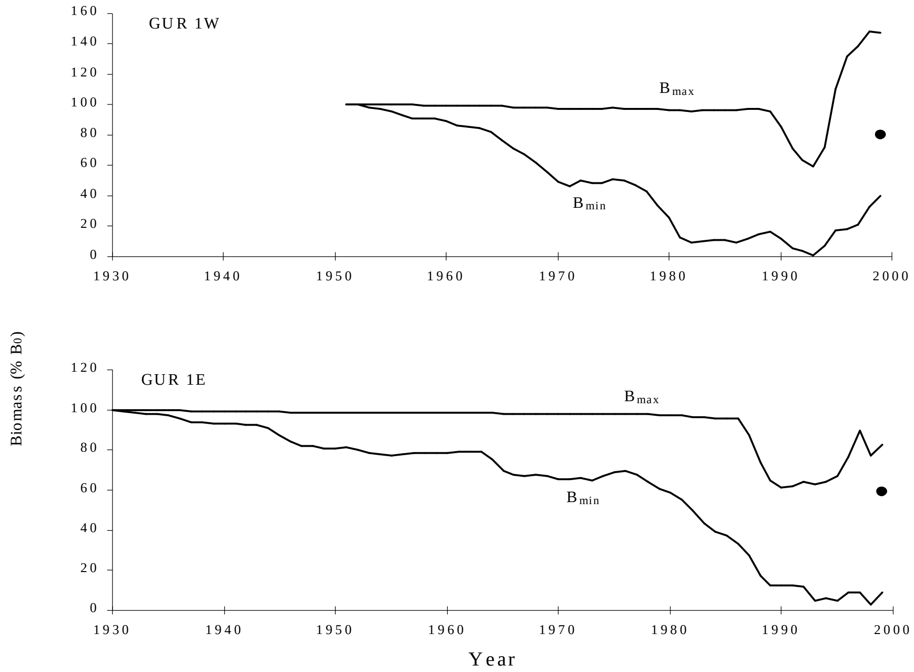


Figure 3: Trajectories for minimum (B_{min}) and maximum (B_{max}) estimates of biomass from the base case model runs for GUR 1W and GUR 1E. The closed circles indicate the MIAEL estimates of mid spawning season biomass at the end of the 1998–99 fishing year.

East coast North Island GUR 2

An assessment of GUR 2 was attempted by fitting the trawl and CPUE indices using the MIAEL method. However, the performance indices were very low (<1%), and the assessment was rejected by the Working Group due to the paucity of data and the assumption of deterministic recruitment.

(c) Estimation of Maximum Constant Yield (MCY)

Two methods were used to estimate MCY.

(i) $MCY = cY_{av}$, where c = 0.7 is based on M = 0.31 and Y_{av} is the mean catch for the years 1983–84 to 1986–87. Data for 1987–88 were excluded, as significant over-runs occurred in GUR 7 and catch may have been limited by the TAC. MCY estimates are shown in Table 12.

(ii) $MCY = p.B_0$ where p is determined for each stock using the simulation method of Francis (1992) such that the spawning biomass does not go below 20% B_0 more than 10% of the time. B_0 and its range are as determined by the MIAEL method (*from* Table 11), and MCY estimates, ranges and related parameters are listed in Table 12.

GUR 1E and GUR 1W

The estimate of MCY for GUR 1E and GUR 1W from the MIAEL method had wide ranges, low performance indices, and were sensitive to the inclusion of age data (Table 14). The combined MCY of 5970 t is considerably higher than the 1120 t estimated using the average catch method (Table 13).

Table 13: Estimates of MCY (t) (rounded to the nearest 10 t).

Fishstock	QMA		Average Catch 1983–84 to 1986–87	MCY
GUR 1	Auckland (East) (West)	1 & 9	1 603	1 120
GUR 2	Central (East)	2	635	450
GUR 3	South-East (Coast) (Chatham), Southland and Sub-Antarctic	3, 4, 5, & 6	280	200
GUR 7	Challenger	7	365	260
GUR 8	Central (West)	8	205	140
GUR 10	Kermadec	10	–	–
Total			3 088	2 170

Table 14: Estimates of B_{MCY} (as % of B_0), MCY (as %B_0), MCY range (t) (from B_{min} and B_{max}), and MCY (t) (from MIAEL) and its performance index (Perf.), for the base case assessment and sensitivity runs for GUR 1W and GUR 1E. B_{may} (% of B_0) was 29.8% for GUR 1W and 29.9% for GUR 1E for the base case runs. All sensitivities tests should be compared to the no age data run.

Fishstock	Model run	B_{MCY} (% of B_0)	MCY (% of B_0)	MCY Range	MCY (t)	Perf. (%)
GUR 1W	**Base case**	**48.1**	**10.2**	**520–10 400**	**2 760**	**9.5**
	No age data	48.0	9.4	470–9 570	1 490	10.7
	M +0.05	49.5	10.7	480–10 070	1 600	9.8
	M –0.05	46.7	8.1	470–8 910	1 430	10.5
	r_{max} = 0.3	47.0	10.3	630–1 040	1 860	4.3
	cpue	48.0	9.4	470–9 580	1 450	11.3
GUR 1E	**Base case**	**48.9**	**10.3**	**650–9 730**	**3 210**	**13.5**
	No age data	48.3	9.6	470–7 360	1 220	1.0
	M +0.05	49.5	10.9	470–7 710	1 180	1.5
	M –0.05	46.7	8.2	480–6 880	1 350	0.0
	r_{max} = 0.3	47.1	10.5	570–8 050	1 790	0.6
	cpue	48.3	9.6	470–7 360	1 280	0.4

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

(d) Estimation of Current Annual Yield (CAY)

No estimate of CAY is available for red gurnard.

(e) Other yield estimates and stock assessment results

Other yield estimates and stock assessment results are not available.

(f) Other factors

Red gurnard is a major by-catch of target fisheries for several different species, such as snapper and flatfish. The target species may differ between areas and seasons. The recorded landings are influenced directly by changes in the fishing patterns of fisheries for these target species and indirectly by the abundance of these target species. Some target fishing for gurnard also occurs. Therefore, MCY estimates based on catch data are subject to a great deal of uncertainty.

5. ANALYSIS OF ADAPTIVE MANAGEMENT PROGRAMMES (AMP)

The Ministry of Fisheries revised the AMP framework in December 2000. The AMP framework is intended to apply to all proposals for a TAC or TACC increase, with the exception of fisheries for which there is a robust stock assessment. In March 2002, the first meeting of the new Adaptive Management Programme Working Group was held. Two changes to the AMP were adopted:

- a new checklist was implemented with more attention being made to the environmental impacts of any new proposal;
- the annual review process was replaced with an annual review of the monitoring requirements only. Full analysis of information is required a minimum of twice during the 5 year AMP.

GUR 3

GUR 3 is managed within the adaptive management programme, with the current five-year term beginning October 2002. The first GUR 3 TACC increase (from 524 t to 600 t) took effect in the 1991–92 fishing year under the adaptive management programme (AMP). A subsequent increase to 900 t was granted in 1996 for the 1996–97 fishing year. From 1 October 2002 the TACC was reduced to 750 t.

Mid-term Review of GUR 3 AMP in 2005

In 2005 the AMP FAWG reviewed the performance of the AMP after 2 years in its current 5-year term (SeaFIC 2005). The WG noted:

Characterisation

- GUR 3 is predominantly taken by bottom trawlers targeting red cod (39%) and flatfish (31%). Most of the catch is made in statistical areas 20 and 22.

CPUE standardization

- When the East Coast South Island trawl survey was discontinued (after 2001), standardized CPUE based on non zero GUR 3 catches in the flatfish bottom trawl fishery was accepted as an alternative index of abundance.
- Log-normal GLM modelling produced a trend that increased sharply from 1998/99 to 2003/04, after varying around an apparent mean prior to that year. Standardized CPUE has approximately doubled since GUR 3 was introduced into the AMP in 1991/92.
- The South East Finfish Management Company also presented a standardized GUR 3 CPUE analysis for the red cod fishery. The lognormal model of non-zero catches for the RCO series was reasonably flat from 2000/01 to 2003/04. Although the CPUE indices for this period were greater than that for 1998/99, the overall trend did not suggest a general increase over the period 1989/90 – 2003/04
- The diagnostics for all models were acceptable. In each case, combining the log-normal indices with binomial models of zero catch did not alter the overall trends.
- The RCO fishery operates predominantly to the north of Banks Peninsula while the focus of the FLA fishery is further south. Given differences in the CPUE indices and in catch trends, it is possible that GUR 3 is comprised of more than one biological stock.
- Future analyses should investigate the possibility of multiple biological stocks (particularly north and south of Banks Peninsula). This could be done by either exploring area/year interactions or by providing separate indices for each area. Given the depth distribution of red gurnard, offshore statistical areas should not be included in the CPUE standardisation.In the current analysis offshore and inshore areas were combined.
- SEFMC also provided a GUR 3 index based on the mixed RCO/FLA bottom trawl fishery with target as an explanatory variable (consistent with an analysis presented in 2002). This index appeared to mimic the FLA-only analysis and should be dropped from future analyses.

GUR 3 Decision Rule

- If the GUR abundance index drops by 50% from the mean index from 1989–90 to 1995–96 in the FLA 3 trawl fishery then the AMP FAWG will review the current stock status. *This decision rule was not triggered in the 2003/04 fishing year.*

Log Book Programme

- Given the uncertainty regarding standardized CPUE as an index of abundance, patterns in age/size structure of the catch would be useful for validating and interpreting CPUE trends. Although the February 2002 AMP proposal for GUR 3 did not include logbook coverage, the Plenary supported including red gurnard in the logbook programme intended to cover ELE 3 and STA 3 in the target RCO 3 bottom trawl fishery.
- GUR 3 is currently still not covered by the logbook programme.
- Appropriate logbook coverage of GUR 3 should be initiated as soon as possible.

Environmental considerations

- GUR 3 is taken as a bycatch of a mixed species bottom trawl fishery. This fishery has had a long history and the increase in GUR 3 TACC is not likely to have resulted in new areas fished or in significant increases in effort.
- On the other hand, the introduction of closed areas (voluntary or statutory) is likely to have displaced some effort and this should be investigated in future presentations.

Conclusion

- Given the increasing trend in CPUE, GUR 3 appears to have increased in stock size since it was introduced into the AMP.
- Future CPUE analyses should, however, investigate the possibility of more than one biological stock.
- The collection of biological data, under the logbook programme, should begin as soon as possible.
- It is not known whether the Fishstock is above or below Bmsy.

<u>Annual Review of GUR 3 AMP in 2006</u>

In 2006 the AMP FAWG reviewed the performance of the logbook monitoring programme (Lydon et al. 2006). The WG noted:

- The current 5-year term for the GUR 3 AMP commenced in October 2002. Although the February 2002 AMP proposal for GUR 3 did not include logbook coverage, the Plenary supported including red gurnard in the logbook programme intended to cover ELE 3 and STA 3 in the target RCO 3 bottom trawl fishery.
- Approximately 3.5% of the bottom trawl catch of GUR was sampled by the logbook programme in 2004/05.
- Logbook coverage is inadequate and should be increased to appropriate levels as soon as possible.

6. STATUS OF THE STOCKS

Estimates of current and reference biomass are available for GUR 1W and GUR 1E. Estimates of current and reference absolute biomass are not available for the other gurnard stocks.

Red gurnard is a major by-catch species subject to wide variations in recorded catch. This is partly due to changes in target fisheries and stocks, and to natural variations in the red gurnard stocks. The MCY estimates derived from catch statistics are subject to a great deal of uncertainty and are probably conservative.

The current TACCs were based on a period of highest ever catches, and these levels have not been reached in recent years. In GUR 1, current catch levels are probably constrained by changes in the target fisheries.

GUR 1W

The stock assessment model was based on data up to the end of the 1997–98 fishing year. The assessment for the GUR 1W stock is reasonably optimistic. Both trawl and CPUE indices are increasing, and the model indicated that B_{mid99} was about 80% of B_0 (range 40–147%, performance index 3%), suggesting that the stock has been only lightly exploited and is also benefiting from several recent years of strong recruitment. Current biomass appears to be greater than stock size that will support the B_{MSY}. Current catch levels appear to be sustainable, and continued catches at the current level will allow the stock to remain above B_{MSY}.

GUR 1E

The abundance indices all suggest that the biomass in GUR 1E declined in the early 1980s, but recovered slightly during the 1990s. Current biomass appears to be above B_{MSY} (B_{mid99} was estimated at 59% of B_0 (range 9–83%, performance index 58%) and current catch levels are probably sustainable. Continued catches at the current level will allow the stock to remain above B_{MSY}.

GUR 3

GUR 3 is being managed within an adaptive management programme with a decision rule relating to the proportion of targeting and CPUE. The TACC for GUR 3 was decreased to 750 t for the 2002–03 fishing year, under the adaptive management programme. Recent catch levels and the previous TACC are probably sustainable. It cannot be determined if the new TACC of 750 t is sustainable in the long-term or will allow the stock to move towards the size that will support the maximum sustainable yield.

GUR 7

The TACC for GUR 7 was increased from 678 t to 815 t for the 1991–92 fishing year under the adaptive management programme, then reduced to 678 t for 1997–98. Landings declined each year from a high of 761 t in 1992–93 to reach 331 t in 1999–00, but have since increased to 685t in 2001/02. Un-standardized commercial-trawl CPUE for GUR 7 declined from 1992/93 to 1996/97 and then increased from 1998/01 to 2002/03. Trawl surveys, on the other hand, indicate that the relative biomass of red gurnard declined gradually from 1992 to 2003 on the west coast of the South Island, and, the relative biomass declined sharply in 2003 in Tasman and Golden Bays. The lack of juveniles (20-30cm) during the 2003 survey was also cause for concern. Relative biomass increased substantially in 2005, but given that increases were observed for most species, the latest survey results may well be anomalous i.e. biased by higher than usual catchability for target species.

Recent catches are probably sustainable, at least in the short term. It is not known if the current TACC is sustainable. It is not known if recent catches or the current TACC will allow the stock to move towards a size that will support the maximum sustainable yield.

Other Fishstocks (GUR 2, 8, 10)

It is not known if recent catch levels or the current TACC are sustainable or if they are at levels that will allow the stock to move towards a size that will support the maximum sustainable yield.

Summary of yield estimates (t), TACCs (t) and reported landings (t) of red gurnard for the most recent fishing year. MCY(1) from cYav method, MCY(2) from MIAEL method (range only given).

Fishstock		QMA		MCY(1)	MCY(2)	2004–05 Actual TACC	2004–05 Reported landings
GUR 1	Auckland	1 & 9	}	1120		2 287	1 349
	GUR 1W				520−10 400		
	GUR 1E				650−9 730		
GUR 2	Central (east)	2	}	450		725	708
GUR 3	South–East, Southland and Sub–Antarctic	3, 4, 5, & 6		200		750	854
GUR 7	Challenger	7		260		678	686
GUR 8	Central (west)	8		140		543	370
GUR 10	Kermadec	10		–		10	0
Total				2 170		4 993	3 967

7. FOR FURTHER INFORMATION

Blackwell, R. (1988). Red gurnard. *N.Z. Fisheries Assessment Research Document 88/23*. 18 p.

Boyd, R.O., Reilly, J.L. (2002). 1999/2000 national marine recreational fishing survey: harvest estimates. *Draft New Zealand Fisheries Assessment Report*

Bradford, E. (1998). Harvest estimates from the 1996 national recreational fishing surveys. *N.Z. Fisheries Assessment Research Document 98/16*. 27 p.

Cordue, P. L. (1998). Designing optimal estimators for fish stock assessment. *Canadian Journal of Fisheries and Aquatic Science. 55*: 376–386.

Challenger Finfisheries Management Company (2003). Report to the Adaptive Management Programme Fishery Assessment Working Group. GUR7 Adaptive Management Proposal for the 2004-05 fishing year. Copies held by MFish.

Elder, R.D. (1976). Studies on age and growth, reproduction and population dynamics of red gurnard, *Chelidonichthys kumu* (Lesson and Garnot), in the Hauraki Gulf, New Zealand. *Fisheries Research Bulletin No. 12*. 62 p.

Francis, R.I.C.C. (1992). Recommendations concerning the calculation of maximum constant yield (MCY) and current annual yield (CAY). N.Z. Fisheries Assessment Research Document 92/8.

Kendrick, T., Walker, N. (2003). Characterisation of the GUR 2 red gurnard (*Chelidonichthys kumu*) and associated inshore trawl fisheries, 1989-90 to 2000-01. Final Research Report to the Ministry of Fisheries for Project GUR2001-01. 84 p.

Lydon, G.J.; Middleton, D.A.J.; Starr, P.J. (2006). Performance of the GUR 3 Logbook Programme. AMP-WG-06/22. (Unpublished manuscript available from the NZ Seafood Industry Council, Wellington.)

SeaFIC (2002). Report to the Adaptive Management Programme Fishery Assessment Working Group. Analysis of Catch and Effort Data from the GUR 3 Trawl Fishery, 1989/90 to 2000/01 (dated 19 February 2002). Copies held by MFish.

Stevenson, M.L. (2000). Assessment of red gurnard (*Chelidonichthys kumu*) stocks GUR 1 and GUR 2. *New Zealand Fisheries Assessment Report 2000/40*. 51 p.

Sutton, C.P. (1997). Growth parameters, and estimates of mortality for red gurnard (*Chelidonichthys kumu*) from off the east and west coasts of the South Island, New Zealand. *New Zealand Fisheries Assessment Research Document 97/1.* 15 p.

Vignaux, M. (1997). CPUE analyses for fishstocks in the adaptive management programme. *New Zealand Fisheries Assessment Research Document 97/24.* 68 p.

Teirney, L.D.; Kilner, A.R.; Millar, R.E.; Bradford, E.; Bell, J.D. (1997). Estimation of recreational catch from 1991–92 to 1993–94 *N.Z. Fisheries Assessment Research Document 97/15*. 43 p.