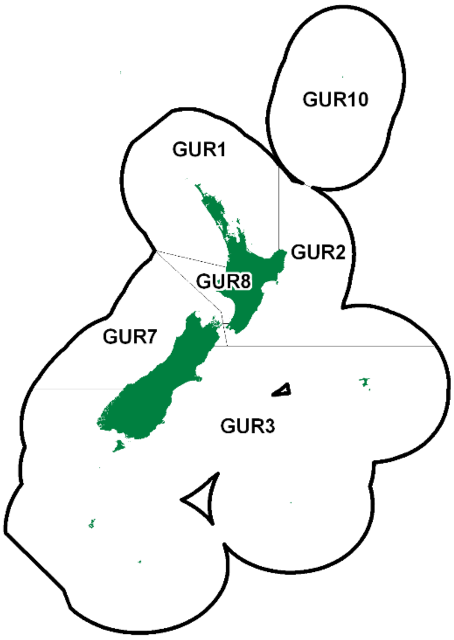
RED GURNARD (GUR)

(*Chelidonichthys kumu*)
Kumukumu



1. FISHERY SUMMARY

1.1 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 (WCSI) and in Tasman Bay. They are also directly targeted in some areas e.g. GUR 2. 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 bottom longline and setnet.

Red gurnard was introduced into the Quota Management System (QMS) in 1986. 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 Programme (AMP), to 600 t in GUR 3 and to 815 t in GUR 7. The GUR 7 TACC was reduced to 678t, in 1997–98. For the 2009–10 fishing season, the TACC in GUR 7 was increased from 681 t to 715 t, including an allocation of 10 t for customary, 20 t for recreational use, and 14 t allocation for other sources of mortality. The GUR 7 TACC was further increased to 785t in October 2012. The TACC for GUR 3 was increased, by 300 t (50%) to 900 t, for the 1996–97 fishing year under the AMP, but decreased to 800 t in 2002–03. For the 2009–10 fishing season, the TACC for GUR 3 was increased from 800 t to 900 t, with allocations of 3 t, 5 t, and 45 t for customary, recreational, and other sources of mortality respectively. The GUR 3 TACC was increased to 1100 t in October 2012. This TACC can be seen in Table 1 along with all current allowances, TACCs and TACs. All AMP programmes ended on 30 September 2009.

Table 1: TACs, TACCs and allowances (t) for Red Gurnard by Fishstock

Fishstock	TAC	TACC	Customary allowance	Recreational allowance	Other mortaility
GUR 1		2 287			
GUR 2		752			
GUR 3	1 163	1 100	3	5	55
GUR 7	855	785	10	20	40
GUR 8		543.2			
GUR 10		10			

Reported landings since 1931 are shown in Tables 2 and 3, while an historical record of landings and TACC values for the five main GUR stocks are depicted in Figure 1.

Annual landings of GUR 1 have been relatively stable since 1986–87, generally ranging between 900 and 1300 t; substantially lower than the 2287 t 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.

Table 2: Reported landings (t) for the main QMAs from 1931 to 1982

Year	GUR 1	GUR 2	GUR 3	GUR 7	Year	GUR 1	GUR 2	GUR 3	GUR 7
1931–32	67	0	1	16	1957	494	402	737	409
1932–33	42	0	0	13	1958	430	394	745	400
1933–34	67	84	1	20	1959	460	320	806	212
1934–35	50	179	0	2	1960	489	417	1008	421
1935–36	75	147	18	2	1961	559	419	1180	419
1936–37	114	215	37	25	1962	505	592	1244	322
1937–38	205	193	83	21	1963	576	562	1364	367
1938–39	109	118	151	31	1964	977	814	1708	397
1939–40	121	149	147	25	1965	1020	668	1459	400
1940–41	124	222	215	38	1966	1157	754	1178	436
1941–42	107	200	267	38	1967	1051	836	745	522
1942–43	124	332	287	58	1968	1137	583	510	368
1943–44	128	244	294	53	1969	1345	632	487	256
1944	238	292	291	60	1970	1493	823	841	381
1945	360	338	222	94	1971	1225	570	940	379
1946	426	387	290	119	1972	770	347	662	333
1947	376	297	243	162	1973	1278	406	1393	491
1948	385	243	267	226	1974	881	299	1083	586
1949	371	264	316	323	1975	691	199	655	365
1950	306	186	486	332	1976	1055	217	960	545
1951	221	231	750	202	1977	1288	381	975	579
1952	394	378	658	211	1978	1571	519	1106	487
1953	490	494	614	334	1979	1936	382	690	349
1954	496	462	660	382	1980	1845	438	672	253
1955	495	283	652	490	1981	2349	603	438	318
1956	434	312	782	435	1982	2084	454	379	368

Year	GUR 8	Year	GUR 8
1931–32	0	1957	46
1932–33	0	1958	51
1933–34	0	1959	44
1934–35	0	1960	27
1935–36	0	1961	27
1936–37	1	1962	14
1937–38	0	1963	8
1938–39	2	1964	16
1939–40	1	1965	34
1940–41	1	1966	27
1941–42	0	1967	45
1942–43	0	1968	52
1943–44	0	1969	33
1944	0	1970	53
1945	3	1971	37
1946	4	1972	15
1947	10	1973	21
1948	9	1974	41
1949	13	1975	28
1950	13	1976	52
1951	10	1977	45
1952	5	1978	26
1953	3	1979	18
1954	7	1980	34
1955	25	1981	16
1956	29	1982	34

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. Data were aggregated to FMA using methods and assumptions described by Francis & Paul (2013).

Table 3: Reported landings (t) of red gurnard by Fishstock from 1983–84 to 2011–12 and actual TACCs (t) from 1986–87 to 2013–14. The QMS data is from 1986–present.

Fishstock	GUR 1		GUR 2		GUR 3		GUR 7	
QMA (s)	1 & 9		2		3, 4, 5 & 6		7	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1983–84*	2 099	-	782	-	366	-	468	-
1984–85*	1 531	-	665	-	272	-	332	-
1985–86*	1 760	-	495	-	272	-	239	-
1986–87	1 021	2 010	592	610	210	480	421	610
1987–88	1 139	2 081	596	657	386	486	806	629
1988–89	1 039	2 198	536	698	528	489	479	669
1989–90	916	2 283	451	720	694	501	511	678
1990–91	1 123	2 284	490	723	661	524	442	678
1991–92	1 294	2 284	663	723	539	600	704	815
1992–93	1 629	2 284	618	725	484	601	761	815
1993–94	1 153	2 284	635	725	711	601	469	815
1994–95	1 054	2 287	559	725	685	601	455	815
1995–96	1 163	2 287	567	725	633	601	382	815
1996–97	1 055	2 287	503	725	641	900	378	815
1997–98	1 015	2 287	482	725	477	900	309	678
1998–99	927	2 287	469	725	395	900	323	678
1999–00	944	2 287	521	725	411	900	331	678
2000–01	1 294	2 287	623	725	569	900	571	678
2001–02	1 109	2 287	619	725	717	900	686	681
2002–03	1 256	2 287	552	725	888	800	793	681
2003–04	1 225	2 287	512	725	725	800	717	681
2004–05	1 354	2 287	708	725	854	800	688	681
2005–06	1 113	2 287	542	725	957	800	604	681
2006–07	1 180	2 287	575	725	1 004	800	714	681
2007–08	1 198	2 287	517	725	842	800	563	681
2008–09	1 060	2 287	621	725	939	800	595	681
2009–10	1 075	2 287	853	725	1 018	900	603	715
2010–11	1 046	2 288	587	725	929	900	545	715
2011–12	981	2 288	558	725	915	900	684	715
2012–13	1 103	2 288	603	725	1 168	1 100	763	785
2013–14	1	2 288	555	725	1 223	1 100	837	785

Fishstock	GUR 8		GUR 10			
QMA (s)	8		10		Total	
	Landings	TACC	Landings	TACC	Landings	TACC
1983–84*	251	-	0	-	3 966	-
1984–85*	247	-	0	-	3 047	-
1985–86*	163	-	0	-	2 929	-
1986–87	159	510	0	10	2 403	4 230
1987–88	194	518	0	10	3 121	4 381
1988–89	167	532	0	10	2 749	4 596
1989–90	173	538	0	10	2 745	4 730
1990–91	150	543	0	10	2 866	4 762
1991–92	189	543	0	10	3 390	4 975
1992–93	208	543	0	10	3 700	4 978
1993–94	174	543	0	10	3 142	4 978
1994–95	217	543	0	10	2 969	4 982
1995–96	182	543	0	10	2 927	4 982
1996–97	219	543	0	10	2 796	5 281
1997–98	249	543	0	10	2 532	5 143
1998–99	170	543	0	10	2 284	5 143
1999–00	222	543	0	10	2 429	5 143
2000–01	291	543	0	10	3 348	5 143
2001–02	302	543	0	10	3 429	5 143
2002–03	342	543	0	10	3 831	4 993
2003–04	329	543	0	10	3 508	4 993
2004–05	370	543	0	10	3 974	4 993
2005–06	373	543	0	10	3 589	4 993
2006–07	349	543	0	10	3 822	4 993
2007–08	223	543	0	10	3 344	4 993
2008–09	274	543	0	10	3 489	4 993
2009–10	239	543	0	10	3 789	5 181
2010–11	182	543	0	10	3 289	5 181
2011–12	213	543	0	10	3 351	5 181
2012–13	170	543	0	10	3 807	5 451
2013–14	151	543	0	10	3 769	5 451

*FSU data.

GUR 2 landings have fluctuated within the range of 400–8530 t since 1991–92, typically well below the TACC. In addition to the target fishery, red gurnard are taken as a bycatch of the tarakihi, trevally and snapper inshore trawl fisheries.

GUR 3 landings regularly exceeded the TACC between 1988–89 and 1995–96. Ageing of fish collected during the east coast South Island trawl (ECSI) surveys suggests that there were 1 or 2 relatively strong year classes moving through the fishery, which may help explain the overcatches. GUR 3 has been consistently overcaught since 2004.

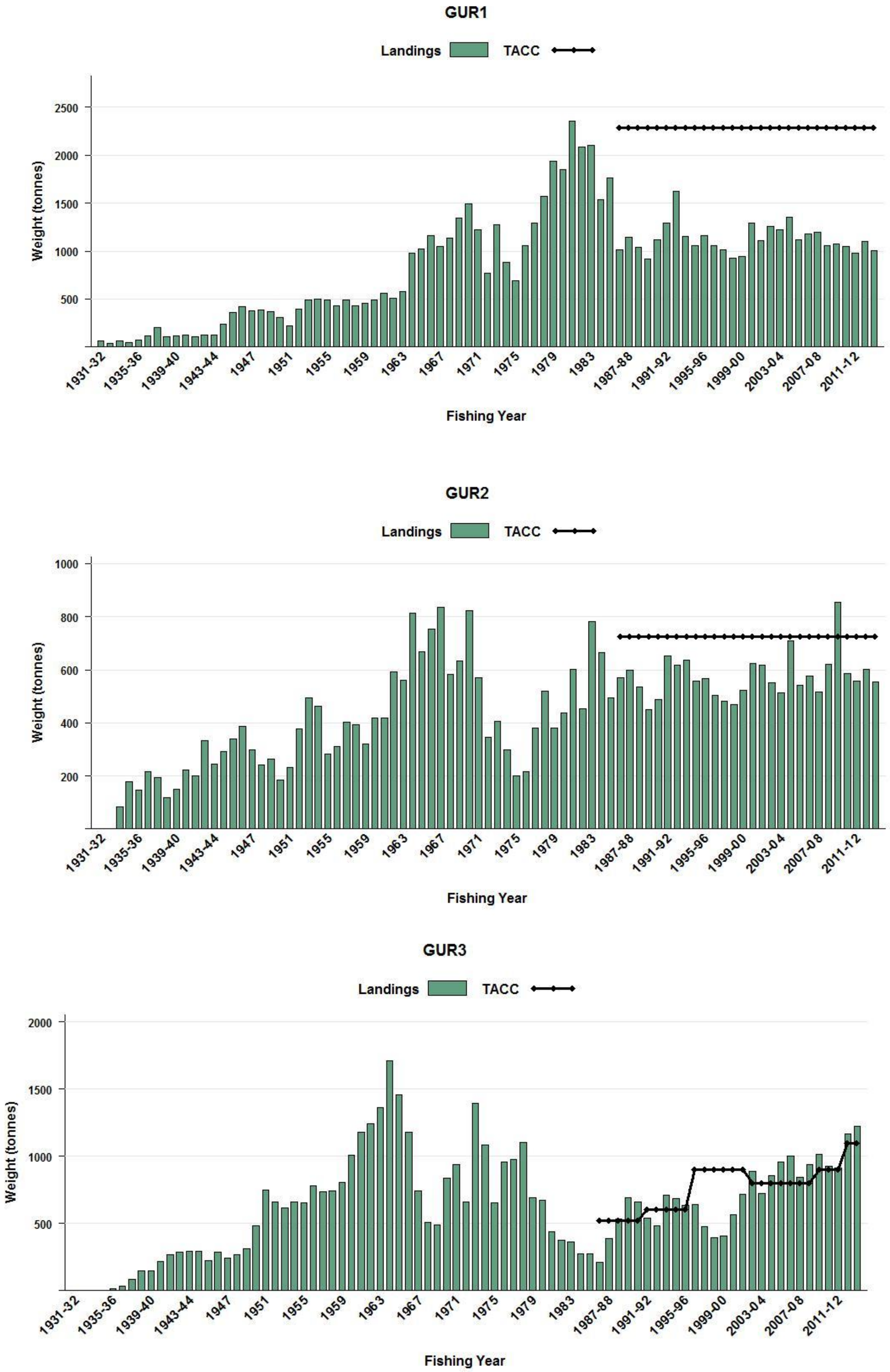


Figure 1: Reported commercial landings and TACCs for the five main GUR stocks. From top to bottom: GUR 1 (Auckland East), GUR 2 (Central East), GUR 3 (South East Coast). [Continued on next page].

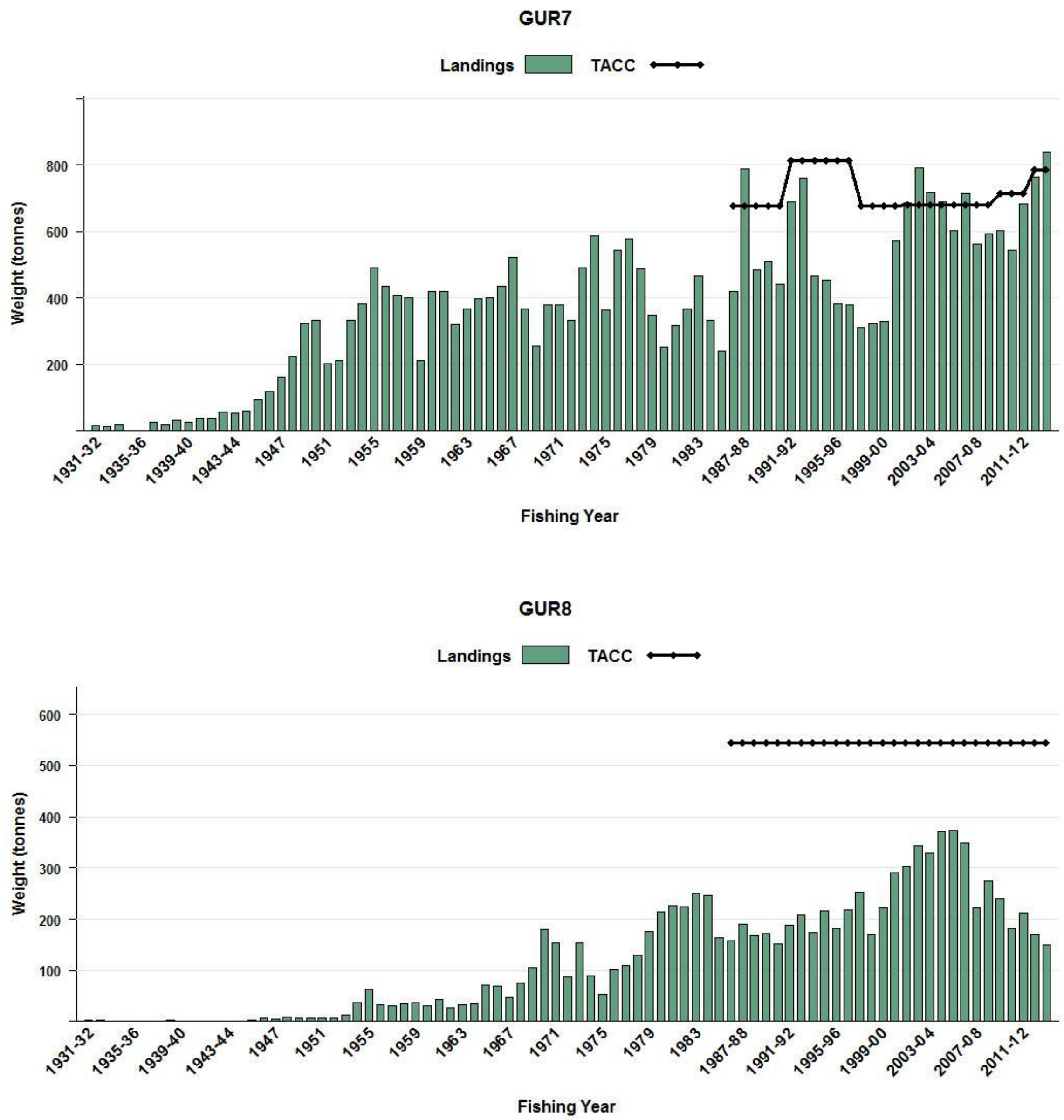


Figure 1 [Continued]: Reported commercial landings and TACCs for the five main GUR stocks. From top to bottom: GUR 7 (Challenger) and GUR 8 (Central Egmont).

GUR 7 landings declined steadily from 761 t in 1992–93, to 309 t in 1997–98, but then increased to a peak of 793 t in 2002–03. They then generally declined to 2010–11, followed by an increased to 2012–13. Landings in GUR 8 have remained well below the levels of the TACC since 1986–87.

1.2 Recreational fisheries

Red gurnard is, by virtue of its wide distribution in harbours and shallow coastal waters, an important recreational species. It is often taken by fishers targeting snapper and tarakihi, particularly around the North Island. The allowances within the TAC for each Fishstock are shown in Table 1.

1.2.1 Management controls

The main methods used to manage recreational harvests of red gurnard are minimum legal size limits (MLS), method restrictions and daily bag limits. Fishers can take up to 20 GUR as part of their combined daily bag limit and the MLS is 25 cm.

1.2.2 Estimates of recreational harvest

Recreational catch estimates are given in Table 4. There are two broad approaches to estimating recreational fisheries harvest: the use of onsite or access point methods where fishers are surveyed or counted at the point of fishing or access to their fishing activity; and, offsite methods where some form of post-event interview and/or diary are used to collect data from fishers.

The first estimates of recreational harvest for red gurnard were calculated using an offsite approach, the offsite regional telephone and diary survey approach. Estimates for 1996 came from a national telephone and diary survey (Bradford 1998). Another national telephone and diary survey was carried out in 2000 (Boyd & Reilly 2005) and a rolling replacement of diarists in 2001 (Boyd & Reilly 2004 allowed estimates for a further year (population scaling ratios and mean weights were not re-estimated in 2001).

The harvest estimates provided by these telephone diary surveys are no longer considered reliable for various reasons. With the early telephone/diary method, fishers were recruited to fill in diaries by way of a telephone survey that also estimates the proportion of the population that is eligible (likely to fish). A "soft refusal" bias in the eligibility proportion arises if interviewees who do not wish to co-operate falsely state that they never fish. The proportion of eligible fishers in the population (and, hence, the harvest) is thereby under-estimated. Pilot studies for the 2000 telephone/diary survey suggested that this effect could occur when recreational fishing was established as the subject of the interview at the outset. Another equally serious cause of bias in telephone/diary surveys was that diarists who did not immediately record their day's catch after a trip sometimes overstated their catch or the number of trips made. There is some indirect evidence that this may have occurred in all the telephone/diary surveys (Wright et al 2004).

Table 4: Recreational harvest estimates for red gurnard stocks. The telephone/diary surveys and earlier aerial-access surveys ran from December to November but are denoted by the January calendar year. The surveys since 2010 have run through the October to September fishing year but are denoted by the January calendar year. Mean fish weights were obtained from boat ramp surveys (for the telephone/diary and panel survey harvest estimates).

Stock	Year	Method	Number of fish	Total weight (t)	CV
GUR 1	1996	Telephone/diary	262, 000	108	0.07
	2000	Telephone/diary	465,000	223	0.16
FMA 1 only	2005	Aerial-access	-	127	0.14
FMA 1 only	2012	Aerial-access			
	2012	Panel survey	230, 521	98	0.15
GUR 2	1996	Telephone/diary	38, 000	16	0.18
	2000	Telephone/diary	209, 000	127	0.37
	2012	Panel survey	64, 292	37	0.20
GUR 3	1996	Telephone/diary	1, 000	-	-
	2000	Telephone/diary	11,000	5	0.70
	2012	Panel survey	4, 635	2	0.62
GUR 7	1996	Telephone/diary	26, 000	12	0.15
	2000	Telephone/diary	36,000	11	0.23
	2012	Panel survey	23, 692	12	0.24
GUR 8	1996	Telephone/diary	67, 000	28	0.15
	2000	Telephone/diary	99,000	40	0.36
	2012	Panel survey	93, 058	46	0.23

The recreational harvest estimates provided by the 2000 and 2001 telephone diary surveys are thought to be implausibly high for many species, which led to the development of an alternative maximum count aerial-access onsite method that provides a more direct means of estimating recreational harvests for suitable fisheries. The maximum count aerial-access approach combines data collected concurrently from two sources: a creel survey of recreational fishers returning to a subsample of ramps throughout the day; and an aerial survey count of vessels observed to be fishing at the approximate time of peak fishing effort on the same day. The ratio of the aerial count in a particular area to the number of interviewed parties who claimed to have fished in that area at the time of the overflight was used to scale up harvests observed at surveyed ramps, to estimate harvest taken by all fishers returning to all ramps. The methodology is further described by Hartill et al (2007).

This aerial-access method was first employed and optimised to estimate snapper harvests in the Hauraki Gulf in 2003–04. It was then extended to survey the wider SNA 1 fishery in 2004–05 and to provide estimates for other species, including red gurnard (FMA 1 only for GUR). In response to the cost and scale challenges associated with onsite methods, in particular the difficulties in sampling other than trailer boat fisheries, offsite approaches to estimating recreational fisheries harvest have been revisited. This led to the development and implementation of a national panel survey for the 2011–12 fishing year. The panel survey used face-to-face interviews of a random sample of New Zealand households to recruit a panel of fishers and non-fishers for a full year. The panel members were contacted regularly about their fishing activities and catch information collected in standardised phone interviews. Note that the national panel survey estimate does not include harvest taken on recreational charter vessels, or recreational harvest taken under s111 general approvals.

1.3 Customary non-commercial fisheries

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

1.4 Illegal catch

No quantitative information is available.

1.5 Other sources of mortality

No quantitative information is available**.**

2. BIOLOGY

Gurnard growth rate varies with location, and females grow faster and are usually larger at age than males. Maximum age (A_{MAX}) is about 16 years and maximum size is 55+ cm. 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. An analysis of the age and growth of red gurnard in FMA 7 revealed that young fish 1–4 years old tend to be most common in Tasman and Golden Bays. Three to six year old fish are found on the inshore areas of the West coast South Island and the older fish are predominantly found further offshore (Lyon & Horn 2011).

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. Samples from the ECSI 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. Samples from the WCSI 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 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 eight days before feeding starts. Small juveniles (under 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. Natural mortality (M)								
				Female			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)
2. Weight = a(length)^b (Weight in g, length in cm fork length).								
							Both Sexes	
				a			b	
GUR 1				0.00998			2.99	Elder (1976)
GUR 1W & 1 E				0.026			2.775	Stevenson (2000)
GUR 2				0.0053			3.19	Stevenson (2000)
3. von Bertalanffy growth parameters								
			Females				Males	
	L_∞	k	t_0		L_∞	k	t_0	
GUR 1	36.4	0.641	0.189		28.8	0.569	-0.552	Elder (1976)
GUR 1W	45.3	0.25	-0.88		36.5	0.45	-0.30	Stevenson (2000)
GUR 1E	44.5	0.28	-0.76		35.2	0.49	-0.24	Stevenson (2000)
GUR 3	48.2	0.44	0.1		42.2	0.49	-0.26	Sutton (1997)
GUR 7	45.7	0.40	-0.36		40.3	0.37	-0.96	Sutton (1997)

3. STOCKS AND AREAS

There are no data that would alter the current stock boundaries. No information is available on stock separation of red gurnard. For GUR 3 the Working Group noted that spatial information from the CPUE analyses indicated that separate stocks or sub-stocks may exist between the East and South coasts of the South Island.

4. STOCK ASSESSMENT

4.1 Biomass estimates

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, South Island west coast and Tasman/Golden Bays combined (GUR 7), and South Island east coast (GUR 3) (Table 6). Only the West Coast South Island (WCSI) and East Coast South Island (ECSI) surveys are currently conducted, and these are conducted on a biennial basis.

ECSI

The ECSI winter surveys from 1991 to 1996 in 30–400 m were replaced by summer trawl surveys (1996–97 to 2000–01) which also included the 10–30 m depth range, but these were discontinued after the fifth in the annual time series because of the extreme fluctuations in catchability between surveys (Francis et al. 2001). The winter surveys were reinstated in 2007 and this time included additional 10–30 m strata in an attempt to index elephantfish and red gurnard which were included in the list of target species. Only 2007, 2012, and 2014 surveys provide full coverage of the 10–30 m depth range.

In the 1990s, red gurnard biomass in the east coast South Island winter surveys core strata (30–400 m) averaged 422 t and this increased nearly four-fold to an average of 1646 t from 2007 to 2014 (Table 7, Figure 2). Since 2007 there were indications of an upward trend in biomass, with the estimate for 2014 being 23% higher than in 2012, and also the highest biomass of the time series. The proportion of pre-recruit biomass in the core strata varied greatly among surveys, but was generally low, 2–20%, and in 2014 was 20%. Similarly, the proportion of juvenile biomass (based on the length-at-50% maturity) within the core strata was close to zero for all surveys (Beentjes et al., 2015). These observations

Table 6: Relative biomass indices (t) and coefficients of variation (CV) for gurnard for east coast South Island (ECSI) - summer and winter, west coast South Island (WCSI) and the Stewart-Snares Island survey areas*. Biomass estimates for ECSI in 1991 have been adjusted to allow for non-sampled strata (7 & 9 equivalent to current strata 13, 16 and 17). The sum of pre-recruit and recruited biomass values do not always match the total biomass for the earlier surveys because at several stations length frequencies were not measured, affecting the biomass calculations for length intervals. – , not measured; NA, not applicable. Recruited is defined as the size-at-recruitment to the fishery (30 cm). [Continued on next page].

Region	Fishstock	Year	Trip number	Total Biomass estimate	CV (%)	Total Biomass estimate	CV (%)	Pre-recruit	CV (%)	Pre-recruit	CV (%)	Recruited	CV (%)	Recruited	CV (%)
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	GUR 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	GUR 8	1989	KAH8918	628	15	-	-	-	-	-	-	-	-	-	-
		1991	KAH9111	817	9	-	-	-	-	-	-	-	-	-	-
		1994	KAH9410	685	22	-	-	-	-	-	-	-	-	-	-
		1996	KAH9615	370	37	-	-	-	-	-	-	-	-	-	-
		1999	KAH9915	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	-	-	-	-	-	-	-	-	-	-

*Assuming areal availability, vertical availability and vulnerability equal 1.0. Biomass is only estimated outside 10 m depth except for COM9901 and CMP0001. Note: because trawl survey biomass estimates are indices, comparisons between different seasons (e.g., summer and winter ECSI) are not strictly valid

FMAs 8 and 9 combined

Table 6 [Continued]: Relative biomass indices (t) and coefficients of variation (CV) for gurnard for east coast South Island (ECSI) - summer and winter, west coast South Island (WCSI) and the Stewart-Snares Island survey areas*. Biomass estimates for ECSI in 1991 have been adjusted to allow for non-sampled strata (7 & 9 equivalent to current strata 13, 16 and 17). The sum of pre-recruit and recruited biomass values do not always match the total biomass for the earlier surveys because at several stations length frequencies were not measured, affecting the biomass calculations for length intervals. – , not measured; NA, not applicable. Recruited is defined as the size-at-recruitment to the fishery (30 cm).

Region	Fishstock	Year	Trip number	Total Biomass estimate	CV (%)	Total Biomass estimate	CV (%)	Pre-recruit	CV (%)	Pre-recruit	CV (%)	Recruited	CV (%)	Recruited	CV (%)
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	625	15	-	-	-	-	-	-	-	-	-	-
		2003	KAH0304	270	20	-	-	-	-	-	-	-	-	-	-
		2005	KAH0503	442	17	-	-	-	-	-	-	-	-	-	-
		2007	KAH0704	553	17	-	-	-	-	-	-	-	-	-	-
		2009	KAH0904	651	18	-	-	-	-	-	-	-	-	-	-
		2011	KAH1004	1 070	17	-	-	-	-	-	-	-	-	-	-
		2013	KAH1305	754	12				-	-					
									-	-					
North Island east coast		1993	KAH9304	439	44	-	-	-	-	-	-	-	-	-	-
		1994	KAH9402	871	16	-	-	-	-	-	-	-	-	-	-
		1995	KAH9502	178	26	-	-	-	-	-	-	-	-	-	-
		1996	KAH9605	708	29	-	-	-	-	-	-	-	-	-	-
ECSI (winter)	GUR 3			30–400 m		10–400 m		30–400 m		10–400 m		30–400 m		10–400 m	
		1991	KAH9105	763	33	-	-	NA	NA	-	-	NA	NA	-	-
		1992	KAH9205	142	30	-	-	21	58	-	-	121	30	-	-
		1993	KAH9306	576	31	-	-	26	45	-	-	551	31	-	-
		1994	KAH9406	123	34	-	-	2	42	-	-	121	34	-	-
		1996	KAH9606	505	27	-	-	8	44	-	-	496	26	-	-
		2007	KAH0705	1 453	35	2 048	27	298	40	494	32	1 155	35	1 554	27
		2008	KAH0806	1 309	34	-	-	100	59	-	-	1 210	33	-	-
		2009	KAH0905	1 725	30	-	-	62	34	-	-	1 663	30	-	-
		2012	KAH1207	1 680	28	3 515	17	193	40	742	31	1 487	27	2 773	16
		2014	KAH1402	2 063	25	3 215	17	409	45	585	32	1 654	23	2 630	16
ECSI (summer)	GUR 3	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	-	-	-	-	-	-	-	-	-	-

*Assuming areal availability, vertical availability and vulnerability equal 1.0. Biomass is only estimated outside 10 m depth except for COM9901 and CMP0001. Note: because trawl survey biomass estimates are indices, comparisons between different seasons (e.g., summer and winter ECSI) are not strictly valid indicate that the core strata survey (30–400 m) may not be shallow enough to provide an index for sub-mature gurnard.

The additional red gurnard biomass captured in the 10–30 m depth range accounted for 29%, 52% and 36% of the biomass in the core plus shallow strata (10–400 m) for 2007, 2012, and 2014 respectively, indicating that it is essential to survey the shallow strata to reliably monitor red gurnard biomass.

The addition of the 10–30 m depth range had no significant effect on the length frequency distributions in 2007 and 2014, but in 2012 there was a strong 1+ cohort in 10–30 m, which was poorly represented in the core strata (Beentjes et al., 2015). Based on the three surveys that included the 10–30 m strata, there are generally more pre-recruit fish in the shallow strata, suggesting the core plus shallow strata (10 to 400 m) survey is probably indexing red gurnard abundance, including juveniles. The distribution of red gurnard hot spots varies, but overall this species is consistently well represented over the entire survey area from 10 to 100 m, but is most abundant in the shallow 10 to 30 m strata.

WCSI
The relative total biomass index (pre-recruit and recruited fish) calculated for the entire GUR 7 stock (West coast and Tasman Bay combined) was stable from 1992 to 2000, was relatively low in 2003 and has steadily increased from 2003 to 2013 (Figure 3). Length frequency trends for the West Coast South Island red gurnard catch show that there were substantial numbers of 20–25 cm fish in 1997 and 2000. Fish of this size did not appear in large numbers in 2003 or 2005, but high numbers were caught again in 2007, 2009 and 2013 (MacGibbon and Stevenson 2013).

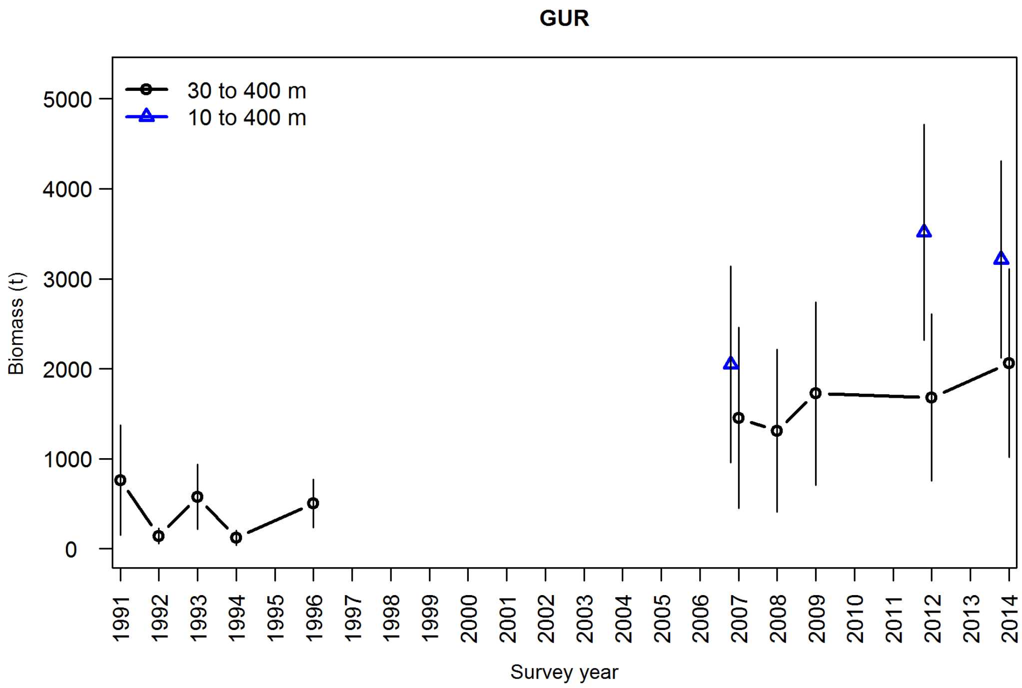


Figure 2: Red gurnard total biomass and 95% confidence intervals for the all ECSI winter surveys in core strata (30–400 m), and core plus shallow strata (10–400 m) in 2007, 2012, and 2014.

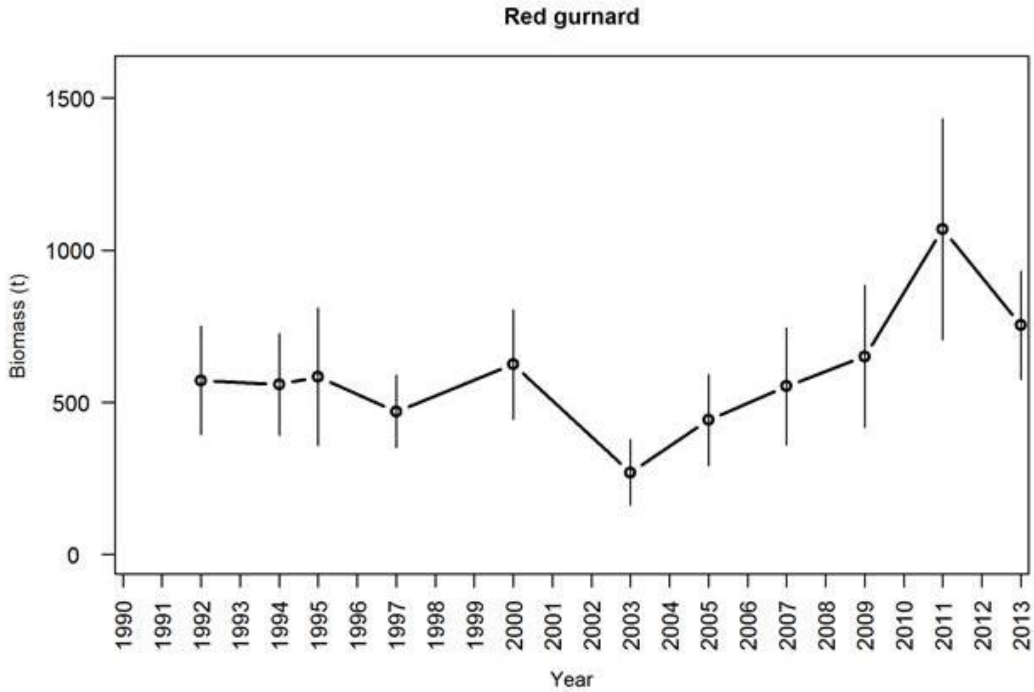


Figure 3: Red gurnard biomass trends ± 95% CI (estimated from survey CVs assuming a lognormal distribution) and the time series mean (dotted line) from the West Coast South Island trawl surveys.

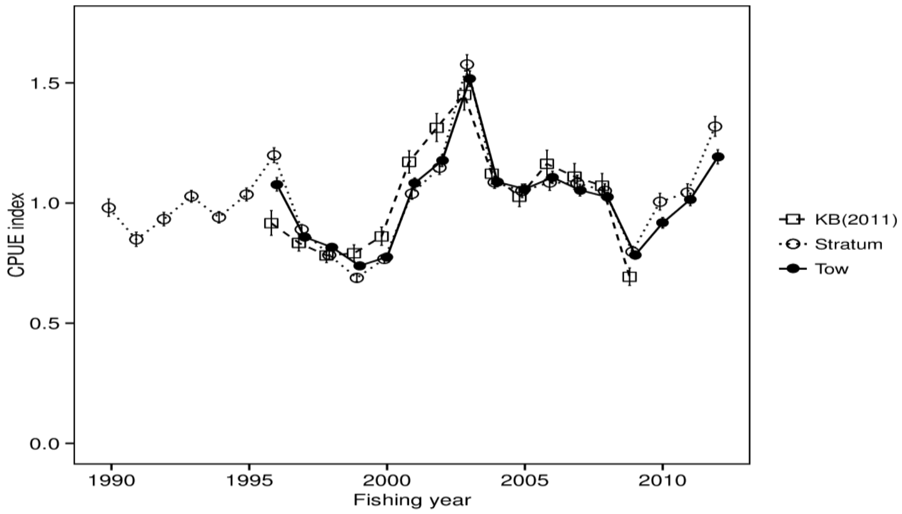
4.3 CPUE Analyses

GUR 1

In 2012, Kendrick & Bentley (in prep) updated CPUE analyses for GUR 1W, GUR 1E, and GUR 1BP (Figures 4 and 5). For each substock, positive catches from single bottom trawl targeted at gurnard, snapper, trevally, tarakihi or John dory were standardised using data from selected core vessels.

The analyses were based on tow based CPUE reported on TCEPR and TCER forms because adequate time series are available in the northern inshore trawl fisheries from 1995–96. Stratum based analyses were also done for each substock that included CELR forms and aggregated data to a common vessel-date-target-area stratum (Table 7). This produced longer time series (from 1989–90) that give an historical perspective to the recent trends.

For each CPUE analysis the suitability of alternative assumptions about the distributions of GLM errors were examined. The distribution which produced the lowest AIC when fitted using a simple, preliminary model was chosen.



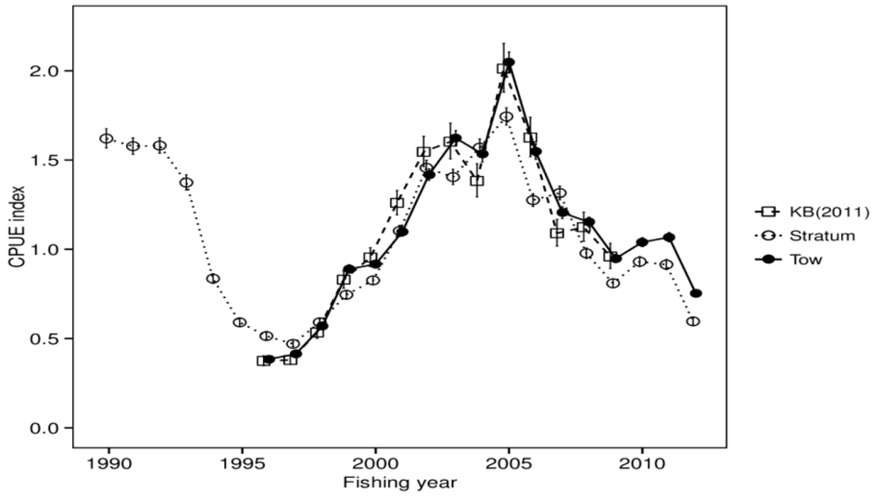


Figure 4: Comparison of indices for GUR 1W (upper) and GUR 1E (lower) for bottom trawl based on TCEPR/ TCE format data (tow) with a longer time series (stratum) that includes CELR data, and also with the previous analysis (Kendrick & Bentley 2011) Error bars are ± 1 s.e.

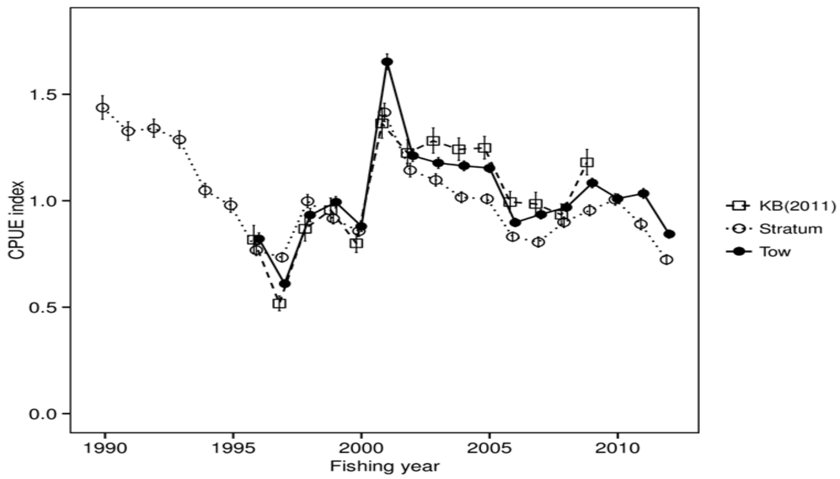


Figure 5: Comparison of indices for GUR 1 BoP for bottom trawl based on TCEPR/ TCE format data (tow) with a longer time series (stratum) that includes CELR data, and also with the previous analysis (Kendrick & Bentley 2011). Error bars are± 1 s.e.

Table 7: Details of CPUE analyses for each substock of red gurnard in GUR 1.

	Core vessels			
	Criteria (trips, years)	Number	Catch (%)	Error distribution
				West coast
Tow	3, 3	34	93	Gamma
Stratum	3, 3	46	97	Weibull
				East coast
Tow	3, 3	41	98	log-logistic
Stratum	3, 3	64	96	log-logistic
				Bay of Plenty
Tow	3, 3	44	98	log-logistic
Stratum	3, 3	61	97	weibull

All three series show strong cyclical fluctuations with a strong recovery from low levels reached between 1995 and 1999 to a peak in the early 2000s followed by a subsequent decline but with bigger magnitude changes evident in the east coast substock than in the other two. The series also differ with respect to the specific years for the nadir and the peak, as well as the nature of the trajectory after the peak in the early 2000s; each is currently near the mean for the series, but the west coast is increasing, while East coast and Bay of Plenty series are in a downward phase.

The Working Group accepted the tow-based series for ongoing monitoring of each substock.

GUR 2

GUR 2 is monitored using the bottom trawl fishery targeting gurnard, snapper or trevally and standardised CPUE is based on a model of positive catches from statistical areas 011–015.

In 2014, Kendrick & Bentley (in prep) updated CPUE analyses for GUR 2 (Figure 4) using a gamma error distribution, and a core fleet of 60 vessels that had completed at least five trips per year in at least five years. Landings were allocated to daily aggregated effort using methods described by Langley (2014) to improve the comparability between the data collected from two different statutory reporting forms (CELR and TCER). The model adjusted for the recent positive influences of shifts in duration, vessel, an area x month interaction term, and target species, and accounted for 51% of the variance in catch. A shorter time series based on TCEPR and TCER format data available since 2007–08, and analysed at tow by tow resolution closely resembles the mixed form series for the years in common (Figure 6).

The series describes a long gradual decline to the lowest point of the series in 2005–06 that is followed by six years of relative stability and the suggestion of an increase in the most recent year to above the mean for the series. An alternative analysis based on bycatch from the deeper tarakihi fishery also corroborated the overall trends.

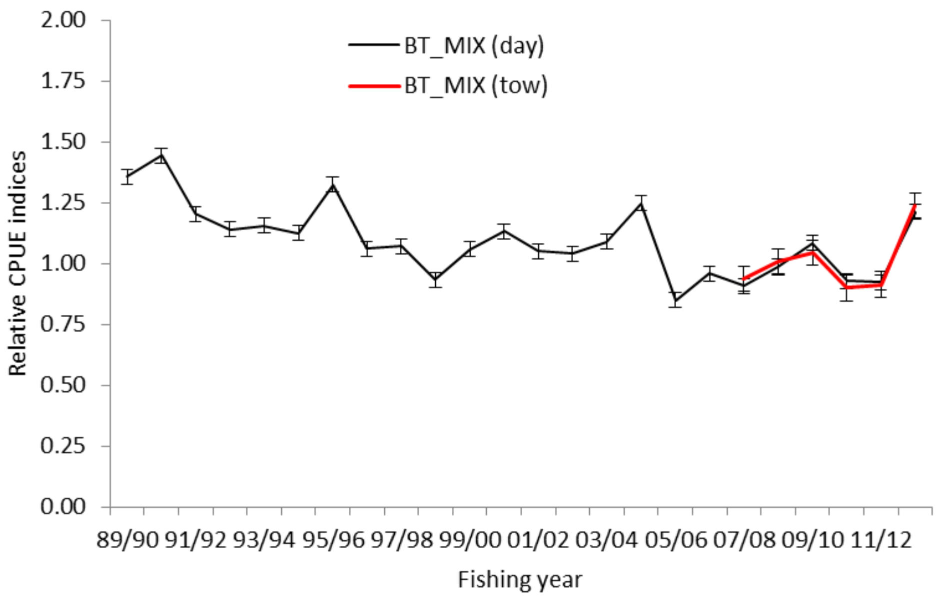


Figure 6: Comparison of standardised catch per unit effort (CPUE) indices for GUR 2 from bottom trawling targeting gurnard, snapper and trevally (GUR.BT.MIX) combined over all form types, and more recently from data based on TCEPR/ TCE (tow) format data only (Kendrick & Bentley, in prep. Both series are scaled relative the geometric mean of the years they have in common. Fishing years are labelled according to the second calendar year e.g 1990 = 1989–90. In both standardisation models a gamma error distribution was assumed.

Chapman and Robson estimates of total mortality (*Z*) for GUR 2, based on the age composition of bottom trawl landings in 2009–10, were 0.518 (SE = 0.0159, CV=3.1%) and 0.632 (0.0196, 3.1), depending on whether the age of full recruitment was 2 or 3 years (Parker & Fu 2012). Assuming an instantaneous rate of natural mortality of 0.307, fishing mortality was estimated to be 0.189 or 0.303.

Although it was not possible to produce reliable estimates of spawner biomass per recruit based targets of *F* (due to unreliable estimates of growth rate and size at maturity), estimates of *F* from this study were either lower or approximately equal to the estimate of natural mortality (depending on the age at full recruitment assumed). Assuming that the fishery is sampling the age structure of the population, and given that catches and standardised CPUE have been reasonably constant over the last decade, these results suggest that GUR 2 was not over-exploited in 2010, and that the stock is likely to be at or above B_{MSY}.

Establishing B_{MSY} compatible reference points

The Working Group accepted mean CPUE from the (BT(MIX)) model for the period 1990–91 to 2009–10 as an B_{MSY}-compatible proxy for GUR 2. The Working Group accepted the default Harvest Strategy Standard definitions that the Soft and Hard Limits would be one half and one quarter the target, respectively.

GUR 3

In 2012, the Working Group accepted two standardised CPUE series for GUR 3 with both series based on the bycatch of red gurnard in bottom trawl fisheries defined by different target species combinations from fishing within the inshore statistical areas of GUR 3 (018, 020, 022,024, 026, 025, 030). The BT(MIX) index included fishing effort targeting RCO, STA, BAR, TAR, GUR while the BT(FLA) index was comprised of FLA target trawls only (Starr & Kendrick 2013).

In 2014, the two CPUE analyses were updated with data from 1989–90 to 2012–13 (Langley 2014). The analysis also included several refinements to improve the comparability between the data collected from two statutory reporting forms (CELR and TCER) which collect data at different levels of detail (daily and by tow), including the approach used to apportion red gurnard landed catches from individual fishing trips to the associated fishing effort records and the daily aggregation of fishing effort. These refinements in data processing resulted in no appreciable change in the resulting CPUE indices for the corresponding period. The 2014 CPUE analyses used the equivalent model formulations to the previous analyses (dependent and explanatory variables and Weibull error structure following Starr & Kendrick 2013).

The two sets of indices were updated in 2015 to include data from 2013–14. The time-series of CPUE indices from the two fisheries are very similar. The indices were at a relatively low level in 1997–98 to 1999–2000 and increased steadily to a peak during 2007–08 to 2010–11 (Figure 7). Both sets of indices were lower than the peak level in 2011–12 to 2013–14, although the indices remained well above the longer term average level from the entire time-series (Figure 7).

The longer term trends in the CPUE indices are similar to the increase in estimates of recruited biomass (defined as fish at least 30 cm T.L.) from the time series of winter ECSI inshore trawl surveys (Figure 7), although the magnitude of the overall increase in the trawl survey biomass is greater than the overall increase in the CPUE indices. Since 2007, the trawl survey biomass estimates have increased and there is no indication of the recent reduction in the CPUE indices from 2011–12 to 2013–14.

Establishing B_{MSY} compatible reference points

In 2012, BT(MIX+FLA), the mean of the BT(MIX) and BT(FLA) series in each year, was accepted by the Working Group as the series for monitoring GUR 3. These fisheries cover different aspects of gurnard distribution, both by depth and spatially, but still have very similar trajectories, providing some confidence that these series are likely to be tracking abundance. The mean from 1997–98 to 1999–00 of BT(MIX+FLA) was selected as the Soft Limit because it was a well-defined low point in the series, along with the observations that both catch and CPUE increased simultaneously from that point. The Working Group accepted the default Harvest Strategy Standard definitions that the target "B_{MSY}-compatible proxy" for GUR 3 would be twice the Soft Limit and the Hard Limit was one-half the Soft Limit.

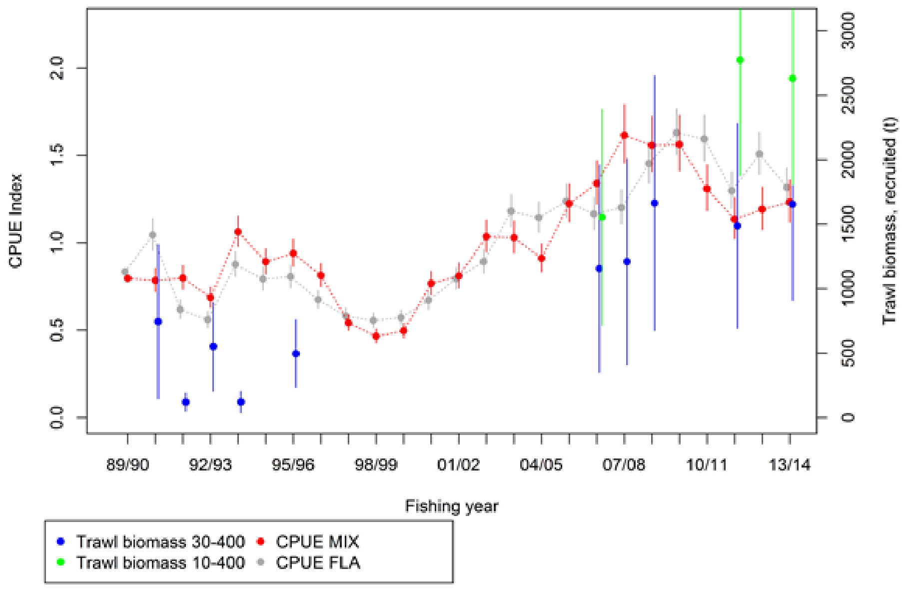


Figure 7: Standardised CPUE indices for two east coast South Island bottom trawl fisheries [BT(MIX) and BT(FLA)] compared to trawl survey estimates of recruited (>= 30 cm T.L.) biomass for red gurnard from the winter ECSI inshore trawl survey for two survey areas (30–400 m and 10–400 m). Error bars show ±95% confidence intervals.

GUR 7

In 2011, the Working Group accepted four standardised CPUE series for GUR 7 based on the bycatch of red gurnard in bottom trawl fisheries defined by different target species combinations in two different sub-areas: west coast South Island (statistical areas 033, 034, 035, 036) and Tasman Bay/Golden Bay and Cook Strait (038, 017, 018 and 039) (Kendrick et al. 2011). The four CPUE data sets are defined in Table 8.

Table 8: Names and descriptions of the four red gurnard GUR 7 bottom trawl CPUE series accepted by the Working Group in 2011. Also shown is the error distribution that had the best fit to the distribution of standardised residuals for the fitted model.

Name	Code	Statistical areas	Target species	Best distribution
GUR 7 WCSI mixed target species	WCSI_BT_MIX	033, 034, 035, 036	RCO, STA, BAR, TAR, WAR	Lognormal
GUR 7 WCSI flatfish target	WCSI_BT_FLA	033, 034, 035, 036	FLA	Lognormal
GUR 7 Tasman Bay/Golden Bay flatfish target	TBGB_BT_FLA	038, 017	FLA, RCO	Lognormal
GUR 7 Tasman Bay/Golden Bay and Cook Strait mixed target	TBCS_BT_FLA	038, 017, 018, 039	BAR, TAR, WAR	Lognormal

In 2014, these four CPUE analyses were updated with data from 1989–90 to 2012–13 (Langley 2014). These analyses also included several refinements to improve the comparability between the data collected from two statutory reporting forms (CELR and TCER) which collect data at different levels of detail (daily and by tow), including the approach used to apportion red gurnard landed catches from individual fishing trips to the associated fishing effort records and the daily aggregation of fishing effort. These refinements in data processing resulted in no appreciable change in the resulting CPUE indices for the corresponding period.

The 2014 CPUE analyses used the equivalent model formulations to the previous analyses (dependent and explanatory variables and error structure) (Kendrick et al 2011).

The two sets of CPUE indices from the west coast South Island fisheries show similar cyclical trends with relatively high CPUE indices during 1990–91 to 1991–92 and 2001–02 to 2003–04 and relatively low CPUE indices in 1993–94 to 1999–2000 and 2006–07 to 2010–11 (Figure 8). The CPUE indices steadily increased from 2009–10 to a relatively high level in 2012–13.

The trawl survey biomass estimates of recruited (at least 30 cm T.L.) red gurnard from the west coast component of the WCSI Trawl Survey do not exhibit the same cyclical trends as seen in the CPUE indices; however, the high biomass estimates from the two recent trawl surveys (2011 and 2013) are consistent with the recent increase in the CPUE indices (Figure 8).

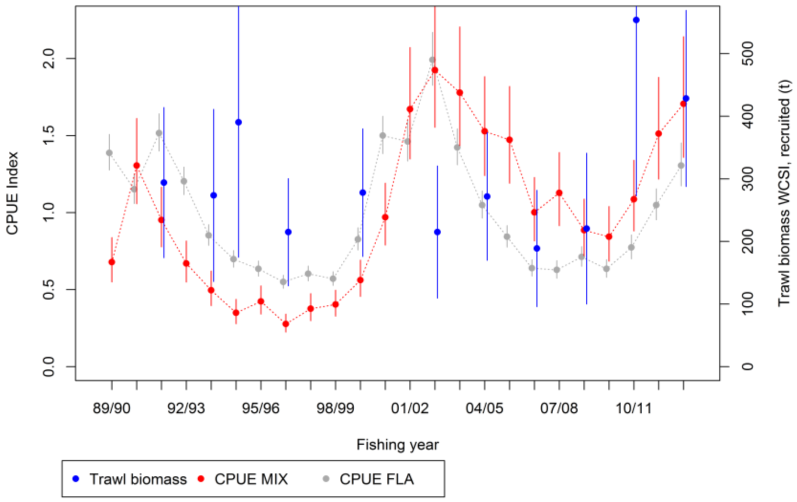


Figure 8: Comparison of the lognormal indices from two independent CPUE series for GUR 7 from the inshore WCSI trawl fisheries (statistical areas 033, 034, 035, and 036); a) WCSI_BT_FLA: bottom trawl, target FLA; b) WCSI_BT_MIX: bottom trawl, target, BAR, TAR, WAR, STA, RCO. Trawl survey biomass estimates of recruited (>= 30 cm T.L.) red gurnard from the WC area of the WCSI inshore trawl survey are also presented. The vertical bars represent the associated 95% confidence intervals.

The trends in CPUE indices from the northern areas (TB/GB and Cook Strait) of GUR 7 are considerably different from the WCSI CPUE indices (Figure 10 compared to Figure 9). For the northern areas, the TBCS_BT_MIX CPUE indices during 1989–90 to 2005–06 tended to follow the trend in the TBGB_BT_FLA CPUE indices with a lag of about 2 years (Figure 10). However, in the subsequent years (2006–07 to 2012–13) the two sets of indices have shown divergent trends. There was a marked decline in the level of red gurnard catch from the TBCS mixed trawl fishery between 2006–07 and

2012–13. In 2010–11 to 2012–13 that mixed fishery accounted for a very small proportion of the total GUR 7 catch. Since 2007–08, there was also a marked shift in the spatial distribution of fishing effort in the TBCS fishery with a reduction in the proportion of fishing effort within the areas of higher red gurnard catch rates and a shift towards trawling in deeper waters (Langley 2014). On that basis, the 2014 Working Group rejected the TBCS_BT_MIX CPUE index as an index of abundance for GUR 7.

The TBGB_BT_FLA CPUE indices were relatively low during 1995–96 to 1998–99, increased in 1999–2000 and remained relatively stable at about that level until 2007–2008. From 2007–08 to 2012–13, the CPUE indices have tended to increase, although the recent increase may be partly attributable to an increase in the proportion of fishing effort within the shallower areas of TB/GB that tend to have a higher catch rate of red gurnard (Langley 2014). Because of this effect and the lack of correspondence with the TBGB WCSI trawl survey results (see next paragraph), the 2014 WG discounted the utility of this CPUE series.

The time series of trawl biomass estimates of recruited (at least 30 cm T.L.) red gurnard from the Tasman Bay/Golden Bay strata of the Challenger survey varies considerably among surveys and the biomass estimates are not well correlated with the corresponding CPUE indices (TBGB_BT_FLA) (Figure 9). There is no persistent trend in the trawl survey biomass estimates and recent (2011 and 2013) biomass estimates are at about the average level for the time series.

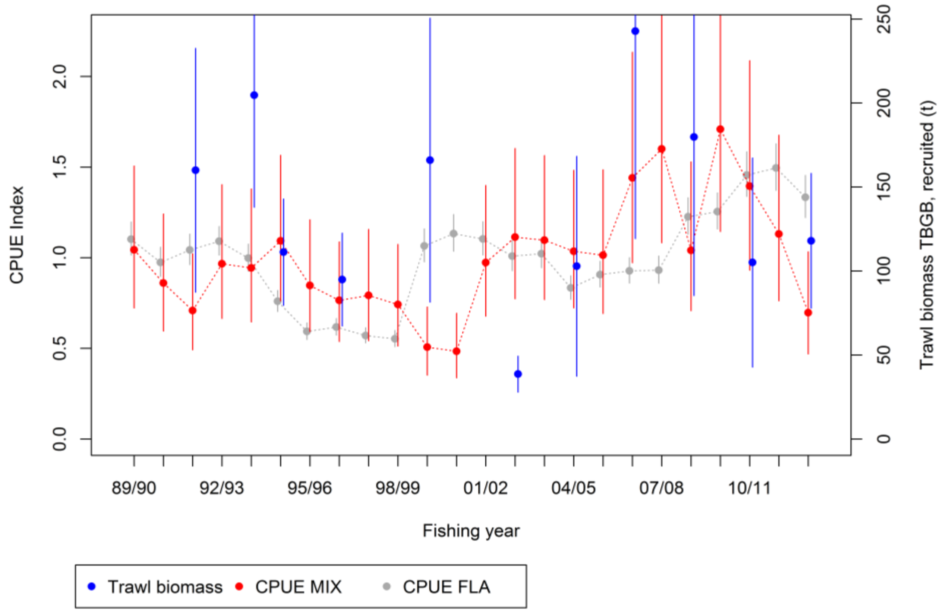


Figure 9: Comparison of the lognormal indices from two independent CPUE series for GUR 7 ; a) TBGB_BT_FLA: bottom trawl in statistical areas 38, and 17, target FLA or RCO ; b) TBCS_BT_MIX: bottom trawl in statistical areas 38, 39, 17 and 18, target, BAR, TAR, WAR. Trawl survey biomass estimates of recruited (>= 30 cm T.L.) red gurnard from the TBGB area of the Challenger inshore trawl survey are also presented. The vertical bars represent the associated 95% confidence intervals.

Establishing B_{MSY} compatible reference points

In 2014, a composite series (WCSI_BT_MIX+FLA), which averaged the WCSI_BT_MIX and WCSI_BT_FLA series in each year, was accepted by the Working Group as the CPUE series for monitoring GUR 7. However, because there was poor agreement between the CPUE series and the relative biomass series from the WCSI trawl survey (also accepted as an index of abundance for GUR 7), the Working Group agreed to use both series to develop B_{MSY} proxy reference points for GUR 7, with one based on the mean WCSI_BT_MIX+FLA series and the other based on relative abundance from the west coast component of the WCSI trawl survey. In each case, the mean of the indices for the complete series (beginning in 1989–90 for the CPUE series and 1992 for trawl survey series; the CPUE series ends in 2012–13 and the trawl survey series ends with the 2013 biomass index) was chosen as a "B_{MSY} compatible proxy" for GUR 7. The Working Group accepted the default Harvest Strategy

Standard definitions that the Soft and Hard Limits would be one half and one quarter the target, respectively.

4.4 Other factors

Red gurnard is a major bycatch 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.

5. STATUS OF THE STOCKS

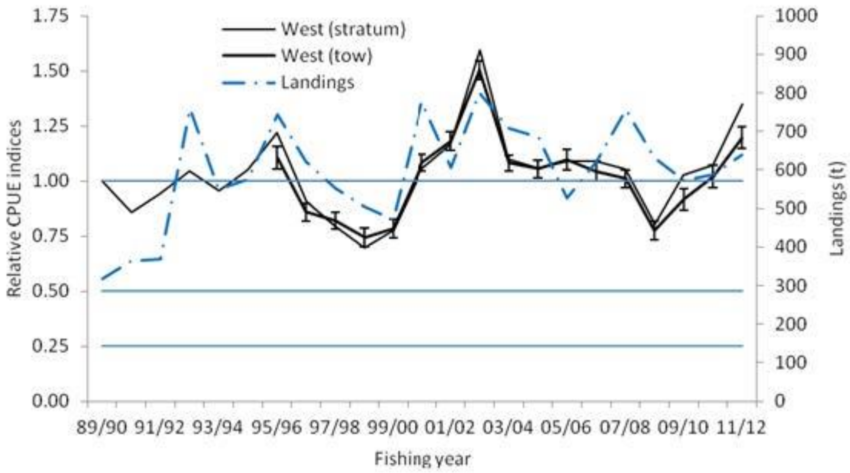
Stock Structure Assumptions

For the purpose of this summary GUR 1 is considered to be a single stock with three sub-stocks.

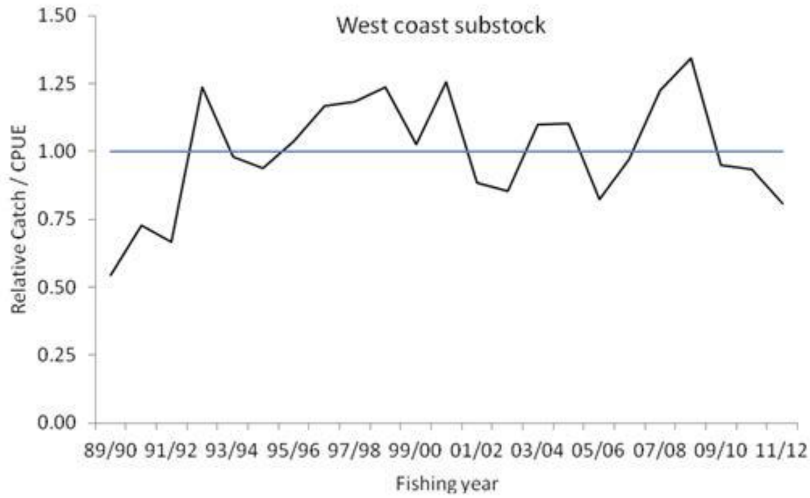
- **GUR 1W**

Stock Status	
Year of Most Recent Assessment	2013
Assessment Runs Presented	Standardised CPUE
Reference Points	Target: B_{MSY}-compatible proxy based on the mean CPUE from 1994–95 to 2011–12 of the bottom trawl GUR 1 west (tow) series Soft Limit: 50% of target Hard Limit: 25% of target Overfishing threshold: F_{MSY}
Status in relation to Target	About as Likely as Not (40–60%) to be at or above B_{MSY}
Status in relation to Limits	Soft Limit: Unlikely (< 40%) Hard Limit: Very Unlikely (< 10%)
Status in relation to Overfishing	Overfishing is Unlikely (< 40%) to be occurring

Historical Stock Status Trajectory and Current Status



Comparison of standardised CPUE for red gurnard in GUR 1W from models of catch rate in successful bottom trawl trips done for tow by tow data from 1995–96 (±2 s.e.) and at stratum level including CELR data from 1989–90 (Kendrick & Bentley in prep. Also shown is the trajectory of total landed GUR 1 from the sub-stock area. The two CPUE series have been scaled to the mean of each series for the years in common. Horizontal lines represent the target and soft and hard limits.



Annual relative exploitation rate for red gurnard in the GUR 1 west coast sub-stock.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	The CPUE index cycles over a 4–8 year period consistent with the dynamics of a short lived species with variable recruitment. CPUE suggests that stock size has fluctuated around the long-term average since 1995–96, recovering from lows in 1998–99 and 2008–09. The CPUE has increased since 2008–09 and in 2011–12 was slightly above the long-term mean.
Recent Trend in Fishing Intensity or Proxy	Relative exploitation rate has fluctuated without trend since 1991–92.
Other Abundance Indices	The GUR 1West (stratum) series is slightly longer than the GUR 1 West (tow) series, but has a similar trend for the overlapping period.
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	Without information on recruitment, it is not possible to predict how the stock is going to respond in the next few years.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unlikely if the catch remains at current levels Hard Limit: Unlikely if the catch remains at current levels Unknown whether catch at the level of the TACC would cause decline below both the soft and hard Limits
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Probability of TACC causing overfishing to occur or commence: Unlikely if the catch remains at current levels Unknown whether catch at the level of the TACC would cause overfishing

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial quantitative stock assessment	
Assessment Method	Standardised CPUE based on positive catches from bottom trawl	
Assessment Dates	Latest assessment: 2013	Next assessment: 2018

Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	The accepted CPUE index is now a tow based index, rather than trip-stratum based.	
Major Sources of Uncertainty		

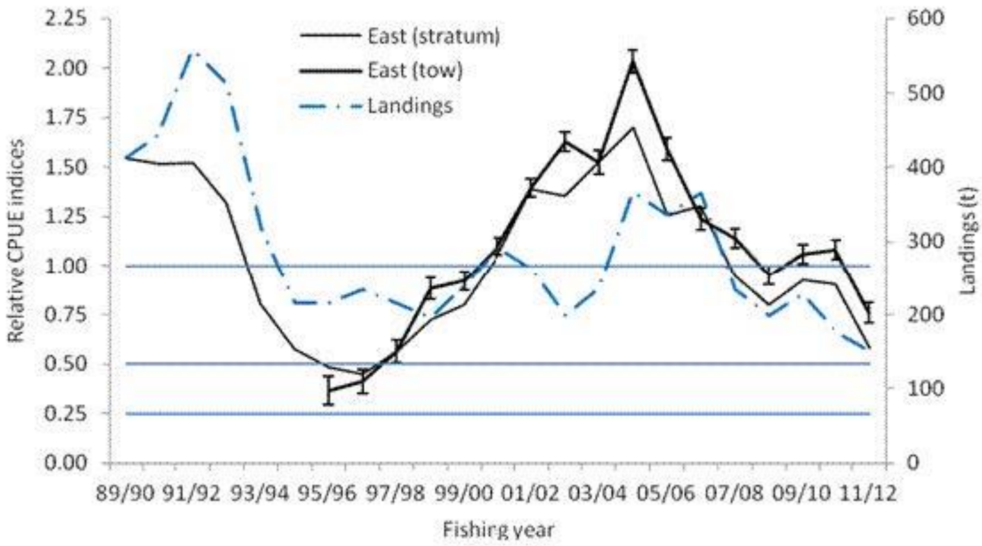
Qualifying Comments
As the red gurnard fishery in FMAs 1 and 9 has a long history, it is difficult to infer stock status from recent abundance trends. The abundance of all three sub-stocks appears to be cyclical, probably in response to recruitment variation, and in two sub-stocks trends are currently downward. This makes it difficult to predict future trends without recruitment information. Given that the catch levels observed from 1986–87 to 2011–12 has been relatively consistent (averaging 1129 t for all of GUR 1) and that red gurnard are mainly taken as bycatch, current catch levels are unlikely to compromise the long-term viability of this stock. As the TACC is substantially higher than the current catch, it is not possible to evaluate potential impacts if catches increased to the level of the TACC.

Fishery Interactions
Red gurnard is taken on the west coast by bottom trawl targeted at snapper and trevally. Incidental captures of seabirds occur and there is a risk of incidental capture of Maui's dolphins.

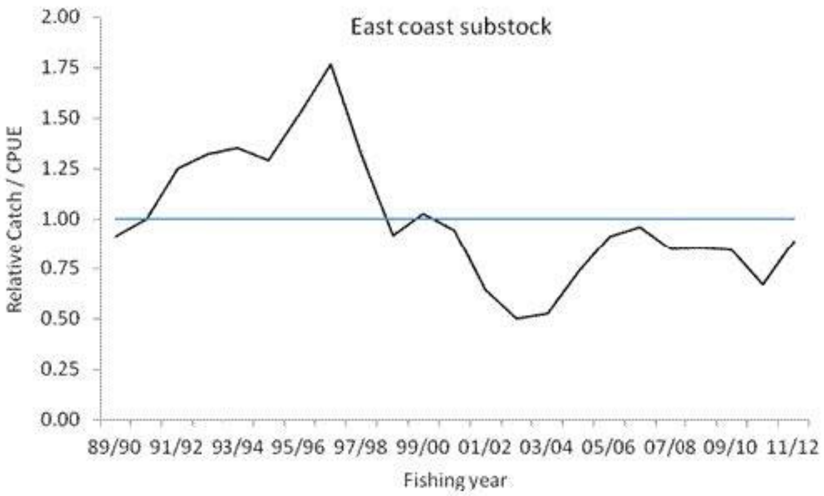
GUR 1E

Stock Status	
Year of Most Recent Assessment	2013
Assessment Runs Presented	Standardised CPUE
Reference Points	Target: B_{MSY}-compatible proxy based on the mean CPUE from 1995–96 to 2011–12 for the bottom trawl GUR 1 East (tow) series Soft Limit: 50% of target Hard Limit: 25% of target Overfishing threshold: F_{MSY}
Status in relation to Target	About as Likely as Not (40–60%) to be at or above B_{MSY}
Status in relation to Limits	Soft Limit: Unlikely (< 40%) Hard Limit: Very Unlikely (< 10%)
Status in relation to Overfishing	Unknown whether Overfishing is occurring

Historical Stock Status Trajectory and Current Status



Comparison of standardised CPUE for red gurnard in GUR 1E from models of catch rate in successful bottom trawl trips done for tow by tow data from 1995–96 (±2 s.e.) and at stratum level including CELR data from 1989–90 (Kendrick & Bentley in prep. Also shown is the trajectory of total landed GUR 1 from the substock area. The two CPUE series have been scaled to the mean of each series for the years in common. Horizontal lines represent the target and the soft and hard limits.



Annual relative exploitation rate for red gurnard in the GUR 1 east coast sub-stock.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	The CPUE index fluctuates in a way that is consistent with the dynamics of a short lived species with variable recruitment, although the period is longer than that for other gurnard stocks. An increase from the lowest levels in 1995–96 was sustained over eight consecutive years, peaked in 2004–05 and has since declined to slightly below the target in 2011–12.
Recent Trend in Fishing Intensity or Proxy	Relative exploitation rate increased from 1989–90 to 1996–97, declined to1998–99 and has since then fluctuated without trend below the long-term average.

Other Abundance Indices	The GUR 1East (stratum) series is slightly longer than the GUR 1 East (tow) series, but has a similar trend for the overlapping period.
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	Without information on recruitment, it is not possible to predict how the stock is going to respond in the next few years.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unknown Hard Limit: Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown if the catch remains at current levels Unknown whether catch at the level of the TACC would cause overfishing.

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial quantitative stock assessment	
Assessment Method	Standardised CPUE based on positive catches from bottom trawl	
Assessment Dates	Latest assessment: 2013	Next assessment: 2016
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	The accepted CPUE index is now a tow based index, rather than trip-stratum based.	
Major Sources of Uncertainty	-	

Qualifying Comments
As the red gurnard fishery in FMAs 1 and 9 has a long history, it is difficult to infer stock status from recent abundance trends. The abundance of all three sub-stocks appears to be cyclical, probably in response to recruitment variation, and in two sub-stocks trends are currently downward. This makes it difficult to predict future trends without recruitment information. Given that the catch levels observed from 1986–87 to 2011–12 has been relatively consistent (averaging 1129 t for all of GUR 1) and that red gurnard are mainly taken as bycatch, current catch levels are unlikely to compromise the long-term viability of this stock. As the TACC is substantially higher than the current catch, it is not possible to evaluate potential impacts if catches increased to the level of the TACC.

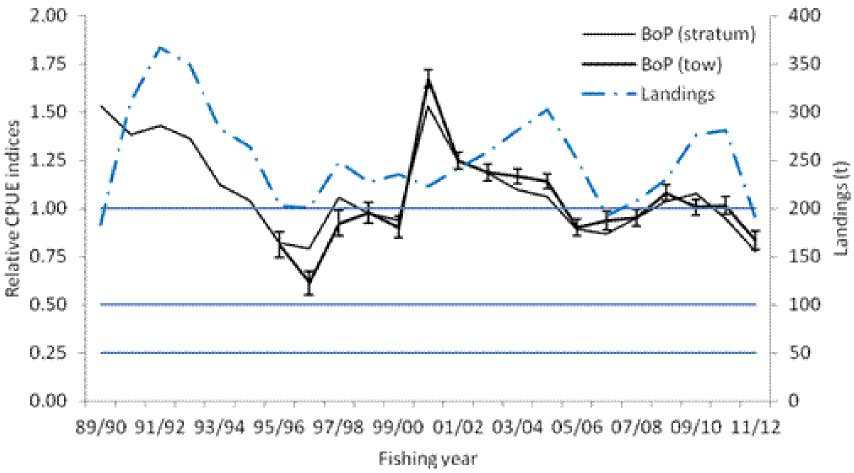
Fishery Interactions
Red gurnard is taken as a bycatch on the east coast mainly by bottom longline targeted at snapper, with the balance taken almost equally by bottom trawl and Danish seine targeting snapper and John dory. Incidental captures of seabirds occur.

- **GUR 1 Bay of Plenty**

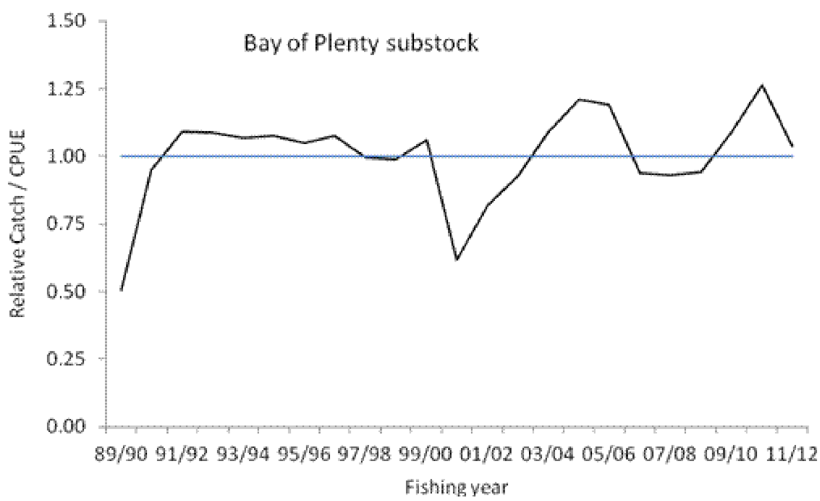
Stock Status	
Year of Most Recent Assessment	2013
Assessment Runs Presented	Standardised CPUE

Reference Points	Target: B_{MSY}-compatible proxy based on the mean CPUE from 1994–95 to 2011–12 for the bottom trawl GUR 1 BoP (tow) series Soft Limit: 50% of target Hard Limit: 25% of target Overfishing threshold: F_{MSY}
Status in relation to Target	About as Likely as Not (40–60%) to be at or above B_{MSY}
Status in relation to Limits	Soft Limit: Unlikely (< 40%) Hard Limit: Very Unlikely (< 10%)
Status in relation to Overfishing	Unknown whether Overfishing is occurring

Historical Stock Status Trajectory and Current Status



Comparison of standardised CPUE for red gurnard in GUR 1BoP from models of catch rate in successful bottom trawl trips done for tow by tow data from 1995–96 (±2 s.e.) and at stratum level including CELR data from 1989–90 (Kendrick & Bentley in prep. Also shown is the trajectory of total landed GUR 1 from the substock area. The two CPUE series have been scaled to the mean of each series for the years in common. Horizontal lines represent the target and the soft and hard limits.



Annual relative exploitation rate for red gurnard in the Bay of Plenty.

Fishery and Stock Trends

Recent Trend in Biomass or Proxy	The CPUE index fluctuates in a way that is consistent with the dynamics of a short lived species with variable recruitment. An increase from the lowest levels in 1995–96 to a peak in 2000–01, and has since declined to slightly below the target in 2011–12.
Recent Trend in Fishing Mortality or Proxy	Relative exploitation rate has fluctuated without trend around the long-term mean since 1991–92

Other Abundance Indices	The GUR 1 BoP (stratum) series is slightly longer than the GUR 1 BoP (tow) series, but has a similar trend for the overlapping period.
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	Without information on recruitment, it is not possible to predict how the stock is going to respond in the next few years.
Probability of Current Catch or TACC causing decline below Limits	Soft Limit: Unknown Hard Limit: Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown if the catch remains at current levels Unknown whether catch at the level of the TACC would cause overfishing.

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial quantitative stock assessment	
Assessment Method	Standardised CPUE based on positive catches from bottom trawl	
Assessment Dates	Latest assessment: 2013	Next assessment: 2016
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	-	
Changes to Model Structure and Assumptions	The accepted CPUE index is now a tow based index, rather than trip-stratum based.	
Major Sources of Uncertainty	-	

Qualifying Comments
As the red gurnard fishery in FMAs 1 and 9 has a long history, it is difficult to infer stock status from recent abundance trends. The abundance of all three sub-stocks appears to be cyclical, probably in response to recruitment variation, and in two sub-stocks trends are currently downward. This makes it difficult to predict future trends without recruitment information. Given that the catch levels observed from 1986–87 to 2011–12 has been relatively consistent (averaging 1129 t for all of GUR 1) and that red gurnard are mainly taken as bycatch, current catch levels are unlikely to compromise the long-term viability of this stock. As the TACC is substantially higher than the current catch, it is not possible to evaluate potential impacts if catches increased to the level of the TACC.

Fishery Interactions
Red gurnard is taken as a bycatch in the Bay of Plenty mainly by bottom longline targeted at snapper, with the balance taken almost equally by bottom trawl and Danish seine targeting snapper and John dory. Incidental captures of seabirds occur.

- **GUR 2**

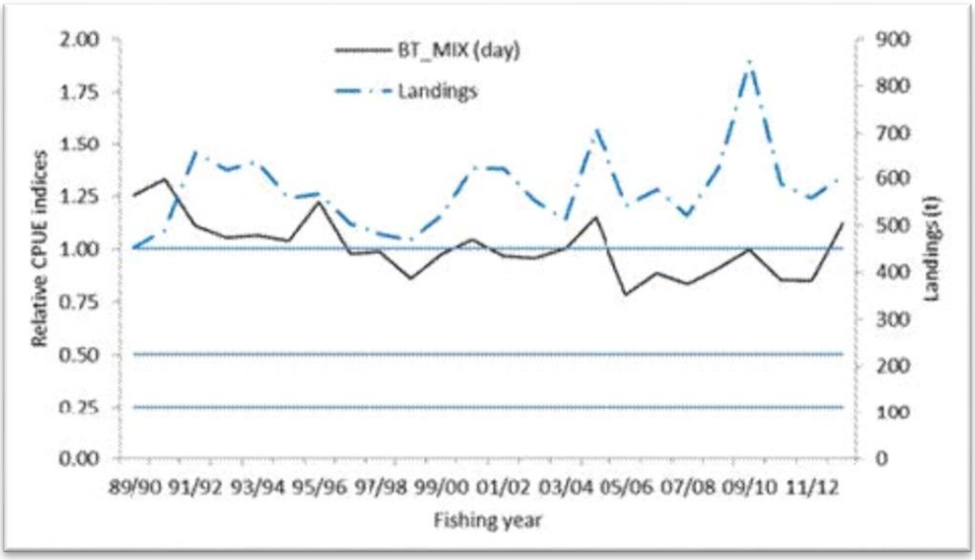
Stock Structure Assumptions

For the purpose of this summary GUR 2 is considered to be a single stock.

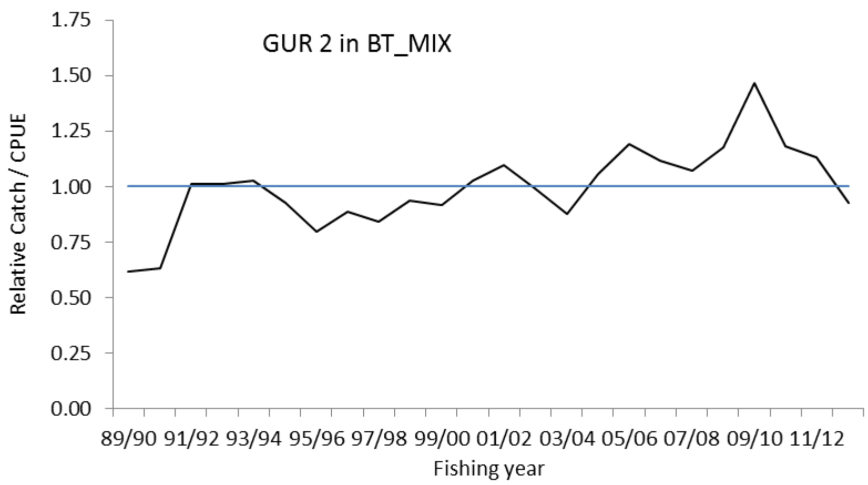
Stock Status	
Year of Most Recent Assessment	2014
Assessment Runs Presented	Standardised CPUE for BT.MIX

Reference Points	Target: B_{MSY}-compatible proxy based on the mean CPUE (BT(MIX)) for period 1990–91 to 2009–10 Soft Limit: 50% of target Hard Limit: 25% of target Overfishing threshold: F_{MSY}
Status in relation to Target	About as Likely as Not (40–60%) to be at or above the target
Status in relation to Limits	Soft Limit: Unlikely (< 40%) Hard Limit: Very Unlikely (< 10%)
Status in relation to Overfishing	Overfishing is Unlikely (< 40%) to be occurring (based on estimates of Z)

Historical Stock Status Trajectory and Current Status



Standardised catch per unit effort (CPUE) indices for GUR 2 from bottom trawling targeting gurnard, snapper and trevally (GUR.BT.MIX) that combines all form types at a daily aggregation, and for a shorter time series that uses only tow based data (Kendrick & Bentley in prep). Scaling is relative to the years in common. In both standardisation models, a gamma error distribution was assumed. Horizontal lines are the target and the soft limits.



Annual relative exploitation rate (catch/CPUE) for red gurnard in GUR 2.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	CPUE indices declined between 1990 and 1998 and then fluctuated without trend until 2012, with an increase in 2013. Standardised CPUE in 2012–13 is above the target.
Recent Trend in Fishing Mortality or Proxy	Relative exploitation rate increased gradually from 1989–90 to 2009–10 and then dropped to the long-term average by 2012–13.
Other Abundance Indices	Tow based analysis of 2007–08 to 2012–13 data closely resembles the mixed form type analysis. CPUE index (BT.TAR) has also followed similar trends to the CPUE BT.MIX index.
Trends in Other Relevant Indicators or Variables	Catch curve analysis indicated that fishing mortality was at or below M in 2010 (depending on the age at full recruitment).

Projections and Prognosis	
Stock Projections or Prognosis	Without information on recruitment, it is not possible to predict how the stock is going to respond in the next few years.
Probability of Current Catch or TACC causing decline below Limits	Soft Limit: Unlikely (<40%) Hard Limit: Very Unlikely (<10%) Unknown whether catch at the level of the TACC would cause decline below both the soft and hard Limits.
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unlikely (< 40%) if the catch remains at the average of 2000–2013 levels Unknown whether catch at the level of the TACC would cause overfishing

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial quantitative stock assessment	
Assessment Method	1. Standardised CPUE. 2. Estimates of total mortality (*Z*) using Chapman-Robson Estimator	
Assessment Dates	Latest assessment: 2014	Next assessment: 2017
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data - Catch-at-age	1 – High Quality 1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	- Gamma instead of lognormal error structure for CPUE analysis	
Major Sources of Uncertainty	- Uncertainty in estimate of M	

Qualifying Comments
As the TACC is substantially higher than the current catch, it is not possible to evaluate potential impacts if catches increased to the level of the TACC.

Fishery Interactions
Red gurnard is taken in FMA 2 by the bottom trawl fishery targeting snapper, gurnard and trevally and as a bycatch in bottom trawl fisheries targeting flatfish and tarakihi. Incidental captures of seabirds occur and there is a risk of incidental capture of Hectors dolphins at the southern end of the QMA.

- **GUR 3**

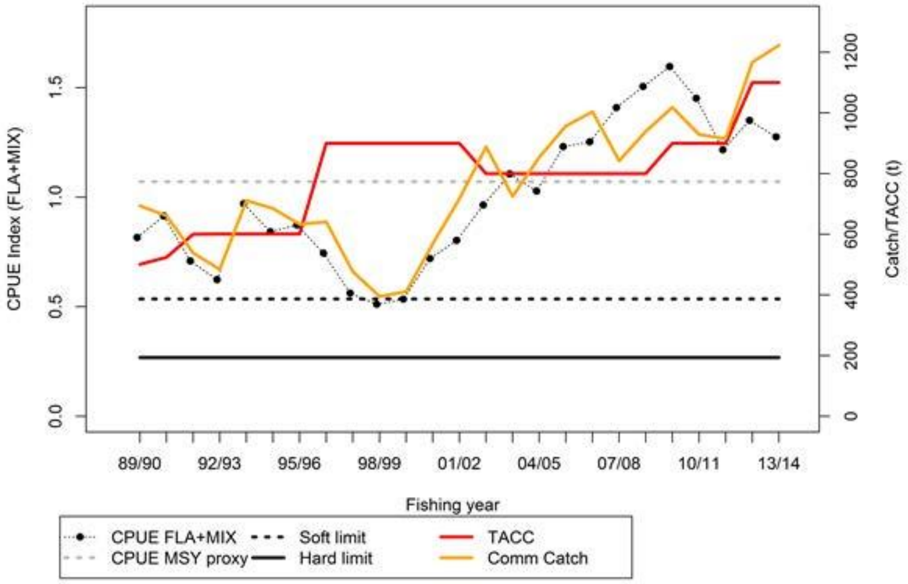
Stock Structure Assumptions

No information is available on the stock separation of red gurnard. The Fishstock GUR 3 is treated in this summary as a unit stock.

Stock Status	
Year of Most Recent Assessment	2015
Reference Points	Target: B_{MSY}-compatible proxy based on CPUE is twice the soft limit Soft Limit: Mean from 1997–98 to 1999–00 of BT(MIX+FLA) series, as defined in Starr & Kendrick (2012) Hard Limit: 50% of soft limit Overfishing threshold: F_{MSY}
Status in relation to Target	Likely (> 60%) to be above the target
Status in relation to Limits	Soft Limit: Very Unlikely (< 10%) to be below Hard Limit: Very Unlikely (< 10%) to be below
Status in relation to Overfishing	About as Likely as Not (40–60%) to be overfishing

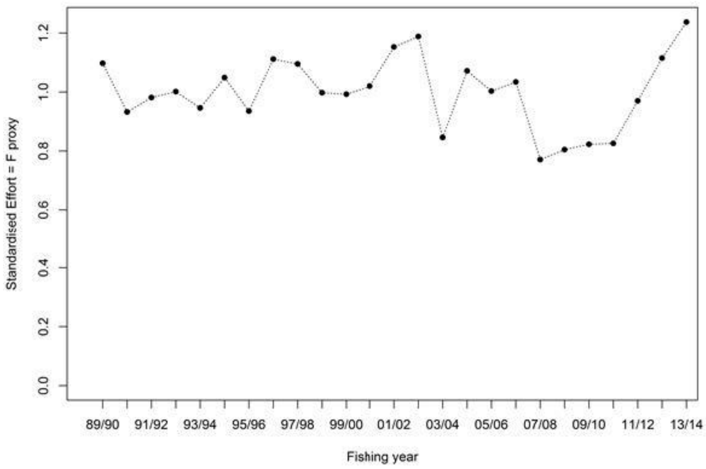
Historical Stock Status Trajectory and Current Status

East coast South Island winter trawl survey, CPUE, Catch and TACC Trajectories



Comparison of east coast South Island winter trawl survey recruited biomass and CPUE indices (average FLA and MIX) and the trajectories of catch and TACCs from 1989–90 to 2013–14. The horizontal grey line represents the MSY proxy relative to the CPUE series. The black dotted and solid lines represent the soft and hard limits, respectively.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Two bottom trawl CPUE series (one targeted at flatfish and the other at red cod), which are considered to be an index of stock abundance, increased steadily from the late 1990s to 2009–10, and then declined, remaining above the target level.

Recent Trend in Fishing Intensity or Proxy	 Fishing mortality proxy is Standardised Fishing Effort = Total catch/CPUE (normalised). Fishing mortality proxy increased sharply from 2010–11 to 2013–14 to above the series mean in 2011–12 and 2013–14.
Other Abundance Indices	ECSI winter survey (30–400m) shows a substantial increase since the early 1990s. The expanded survey (10–400m) shows a marked increase from 2007–2014 (n = 3).
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	Quantitative stock projections are unavailable.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Very Unlikely (< 40%) Hard Limit: Very Unlikely (< 10%) Current abundance is at historically high levels and is unlikely to decline below limits in 3–5 years.
Probability of Current Catch or TACC causing Overfishing to continue or to commence	GUR is mostly taken as a bycatch (about 10% targeted). The correspondence between relative abundance and catch suggests a constant exploitation rate. The current catch is therefore Unlikely (< 40%) to cause overfishing.

Assessment Methodology and Evaluation		
Assessment Type	Level 2: Partial Quantitative Stock Assessment	
Assessment Method	Agreed standardised CPUE series and trawl survey biomass indices	
Assessment Dates	Latest assessment: 2015	Next assessment: 2017
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	-Trawl survey biomass indices and associated length frequencies - Catch and effort data	1– High Quality 1– High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	Prior to 2007 the ECSI trawl survey did not cover the entire depth range for red gurnard. Variable proportion of the population in the previously unsurveyed 10–30m	

	depth range suggests that survey catchability varies between years in the core survey area (30–400m).

Qualifying Comments
Red gurnard are relatively short-lived and reasonably productive. They exhibit cyclic fluctuations and were at low levels in the mid-1990s. Stock size has increased substantially since then and commercial fishers indicate that they find it difficult to stay within the TACC despite the low level of targeting on this species. Two independent CPUE series and the winter trawl survey corroborate that stock size for GUR 3 has increased since the late 1990s. There are potentially sufficient data to undertake a quantitative stock assessment for GUR 3. This would allow the estimation of B_{MSY} and other reference points.

Fishery Interactions
Red gurnard in GUR 3 are taken almost entirely by bottom trawl in fisheries targeted at red cod, barracouta and flatfish. Some gurnard are also taken in the target tarakihi and stargazer bottom trawl fisheries. The level of targeting on this species is low, averaging less than 10% of the total landed catch since 1989–90. Incidental captures of seabirds occur and there is a risk of incidental capture of Hector's dolphins

- **GUR 7**

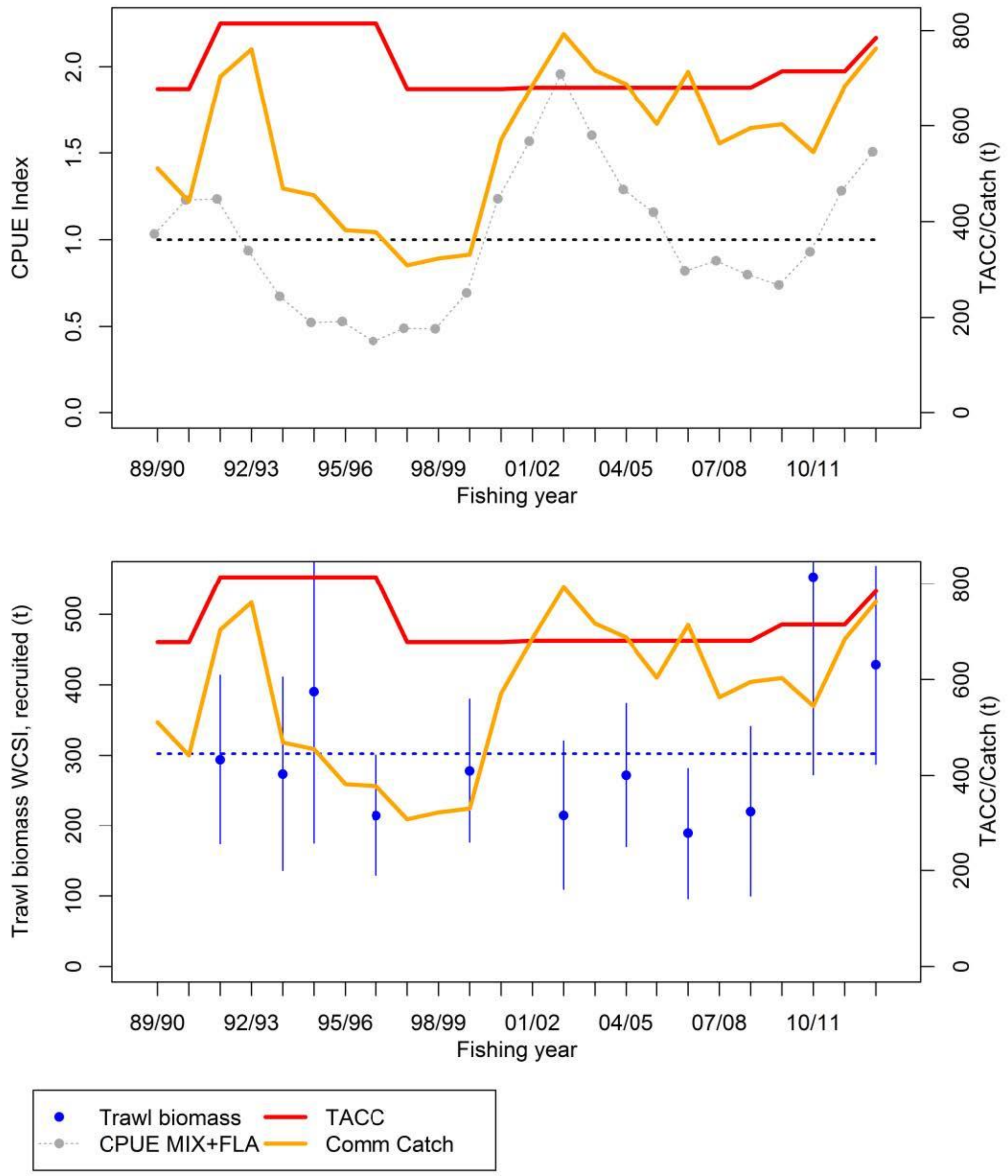
Stock Structure Assumptions

Stock boundaries are unknown, but for the purpose of this summary, GUR 7 is considered to be a single management unit.

Biomass trends differ between the west coast South Island and Tasman Bay/Cook Strait areas; however, the former area accounts for the largest proportion of the catch (about 65% in recent years). Because the WG has discounted the value of both CPUE series from TBGB, and the TGBG trawl survey indices are skewed towards juveniles, advice for GUR 7 is largely based on abundance indices for the west coast portion of the QMA.

Stock Status	
Year of Most Recent Assessment	2013 (West Coast South Island trawl survey); 2014 CPUE analysis
Reference Points	Target1: B_{MSY}-compatible proxy based on the WCSI Trawl Survey is the mean from 1992 to 2013 for the west coast region Target2: B_{MSY}-compatible proxy based on CPUE is the mean from 1989–90 to 2012–13 of the average BT(MIX+FLA) west coast series, as defined in Langley (2014). Soft Limit: 50% Target Hard Limit 25% Target Overfishing threshold: F_{MSY}
Status in relation to Target	About as Likely as Not (40–60%) to be at or above the target
Status in relation to Limits	Soft limit: Unlikely (< 40%) to be below Hard Limit: Very Unlikely (< 10%) to be below
Status in relation to Overfishing	Overfishing is Unlikely (< 40%) to be occurring

Historical survey biomass, Catch and TACC Trajectories



Standardised CPUE indices for GUR 7 from a composite west coast inshore trawl fishery index series (top panel), and WCSI trawl survey biomass indices for recruited (>= 28 cm T.L.) red gurnard in the west coast area (bottom Panel). The vertical bars represent the associated 95% confidence intervals for the trawl survey. The GUR 7 annual catches and TACCs are also presented.

Fishery and Stock Trends	
Recent trend in Biomass or Proxy	The West Coast South Island trawl survey relative biomass indices from 2011 and 2013 were the highest of the entire time series. WCSI CPUE indices increased steadily from 2009–10 to 2012–13; CPUE indices for the Tasman Bay fishery also remained high in recent years.
Recent trend in Fishing Mortality or Proxy	Unlikely (< 40%) that overfishing is occurring. Biomass has increased considerably since 2009–10 while there was only a moderate increase in annual catches.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Estimates of pre-recruit fish from the Challenger trawl survey indicate moderate recruitment in recent years. These year classes will continue to sustain the commercial fishery over the next few years.

Projections and Prognosis	
Stock Projections or Prognosis	Recent catches and the TACC are likely to be sustainable, at least in the short-term. Quantitative stock projections are unavailable.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unlikely (< 40%) Hard Limit: Very Unlikely (< 10%) Current abundance is at historically high levels and is unlikely to decline below limits in 3–5yrs
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unlikely (< 40%)

Assessment Methodology and Evaluation		
Assessment Type	Level 2: Partial Quantitative Stock Assessment	
Assessment Method	West Coast South Island trawl survey biomass - Survey length frequency - Standardised CPUE indices	
Assessment Dates	Latest assessment: 2014	Next assessment: 2015
Overall assessment quality rank	1 – High Quality	
Main data inputs	- Survey biomass and length frequencies - CPUE indices	1 – High Quality 1 – High Quality
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	-	

Qualifying Comments
Red gurnard are a survey target of the West Coast South Island trawl survey and the Southern Inshore Working Group regards the series as a reliable index of abundance. Trends in CPUE indices are not consistent with trends in trawl survey biomass. The selectivity of the commercial fishery is unknown and it is unknown whether the two sets of indices are monitoring the same component of the stock. However, the CPUE indices for a mixed target species bottom trawl fishery and the flatfish target bottom trawl fishery have similar trends and have been averaged to obtain a composite series.

Fishery Interactions
Red gurnard are primarily taken in conjunction with the following QMS species: barracouta, stargazer, red cod, tarakihi and other species in the West Coast South Island arget bottom trawl fishery. Incidental captures of seabirds occur and there is a risk of incidental capture of Hector's dolphins.

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