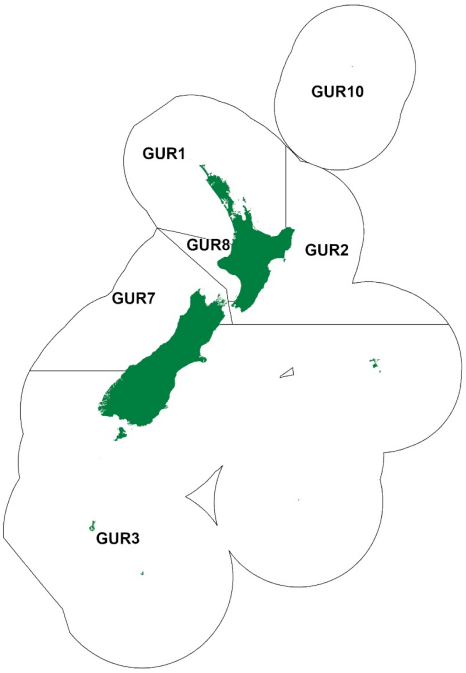
RED GURNARD (GUR)

(*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 off 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 set net.

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 all red gurnard Fishstocks were gradually increased from 1986 to 1990, with the total TACC increasing from 4230 t to 4762 t. TACCs for GUR 1, GUR 2, and GUR 8 have remained unchanged since. The TACCs for GUR 3 and 7 were further 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 678 t, in 1997–98. All AMP programmes ended on 30 September 2009. For the 2009–10 fishing season, the TACC in GUR 7 was increased 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 785 t in October 2012, 845 t in October 2015, 975 t in October 2017, and to 1073 t in October 2019 along with increased allowances. The TACC for GUR 3 was increased by 300 t (50%) to 900 t for the 1996–97 fishing year under the AMP, but was 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, 1220 t in October 2015, and to 1320 t in October 2018. This TACC is given in Table 1 along with all current allowances, TACCs, and TACs.

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

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Table 1: Current TACs, TACCs, and allowances (t) for red gurnard by Fishstock as of October 2019.

Fishstock	TAC	TACC	Customary allowance	Recreational allowance	Other mortality
GUR 1		2 288			
GUR 2		725			
GUR 3	1 593	1 320	3	6	264
GUR 7	1 176	1 073	15	38	50
GUR 8		543			
GUR 10		10			

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

Year	GUR 1	GUR 2	GUR 3	GUR 7	GUR 8
1931–32	67	0	1	16	0
1932–33	42	0	0	13	0
1933–34	67	84	1	20	0
1934–35	50	179	0	2	0
1935–36	75	147	18	2	0
1936–37	114	215	37	25	1
1937–38	205	193	83	21	0
1938–39	109	118	151	31	2
1939–40	121	149	147	25	1
1940–41	124	222	215	38	1
1941–42	107	200	267	38	0
1942–43	124	332	287	58	0
1943–44	128	244	294	53	0
1944	238	292	291	60	0
1945	360	338	222	94	3
1946	426	387	290	119	4
1947	376	297	243	162	10
1948	385	243	267	226	9
1949	371	264	316	323	13
1950	306	186	486	332	13
1951	221	231	750	202	10
1952	394	378	658	211	5
1953	490	494	614	334	3
1954	496	462	660	382	7
1955	495	283	652	490	25
1956	434	312	782	435	29
1957	494	402	737	409	46
1958	430	394	745	400	51
1959	460	320	806	212	44
1960	489	417	1 008	421	27
1961	559	419	1 180	419	27
1962	505	592	1 244	322	14
1963	576	562	1 364	367	8
1964	977	814	1 708	397	16
1965	1 020	668	1 459	400	34
1966	1 157	754	1 178	436	27
1967	1 051	836	745	522	45
1968	1 137	583	510	368	52
1969	1 345	632	487	256	33
1970	1 493	823	841	381	53
1971	1 225	570	940	379	37
1972	770	347	662	333	15
1973	1 278	406	1 393	491	21
1974	881	299	1 083	586	41
1975	691	199	655	365	28
1976	1 055	217	960	545	52
1977	1 288	381	975	579	45
1978	1 571	519	1 106	487	26
1979	1 936	382	690	349	18
1980	1 845	438	672	253	34
1981	2 349	603	438	318	16
1982	2 084	454	379	368	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 the present and actual TACCs (t) from 1986–87 to the present. The QMS data are from 1986 to the 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	1 005	2 288	555	725	1 223	1 100	837	785
2014–15	1 020	2 288	695	725	1 150	1 100	852	785
2015–16	860	2 288	748	725	1 348	1 220	852	845
2016–17	856	2 288	669	725	1 279	1 220	905	845
2017–18	785	2 288	560	725	1 419	1 220	882	975
2018–19	710	2 288	587	725	1 467	1 320	998	975
2019–20	745	2 288	562	725	1 537	1 320	1 182	1 073

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
2014–15	193	543	0	10	3 910	5 451
2015–16	145	543	0	10	3 953	5 631
2016–17	145	543	0	10	3 854	5 631
2017–18	209	543	0	10	3 855	5 761
2018–19	267	543	0	10	4 029	5 861
2019–20	386	543	0	10	4 412	5 959

*FSU data.

Annual landings of GUR 1 were relatively stable from 1986–87 to 2014–15, generally ranging between 920 t and 1300 t; substantially lower than the 2288 t TACC. Since then catches have declined slightly, with 745 t landed in 2019–20. 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 451–853 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 and this stock has been consistently over-caught since 2004–05.

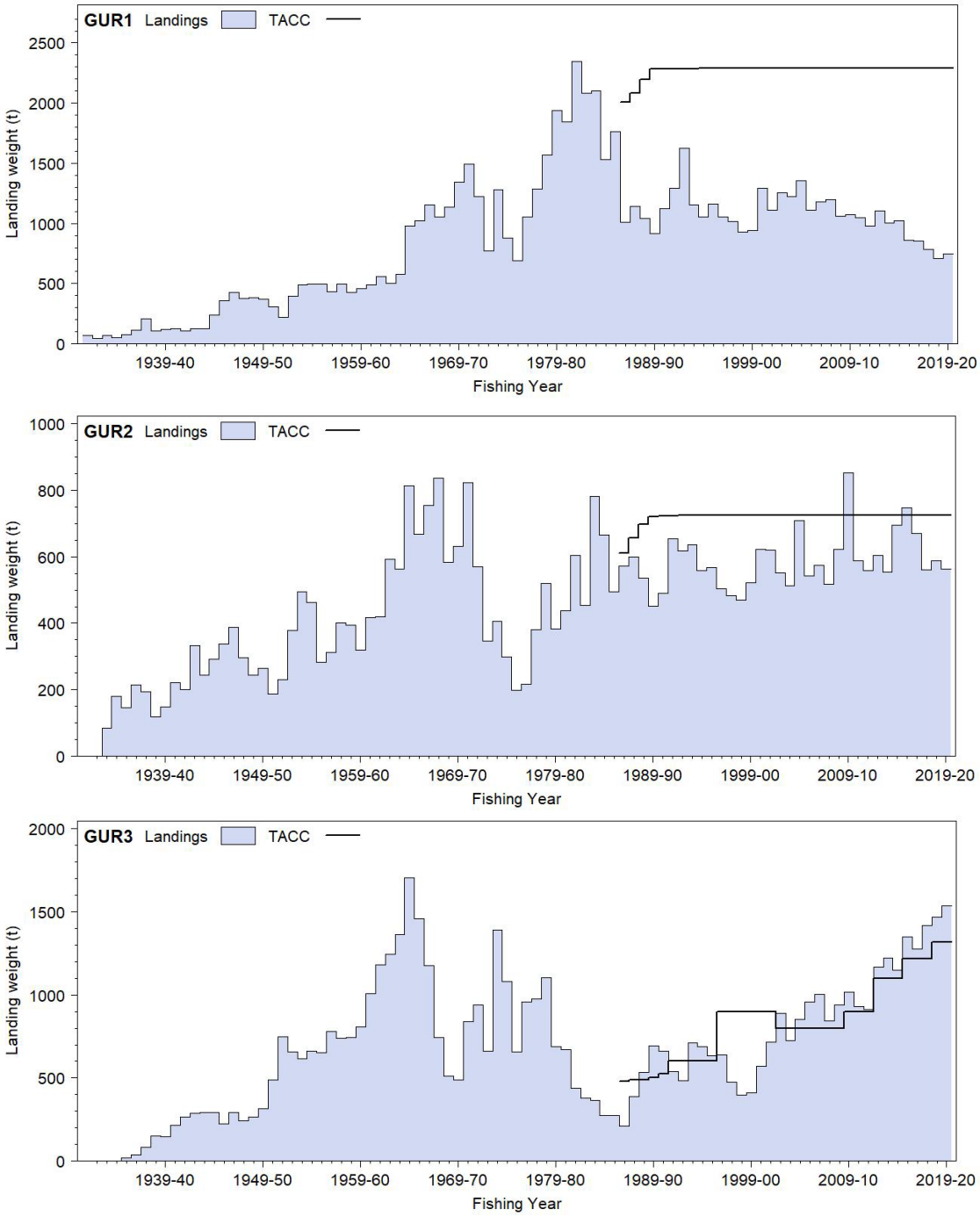

Figure 1: Reported commercial landings and TACCs for the five main GUR stocks. From top to bottom: GUR 1 (Auckland East), GUR 2 (Central East) and GUR 3 (South East Coast). [Continued on next page]

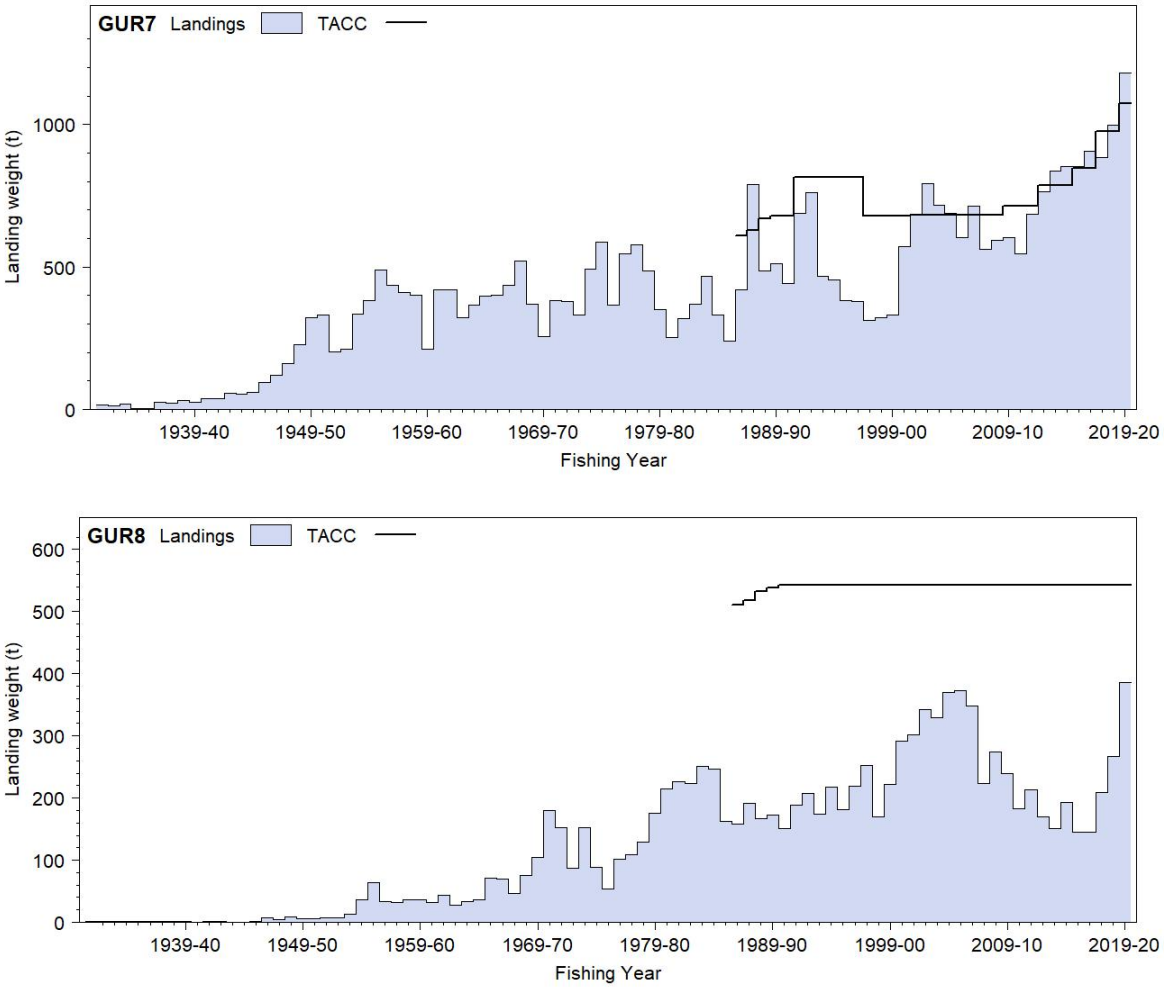

Figure 1 [Continued]: Reported commercial landings and TACCs for the five main GUR stocks. From top to bottom: GUR 7 (Challenger) and GUR 8 (Central Egmont).

GUR 7 landings declined steadily from 761 t in 1992–93, to 309 t in 1997–98, but then increased to 793 t by 2002–03. Landings then generally declined to 2010–11, before increasing to a peak of 1182 t in 2019–20, slightly exceeding the TACC.

Landings in GUR 8 have remained well below the TACC since 1986–87, averaging 225 t.

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, but have currently only been set for GUR 3 and GUR 7.

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.

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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 2002) and a rolling replacement of diarists in 2001 (Boyd et al 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, Hartill & Davey 2015 and Davey et al 2019).

Stock	Year	Method	Number of fish	Total weight (t)	CV
GUR 1	1996	Telephone/diary	262 000	108	0.07
	2000	Telephone/diary	465000	223	0.16
FMA 1 only	2005	Aerial–access	–	127	0.14
FMA 1 only	2012	Aerial–access	–	24	0.09
FMA 1 only	2012	Panel survey	120 500	49	0.16
	2012	Panel survey	241 957	103	0.15
FMA 1 only	2018	Aerial–access	–	31	0.11
FMA 1 only	2018	Panel survey	85 000	36	0.14
	2018	Panel survey	168 798	86	0.15
GUR 2	1996	Telephone/diary	38 000	16	0.18
	2000	Telephone/diary	209 000	127	0.37
	2012	Panel survey	66 661	38	0.20
	2018	Panel survey	71 702	39	0.28
GUR 3	1996	Telephone/diary	1 000	–	–
	2000	Telephone/diary	11 000	5	0.70
	2012	Panel survey	4 605	2	0.62
	2018	Panel survey	3 486	2	0.39
GUR 7	1996	Telephone/diary	26 000	12	0.15
	2000	Telephone/diary	36 000	11	0.23
	2012	Panel survey	23 653	12	0.24
	2018	Panel survey	60 759	38	0.18
GUR 8	1996	Telephone/diary	67 000	28	0.15
	2000	Telephone/diary	99 000	40	0.36
	2012	Panel survey	93 656	47	0.23
	2018	Panel survey	55 314	31	0.19

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 (Wynne-Jones et al 2014) and repeated for the 2017–18 fishing year (Wynne-Jones et al 2019). 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.

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 Bay and Golden Bay. Three to six year old fish are found on the inshore areas off the west coast South Island and the older fish are predominantly found further offshore (Lyon & Horn 2011).

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)

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.

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; west coast South Island and Tasman Bay/Golden Bay combined (GUR 7); and east coast South Island (GUR 3) (Table 6). The west coast South Island (WCSI) and east coast South Island (ECSI) surveys are the only ongoing surveys, currently 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 elephant fish and red gurnard which were officially included in the list of target species in 2012. Only the 2007, 2012, 2014, 2016, and 2018 surveys provide full coverage of the 10–30 m depth range.

In the 1990s, red gurnard biomass averaged 422 t in the core strata, increasing more than three-fold to 1453 t in 2007. From 2007 to 2014 biomass had an upward trend followed by a substantial decline in 2016 when biomass more than halved (Table 6, Figure 2). The biomass increased again in 2018 to 2043 t, the second highest estimate in the time series. Biomass for the four core plus shallow strata followed the same general trend as that for the core strata. The proportion of pre-recruit biomass in the core strata varied greatly among surveys, but was generally low, 2–20%, and in 2018 it was 15%. In some years the proportion of pre-recruit biomass in the core plus shallow strata was greater than that of the core strata alone, indicating that younger fish were more common in shallow water. The proportion of juvenile biomass (based on the length-at-50% maturity) within the core strata was close to zero for all surveys (MacGibbon et al 2019).

Table 6: Relative biomass indices (t) and coefficients of variation (CV) for red gurnard for research trawl survey areas around the North Island and South Island*. Biomass estimates for ECSI in 1991 were 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 does not always match the total biomass for the earlier surveys because at several stations length frequency data were not collected, 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	GUR 1	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	GUR 1	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. 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 red gurnard around the North Island and South Island*. Biomass estimates for ECSI in 1991 were 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). Biomass estimates from current surveys with extreme catchability are denoted with a #.

Region	Fishstock	Year	Trip number	Total biomass estimate	CV (%)	Total biomass estimate	CV (%)	Pre-recruit	CV (%)	Pre-recruit	CV (%)	Recruited	CV (%)	Recruited	CV (%)
		1992	KAH9204	572	15	–	–	–	–	–	–	–	–	454.0	15.4
		1994	KAH9404	559	15	–	–	–	–	–	–	–	–	478.3	16.0
WCSI	GUR 7	1995	KAH9504	584	19	–	–	–	–	–	–	–	–	501.6	21.7
		1997	KAH9704	471	13	–	–	–	–	–	–	–	–	309.8	14.5
		2000	KAH0004	625	15	–	–	–	–	–	–	–	–	444.0	14.9
		2003	KAH0304	#270	20	–	–	–	–	–	–	–	–	253.7	20.9
		2005	KAH0503	442	17	–	–	–	–	–	–	–	–	374.7	16.2
		2007	KAH0704	553	17	–	–	–	–	–	–	–	–	431.6	17.9
		2009	KAH0904	651	18	–	–	–	–	–	–	–	–	400.4	19.1
		2011	KAH1104	1 070	17	–	–	–	–	–	–	–	–	798.6	18.6
		2013	KAH1305	754	12	–	–	–	–	–	–	–	–	546.5	13.4
		2015	KAH1503	1 774	16	–	–	–	–	–	–	–	–	1 335.2	18.6
		2017	KAH1703	1 708	12	–	–	–	–	–	–	–	–	1 352.0	12.0
		2019	KAH1902	1 642	16	–	–	–	–	–	–	–	–	1 079.0	16.0
North Island	GUR 2	1993	KAH9304	439	44	–	–	–	–	–	–	–	–	–	–
east coast		1994	KAH9402	871	16	–	–	–	–	–	–	–	–	–	–
		1995	KAH9502	178	26	–	–	–	–	–	–	–	–	–	–
		1996	KAH9602	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
		2016	KAH1605	941	30	2 420	15	63	41	306	19	877	30	2 114	15
		2018	KAH1803	2043	19	3 831	17	308	24	610	21	1735	20	3221	18
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. Note: because trawl survey biomass estimates are indices, comparisons between different seasons (e.g., summer and winter ECSI) are not strictly valid.

The additional red gurnard biomass captured in the 10–30 m depth range accounted for 29%, 52%, 36%, 61%, and 47% of the biomass in the core plus shallow strata (10–400 m) for 2007, 2012, 2014, 2016, and 2018 respectively, indicating the importance of shallow strata for red gurnard biomass. These observations indicate that the core strata survey (30–400 m) may not be shallow enough to provide an index for sub-mature gurnard.

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 and 2016 there was a strong 1+ cohort in 10–30 m, which was poorly represented in the core strata (MacGibbon et al 2019). In 2018 the distributions in the 10–30 m and the core strata were similar. Based on the five surveys that included the 10–30 m strata, there are generally more pre-recruit fish in the shallow strata, suggesting that 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 m to 100 m, but is most abundant in the shallow 10 m to 30 m strata. They are almost absent deeper than 100 m.

WCSI

There has been a steady increase in red gurnard biomass since the mid-2000s and the last three points were the highest in the series (Figure 3). Sixty-six percent of the total biomass in 2017 was recruited fish (30 cm and over). A significant proportion of the biomass has always occurred in the Tasman Bay and Golden Bay region, although for the last four surveys a higher proportion was found off the west coast South Island. The trend in pre-recruit biomass for the entire survey area has largely followed that of the recruited (> 30 cm) fish; however, in 2019 recruited biomass dropped compared with 2017 and pre-recruited biomass increased (Figure 4).

Scaled length frequencies are similar between surveys. Larger numbers of smaller fish are found in Tasman Bay and Golden Bay which is thought to be a nursery area, and larger number of large fish are found off the west coast, although a wide size range occurs in both areas (see figure 5i from MacGibbon 2019).

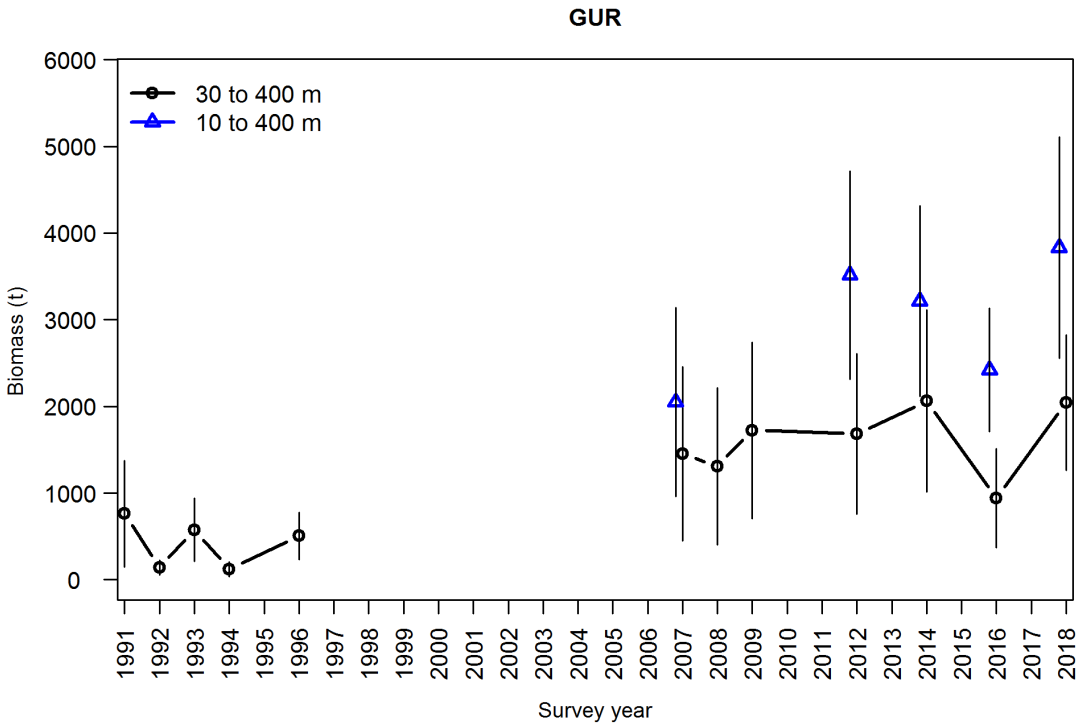


Figure 2: Red gurnard total biomass for all ECSI winter surveys in core strata (30–400 m), and core plus shallow strata (10–400 m) in 2007, 2012, 2014, 2016, and 2018. Error bars are ± two standard deviations.

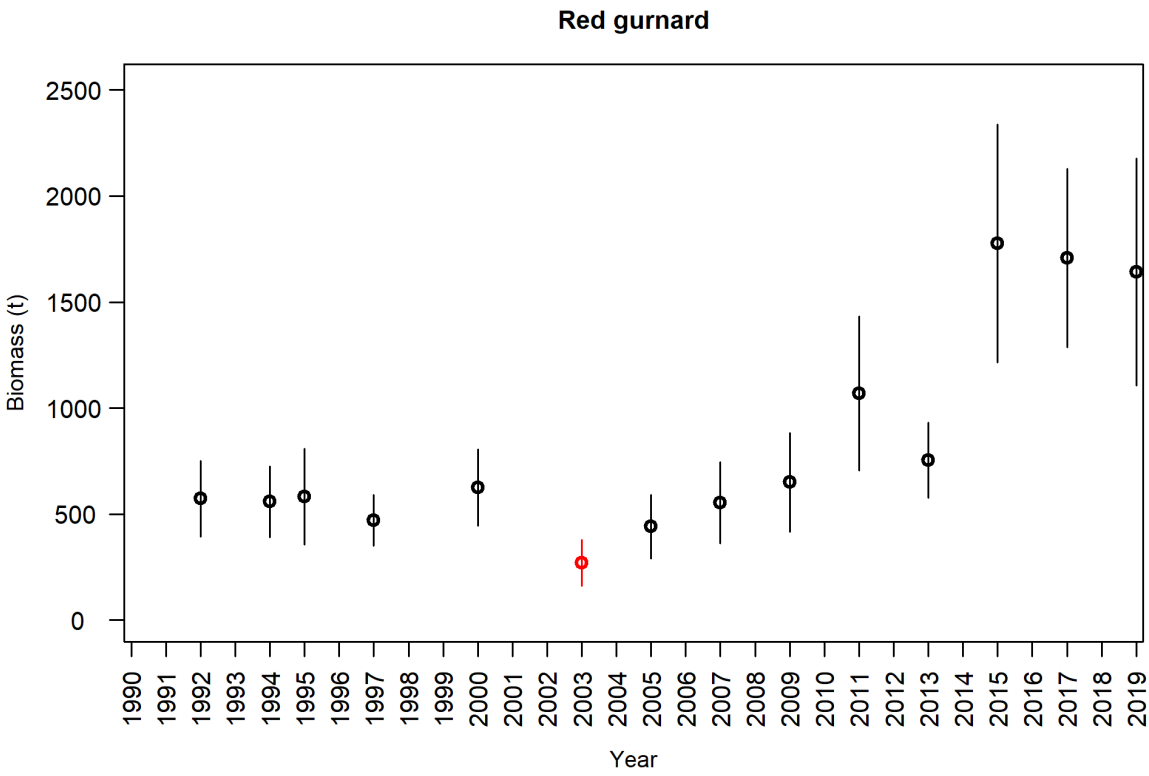


Figure 3: Red gurnard biomass trends from the West Coast South Island inshore trawl survey time series. Error bars are ± two standard deviations. The red symbol denotes biomass estimated from a survey conducted when catchability was extremely low.

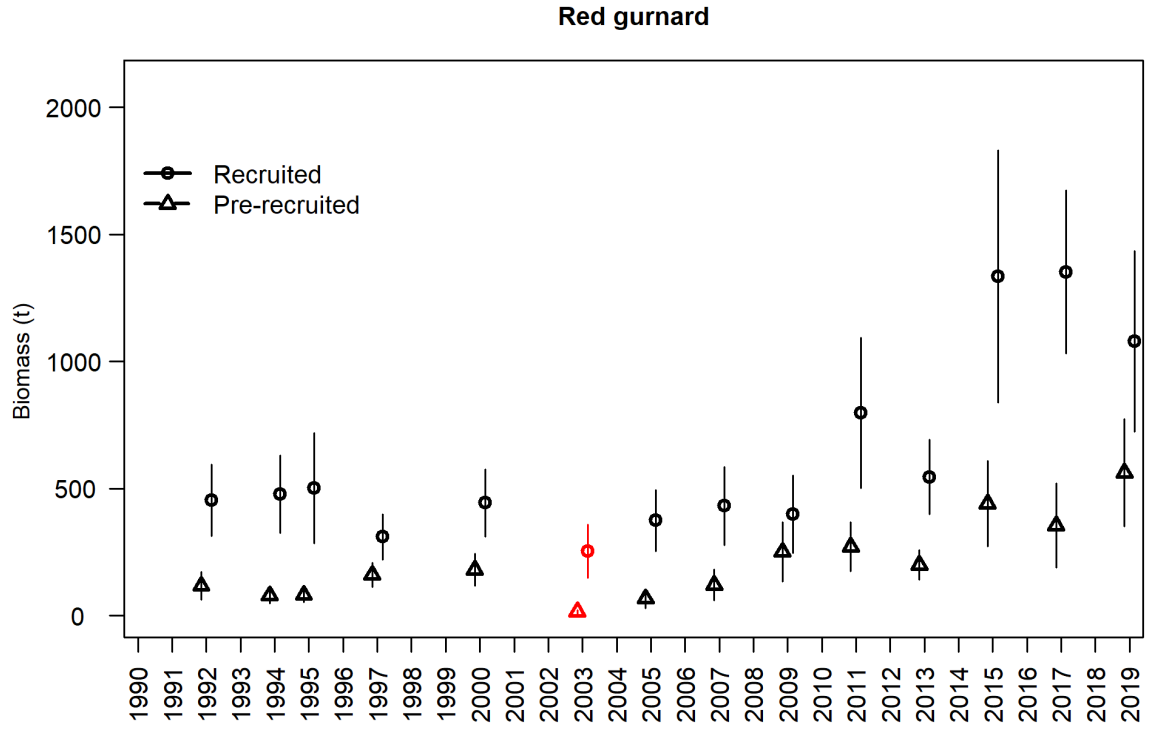


Figure 4: Red gurnard pre-recruit (< 30 cm) and recruited biomass trends from the West Coast South Island inshore trawl survey time series. Error bars are ± two standard deviations. The red symbols denote biomass estimated from a survey conducted when catchability was extremely low.

4.2 CPUE Analyses

GUR 1

In 2017, Kendrick & Bentley (in prep. a) updated CPUE analyses for GUR 1W (west coast, Figure 5), GUR 1E (east Northland and Hauraki Gulf, Figure 6), and GUR 1BP (Bay of Plenty, Figure 7).

The analyses were based on catch and effort data for individual tows reported on TCEPR and TCER forms because adequate time series are available in the northern inshore trawl fisheries from 1995–96. Based on catch and effort data from single bottom trawls targeting gurnard, snapper, trevally, tarakihi, or John dory, two GLM models were produced for each subarea: one based on the magnitude of positive catch (gamma error distribution), and the other a binomial model of the probability of capture (based on the proportion of tows capturing GUR). The two models were then combined to produce a single series for each sub-area, and the Working Group accepted the combined models as indices of abundance. The data used to generate the GLM models were restricted to core fleets of vessels having had at least three trips in each of three years.

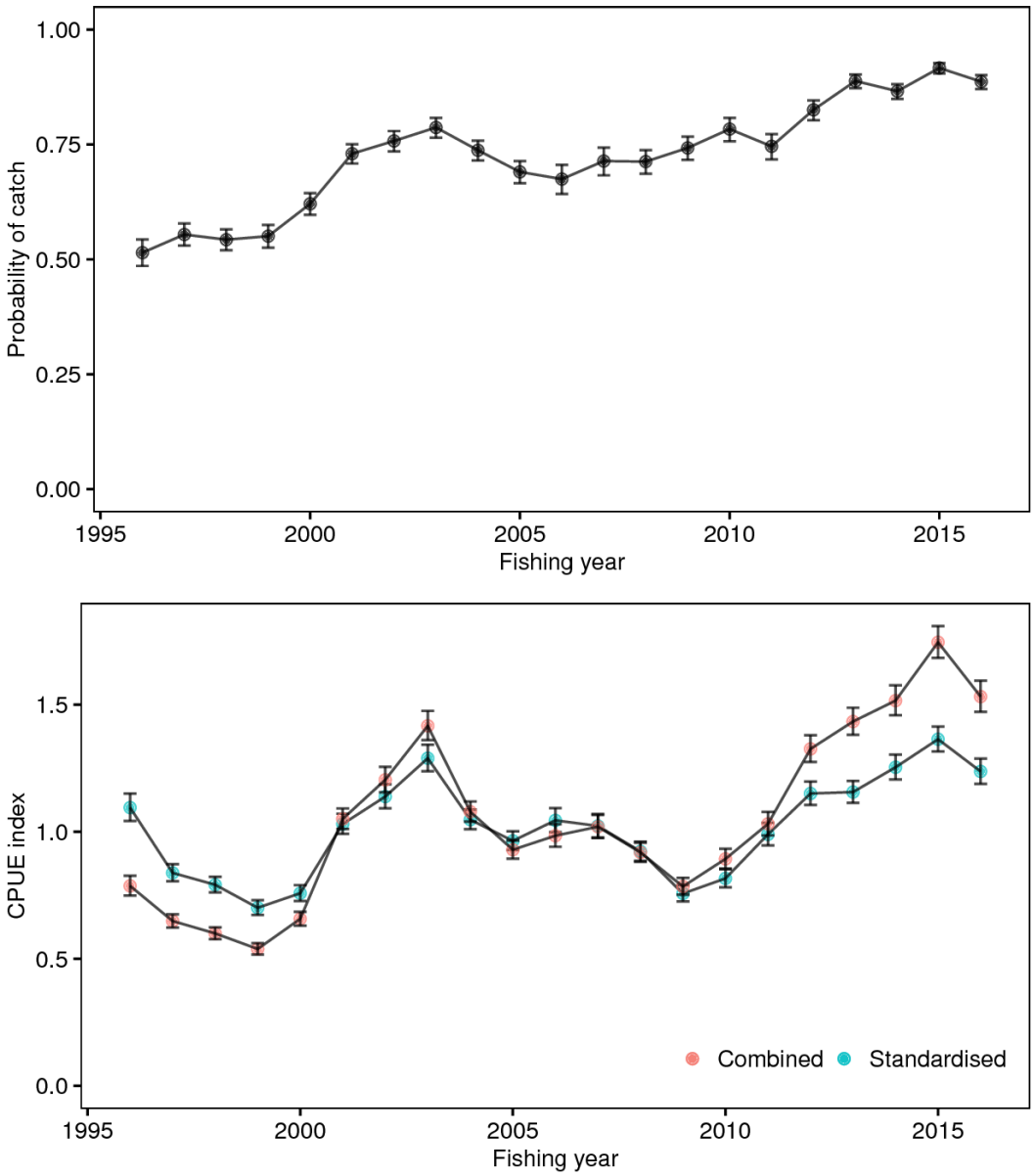


Figure 5: Standardised probability of catch (binomial model), positive CPUE indices (gamma model), and combined model for GUR 1W using bottom trawl tow data from TCEPR/ TCER forms (Kendrick & Bentley in prep a). Error bars are 95% confidence intervals.

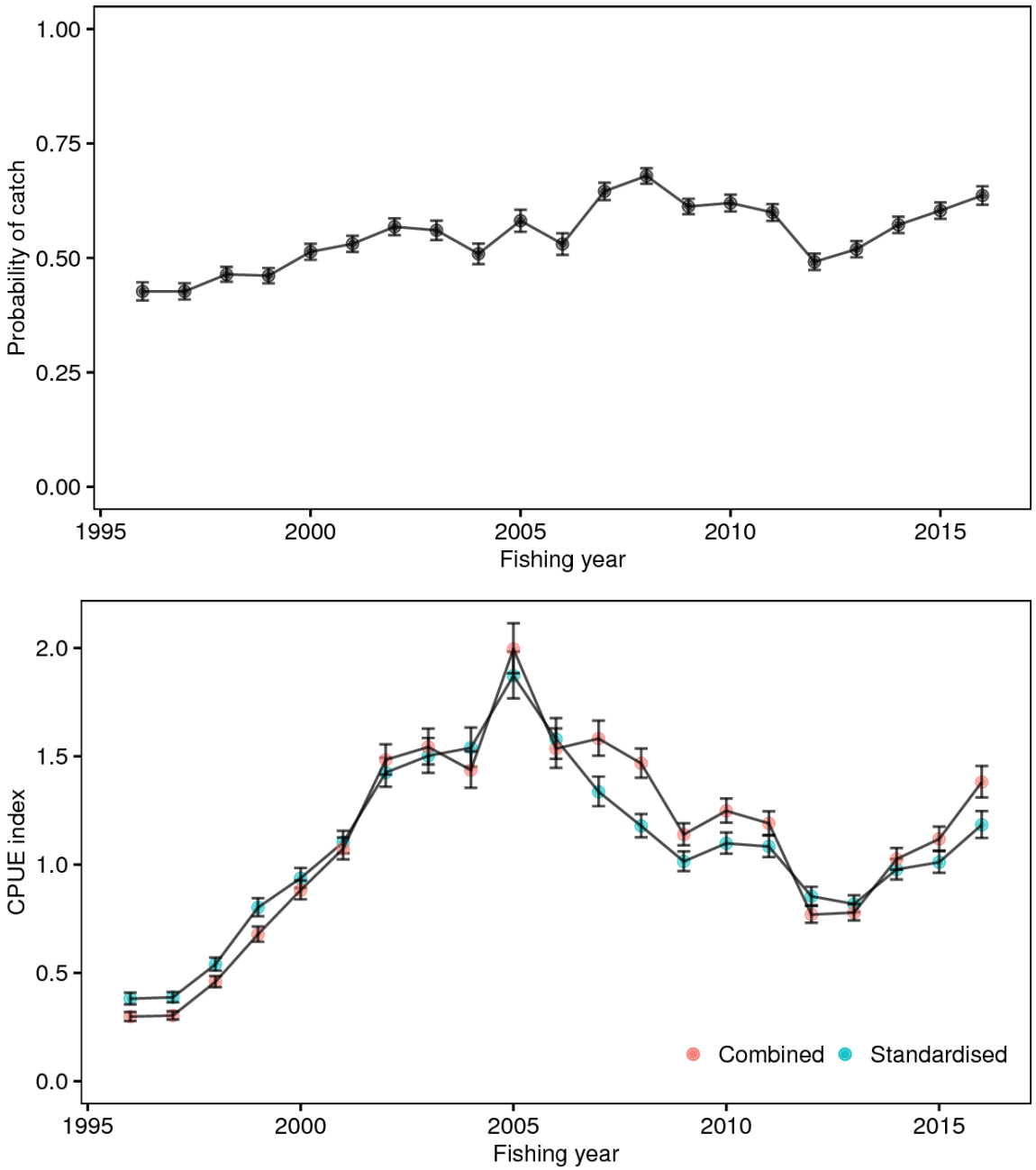


Figure 6: Standardised probability of catch (binomial model), positive catch CPUE indices (gamma model), and combined model for GUR 1E using bottom trawl tow data from TCEPR/ TCER forms (Kendrick & Bentley in prep a). Error bars are 95% confidence intervals.

All three series show strong cyclical fluctuations with a recovery from low levels between 1995 and 1999 to a peak in the early 2000s, followed by a subsequent decline to low levels again between 2009 and 2013. In all three regions there have been subsequent increases and all combined series have a value near, or above, the long-term average in 2016. Despite overall similarities, the series differ somewhat with respect to the magnitude of the fluctuations and the specific years for the nadir and the peak.

The Working Group accepted the tow-based combined series for ongoing monitoring of each substock. The trends for these series are consistent with previous analyses for corresponding periods (Kendrick & Bentley in prep a).

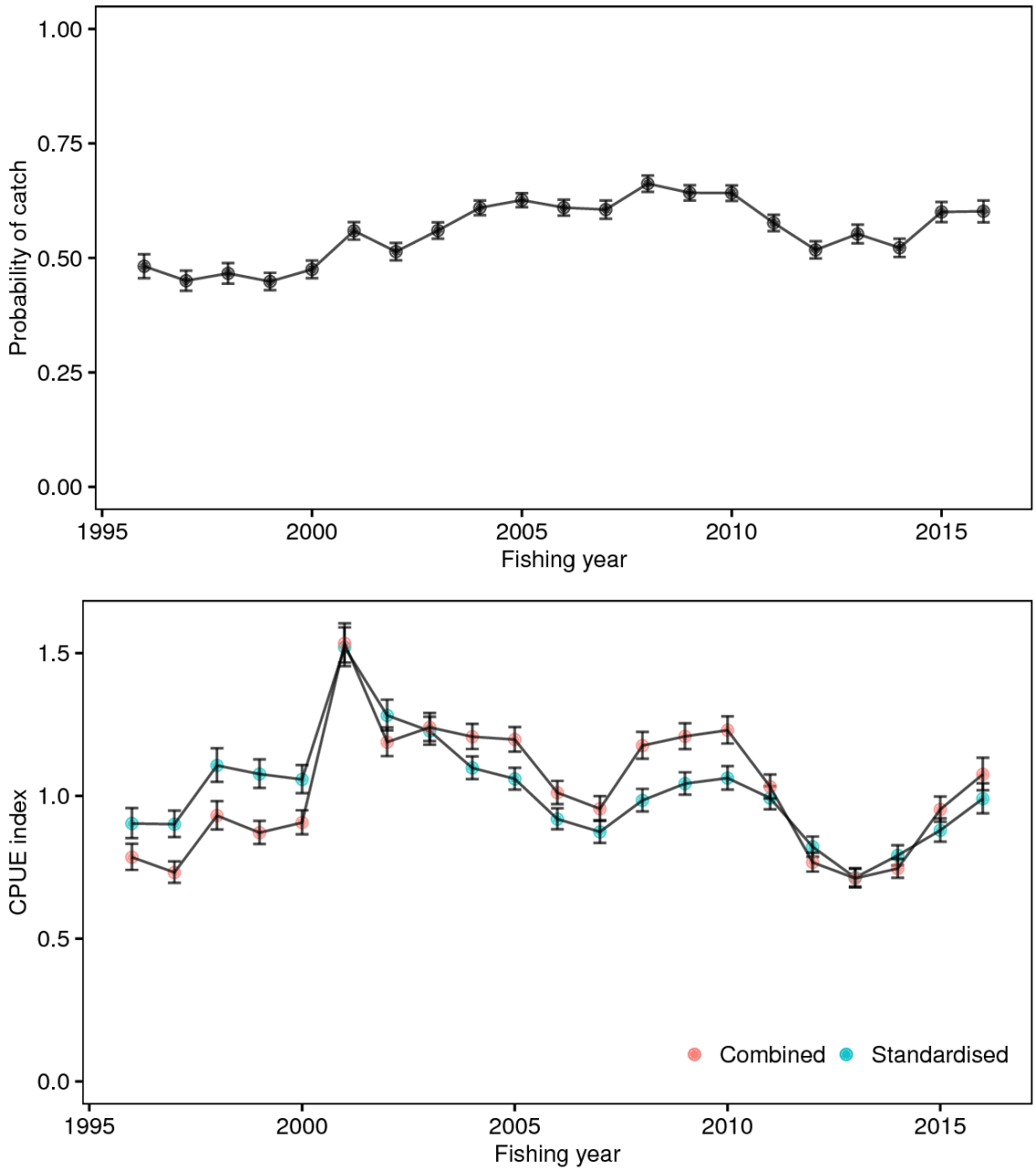


Figure 7: Standardised probability of catch (binomial model), positive catch CPUE indices (gamma model), and combined model for GUR 1BP using bottom trawl tow data from TCEPR/ TCER forms (Kendrick & Bentley in prep a). Error bars are 95% confidence intervals.

Establishing B_{MSY} compatible reference points for GUR 1

In 2013, the Working Group accepted mean standardised bottom trawl CPUE for the period 1995–96 to 2011–12 as B_{MSY}-compatible proxies for each of the GUR 1 sub-stocks. All three series were based on combined positive catch and probability of capture models derived from event scale fishing events (i.e., tow). GUR abundance tends to fluctuate in cycles, according to recruitment, and the period was chosen because it included at least one cycle of abundance and high catch. 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 for each sub-stock, respectively.

GUR 2

GUR 2 is monitored using standardised CPUE from the bottom trawl fishery targeting gurnard, snapper, or trevally.

In 2017, Schofield et al (2018a) updated CPUE analyses for GUR 2. Landings were allocated to daily aggregated effort using methods described by Langley (2014) to improve the consistency of the data collected from the different statutory reporting forms (CELR and TCER). A core fleet of vessels that had completed at least five trips per year in at least seven years was modelled using a Weibull distribution. A shorter time series based on TCEPR and TCER format data available since 2007–08, and analysed at tow by tow resolution, closely resembled the mixed-form series for the years in common.

The NINSWG noted that almost of the records in the aggregated data had catches of gurnard and that a binomial index was flat. As a result, the positive catch index was retained as the key monitoring series.

The indices were updated in 2018 and 2019, and in 2020 a new fisheries characterisation was also carried out. This indicated that the fishery had been stable in the intervening period, and the accepted indices were updated with the addition of data from the ERS – Trawl reporting regime which was introduced for deepwater vessels from 2017–18, and for all other fisheries during 2019.

In the longer CPUE series using aggregated data (i.e., PseudoCELR series) there are indications of cyclical variations in abundance with a 4- to 5-year period (Figure 8). There was an overall decreasing trend in CPUE from 1990 to 2007, after which CPUE stabilised and then increased to 2016, before decreasing to 2017 followed by a recent slight increase. As before, the series using tow level data showed a similar pattern to the longer, daily aggregated, index for years after 2007–08 (Figure 8).

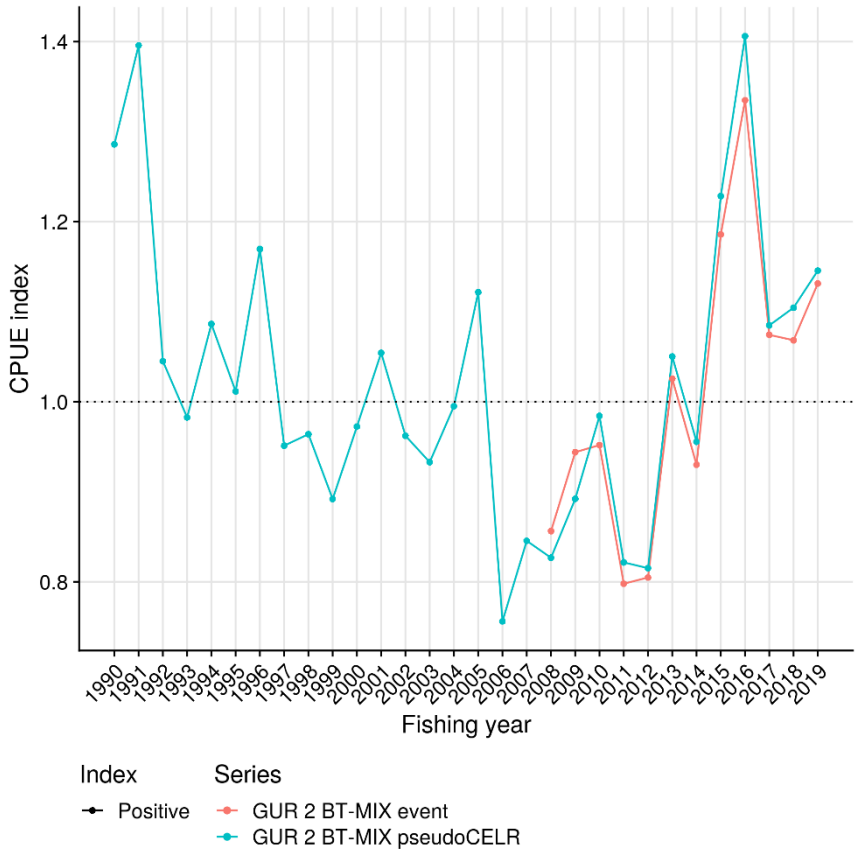


Figure 8: Comparison of standardised catch per unit effort (CPUE) indices for GUR 2 from bottom trawling targeting gurnard, snapper, and trevally (BT-MIX pseudoCELR; Weibull) combined over all form types, and more recently from data based on TCEPR/ TCER (tow) format data only (BT-MIX event; gamma). The series are scaled relative to the geometric mean of the years they have in common.

Chapman-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 at 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

In 2014, the NINSWG adopted mean CPUE from the (BT(MIX)) model for the period 1990–91 to 2009–10 as a B_{MSY}-compatible proxy for GUR 2. In 2020 the reference period was extended from 1991 to 2018, on the grounds that the new period included two peaks in abundance. The Working Group adopted the default Harvest Strategy Standard definitions for the Soft and Hard Limits of 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, and 030). The BT(MIX) index included fishing effort targeting red cod, giant stargazer, barracouta, tarakihi, and red gurnard, and the BT(FLA) index comprised flatfish 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 9). 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 9).

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 TL) from the time series of winter ECSI inshore trawl surveys (Figure 9), 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.

The accepted CPUE indices were updated in 2018 (Schofield et al 2018b) to include data to 30 September 2017. However, the Working Group concluded that a full update of CPUE indices, including a binomial component, was required.

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.

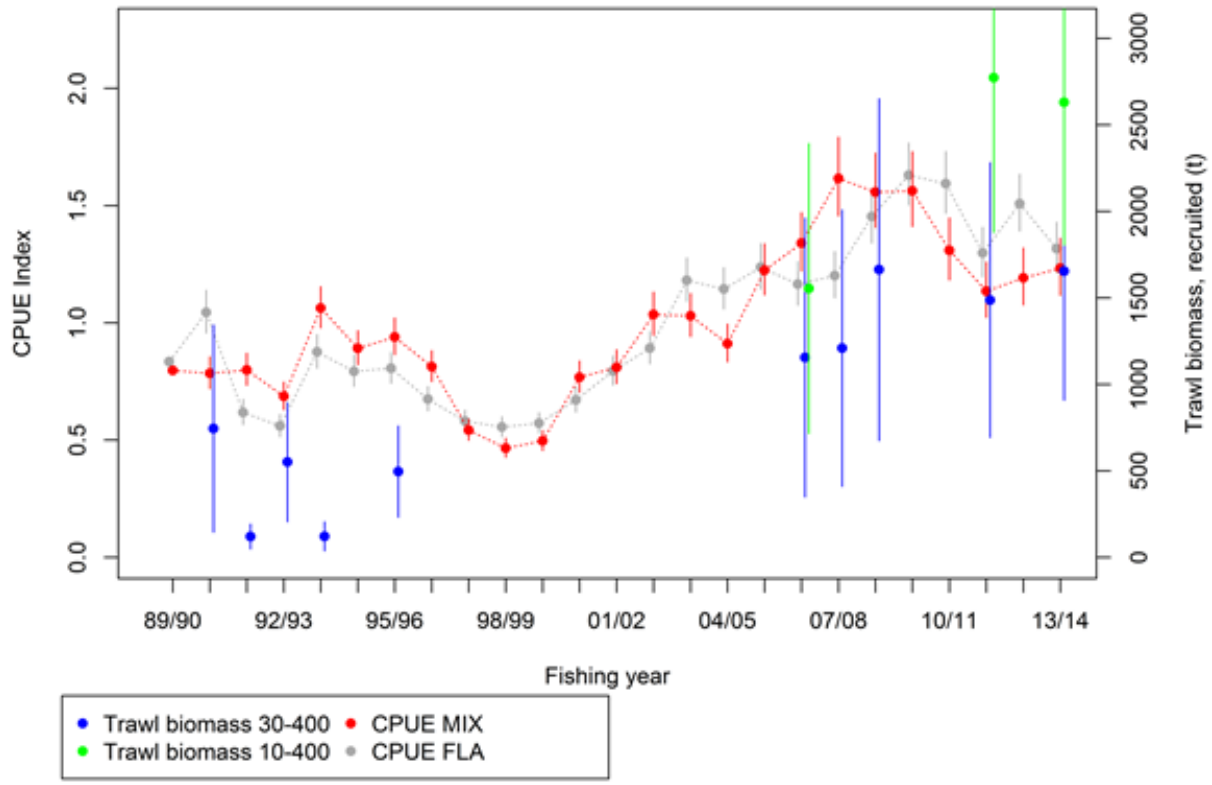


Figure 9: Standardised CPUE indices for two east coast South Island bottom trawl fisheries (BT(MIX) and BT(FLA)) compared with trawl survey estimates of recruited (≥ 30 cm TL) biomass for red gurnard from the winter ECSI inshore trawl survey for two survey depth strata (30–400 m and 10–400 m). Error bars show ±95% confidence intervals.

GUR 7

In both 2014 and 2017, only two standardised CPUE analyses based on the catch of gurnard in bottom trawl fisheries operating off the west coast of the South Island for monitoring GUR 7 were accepted. These fisheries are defined as follows:

- WCSI(FLA): bottom trawl effort targeted at flatfish (or any of the species that make up this complex) in Statistical Areas 033, 034, 035, or 036;
- WCSI(MIX): bottom trawl effort targeted at red gurnard, red cod, tarakihi, barracouta, giant stargazer, or blue warehou in Statistical Areas 033, 034, 035, or 036;

The data for these analyses were prepared using the "daily effort" procedure documented by Langley (2014). The Plenary agreed in 2017 to use the combined model (lognormal model of positive catches and binomial model of probability of capture) using the delta-lognormal method (Vignaux 1994) for stock evaluations. This was done because the Inshore Working Groups have adopted the standard of combining positive catch and fishing success models when there is a trend in the proportion zero catch. In addition, simulation work has indicated that calculating a combined index may reduce bias when reporting small catch amounts (Langley 2015).

These fishery definitions build on the work of Kendrick et al (2011) and Langley (2014), which defined four fisheries for monitoring GUR 7, two on the WCSI and two in western Cook Strait/Tasman Bay-Golden Bay, some with slightly different target species definitions than indicated above. These four GUR 7 BT fisheries were reviewed in 2014, comparing the CPUE series with the red gurnard biomass indices obtained from the West Coast South Island trawl survey (Table 6). The Plenary rejected the two series based on catch-effort data from Tasman Bay-Golden Bay, partly because those series did not match the biomass survey indices very well, and because there was a marked shift in the spatial distribution of fishing effort in the western Cook Strait 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 the other hand, the two sets of CPUE indices from the west coast South Island fisheries showed similar cyclical trends with relatively high CPUE indices during 1990–91 to 1991–92 and 2001–02 to 2003–04 and also relatively low CPUE indices in 1993–94 to 1999–2000 and 2006–07 to 2010–11 (Figure 10). These CPUE indices have since steadily increased from 2009–10 to a high level in 2015–16.

A composite series (WCSI(MIX+FLA)), which averaged the WCSI(MIX) and WCSI(FLA) series in each year, was accepted in 2014 by the Plenary as the best CPUE series for monitoring GUR 7.

The biomass estimates of recruited (≥ 30 cm TL) red gurnard from the WCSI trawl survey do not show the same strong abundance signal in the early to mid-2000s as do the CPUE indices. However, with the omission of the 2003 survey on the basis of an apparently large (negative) change in catchability (see Appendix 6, Stevenson & MacGibbon 2015), the trends are not incompatible. Also, recent survey biomass estimates in 2015, 2017, and 2019 are consistent with the high levels of CPUE observed in the two WCSI BT series (Figure 10).

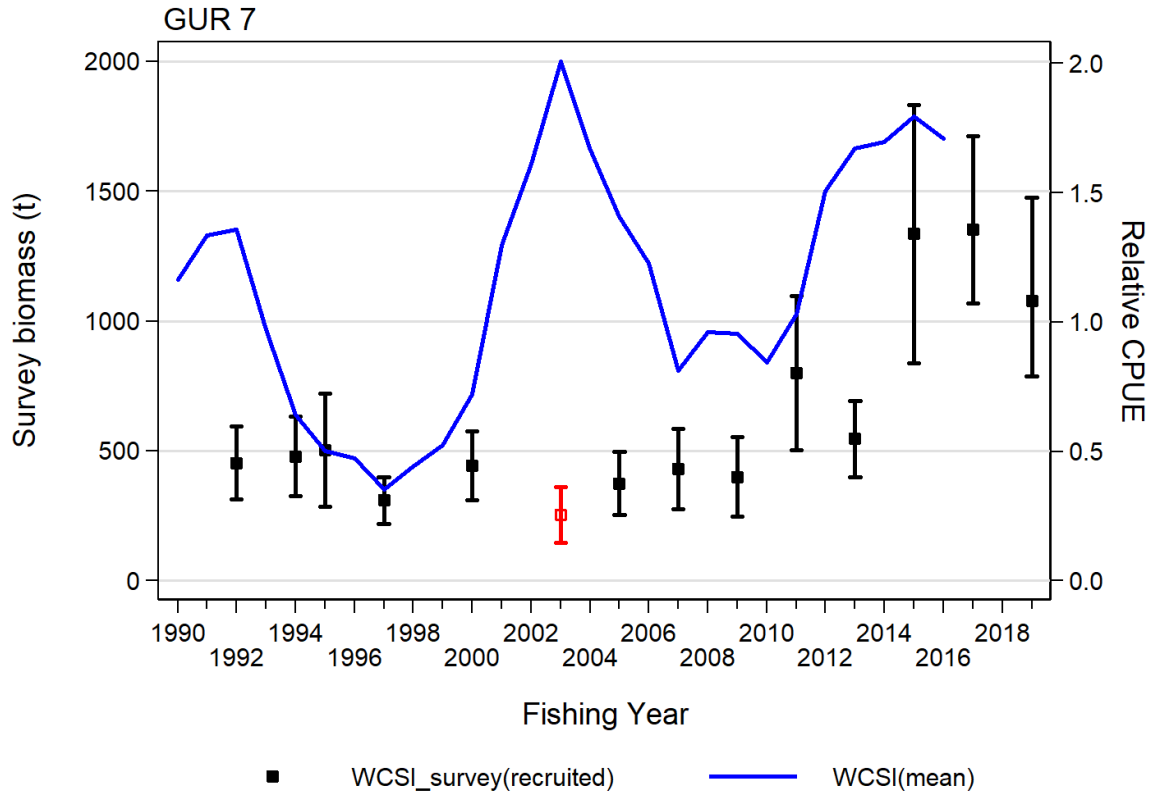


Figure 10: Comparison of the combined (mean) indices from two independent CPUE series for GUR 7 from the inshore WCSI bottom trawl fisheries (Statistical Areas 033, 034, 035, and 036); a) WCSI(FLA): target FLA; b) WCSI(MIX): target, GUR, BAR, TAR, WAR, STA, RCO. Trawl survey biomass estimates of recruited (≥ 30 cm TL) red gurnard from the WCSI inshore trawl survey are also presented with the excluded 2003 survey estimate plotted in red with a hollow marker. The vertical bars represent the associated 95% confidence intervals.

Establishing B_{MSY} compatible reference points

The Plenary reviewed the WCSI trawl survey biomass estimates in 2017 and concluded that there was no need to separate the Tasman Bay-Golden Bay strata from the WCSI strata, given the strong similarity in the biomass signals from the two survey components in 9 of the 11 survey years. Consequently, it was agreed that the recruited biomass from the total survey should be used as the main tool for monitoring GUR 7.

The Plenary concluded that the trawl survey time series is a better index of trends in abundance than the CPUE time series, primarily because it is more consistent through time and is not affected by changes in fishing behaviour. The mean of the WCSI trawl survey series from 1992–2013, but excluding 2003 because of a large negative change in catchability, was chosen as a "B_{MSY} compatible proxy" for GUR 7 on the basis that this was a period of relative stability in the series. The Plenary then adopted the default Harvest Strategy Standard definitions that the Soft and Hard Limits would be one half and one quarter the target, respectively.

The averaged WCSI(MIX+FLA) series was retained for corroboration purposes only, with no associated reference points being derived from it.

4.3 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.

4.4 Future research considerations

- Investigate the potential benefits of undertaking a full stock assessment for GUR 7, which would entail conducting more ageing of otoliths.
- Further investigation of the relationship between pre-recruits and subsequent recruitment may be useful.

5. STATUS OF THE STOCKS

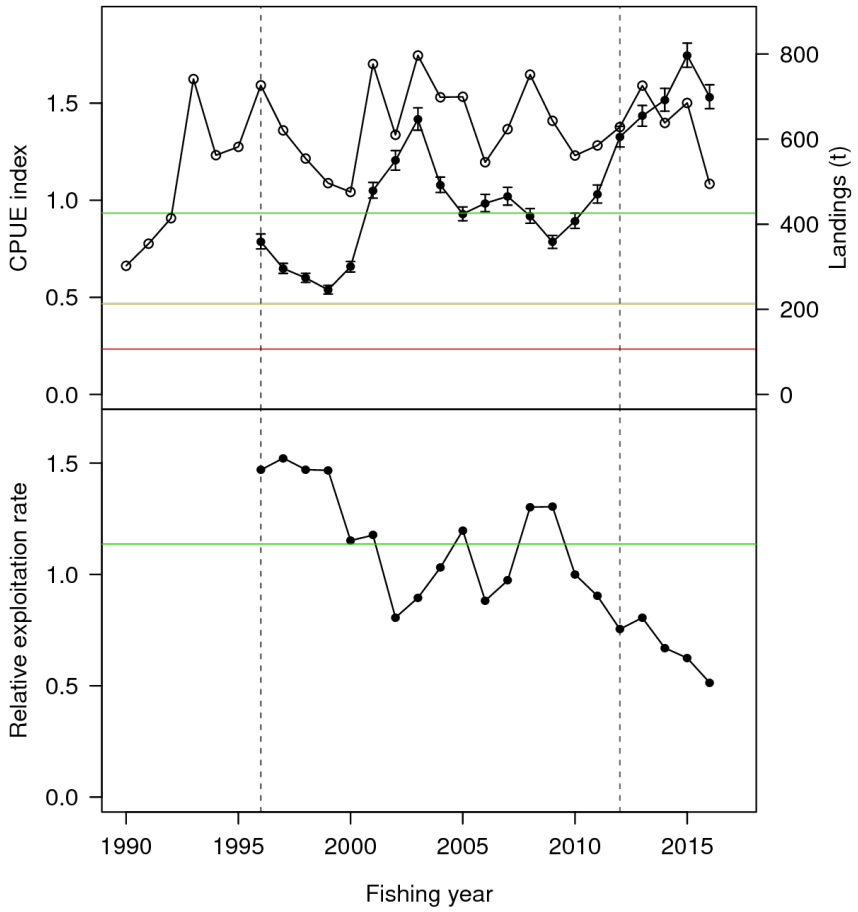
Stock Structure Assumptions

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	2017
Assessment Runs Presented	Standardised CPUE
Reference Points	Target: B_{MSY}-compatible proxy based on the mean CPUE from 1995–96 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} compatible proxy based on the mean relative exploitation rate for the period: 1995–96 to 2011–12
Status in relation to Target	Very Likely (> 90%) to be at or 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	Overfishing is Very Unlikely (< 10%) to be occurring

Historical Stock Status Trajectory and Current Status



Top panel: landings (open circles) and standardised CPUE (combined model using tow by tow data from 1995–96, ±2 s.e.). The green, yellow and red horizontal lines represent the target, soft and hard limits, respectively. Bottom panel: annual relative exploitation rate (landings divided by standardised CPUE and normalised to a geometric mean of one) for red gurnard in the GUR 1 west coast sub-stock. The horizontal green line represents the average relative exploitation rate during the period used to define the reference points (depicted by vertical dotted lines).

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	The CPUE index cycles over a 4–10 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 2015–16 was well above the long-term mean.
Recent Trend in Fishing Intensity or Proxy	Relative exploitation rate has declined since 1995–96.
Other Abundance Indices	-
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	Current Catch Soft Limit: Unlikely (< 40%) Hard Limit: Unlikely (< 40%) TACC Unknown for 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 current levels Unknown if the catch were to increase to the level of the TACC

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: 2017	Next assessment: 2020
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	-	

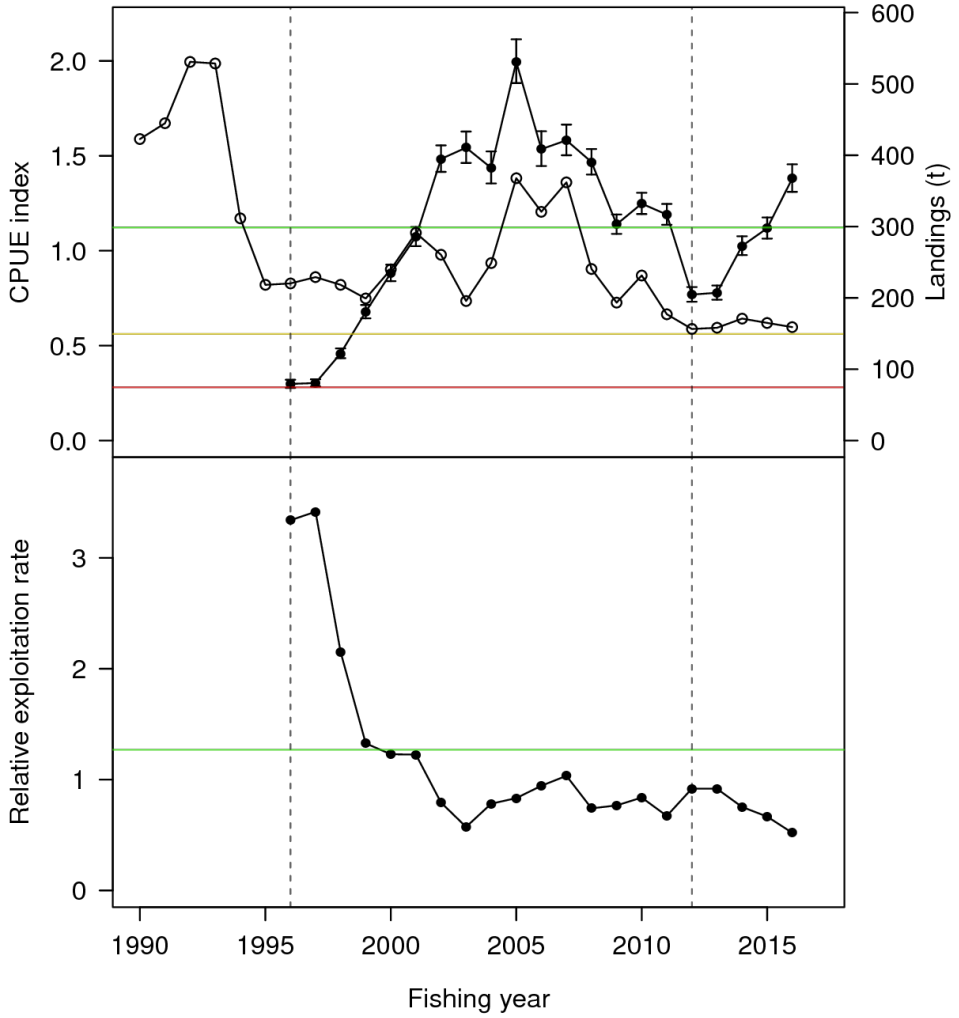
Qualifying Comments
As the red gurnard fishery in FMAs 1 and 9 has a long history, it is difficult to infer stock status from recent abundance trends. The abundance of all three sub-stocks appears to be cyclical, probably in response to recruitment variation. This makes it difficult to predict future trends without recruitment information. Given that the catch levels observed from 1986–87 to 2015–16 has been relatively consistent 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. A Danish seine summer fishery for Red gurnard and John dory also occurs on the west coast. Interactions with other species are currently being characterised.

- **GUR 1E**

Stock Status	
Year of Most Recent Assessment	2017
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} compatible proxy based on the mean relative exploitation rate for the period: 1995–96 to 2011–12
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 Stock Status Trajectory and Current Status



Top panel: landings (open circles) and standardised CPUE (combined model using tow by tow data from 1995–96, ±2 s.e.). The green, yellow and red horizontal lines represent the target, soft and hard limits, respectively. Bottom panel: annual relative exploitation rate (landings divided by standardised CPUE and normalised to a geometric mean of one) for red gurnard in the GUR 1 east coast sub-stock. The horizontal green line represents the average relative exploitation rate during the period used to define the reference points (depicted by vertical dotted lines).

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. The CPUE index declined to slightly below the target in 2011–12 and has subsequently risen to above it in 2015–16
Recent Trend in Fishing Intensity or Proxy	Relative exploitation rate declined from 1995–96 to 2002–03 and has then fluctuated without trend below the long-term average.
Other Abundance Indices	-
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	ft Limit: Unknown rd Limit: Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	known if the catch remains at current levels known if catch were to increase to the level of the TACC

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: 2017	Next assessment: 2020
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	-	

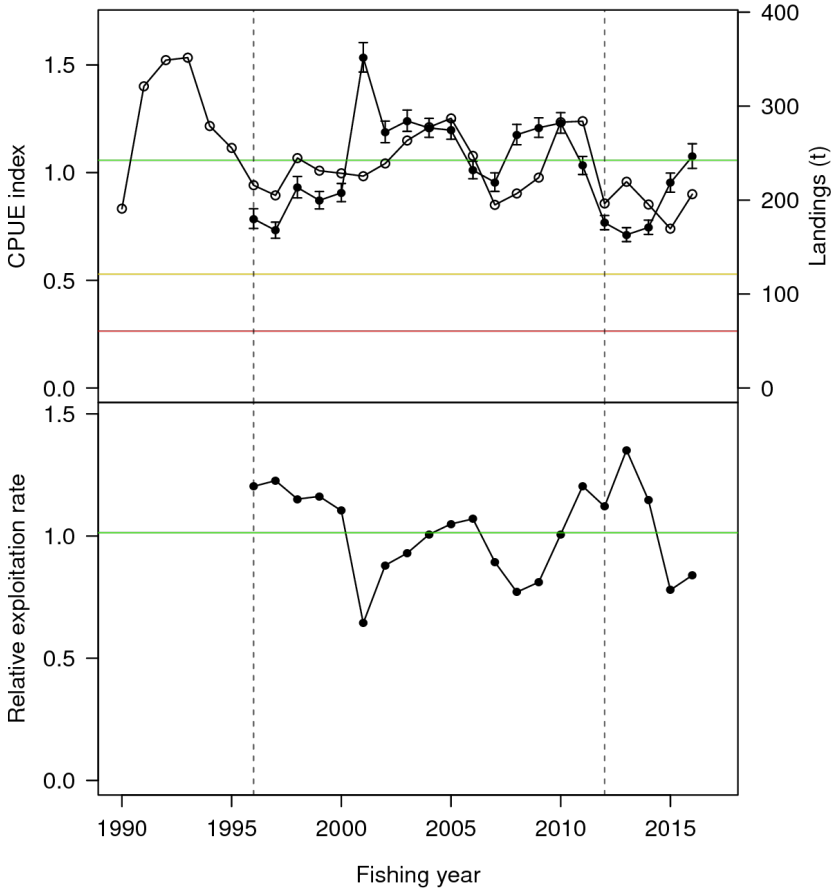
Qualifying Comments
As the red gurnard fishery in FMAs 1 and 9 has a long history, it is difficult to infer stock status from recent abundance trends. The abundance of all three sub-stocks appears to be cyclical, probably in response to recruitment variation. This makes it difficult to predict future trends without recruitment information. Given that the catch levels observed from 1986–87 to 2015–16 has been relatively consistent 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. Interactions with other species are currently being characterised.

- **GUR 1 Bay of Plenty**

Stock Status	
Year of Most Recent Assessment	2017
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 BoP (tow) series Soft Limit: 50% of target Hard Limit: 25% of target Overfishing threshold: F_{MSY} compatible proxy based on the mean relative exploitation rate for the period: 1995–96 to 2011–12
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 Stock Status Trajectory and Current Status



Top panel: landings (open circles) and standardised CPUE (combined model using tow by tow data from 1995–96, ±2 s.e.). The green, yellow and red horizontal lines represent the target, soft and hard limits, respectively. Bottom panel: annual relative exploitation rate (landings divided by standardised CPUE and normalised to a geometric mean of one) for red gurnard in the Bay of Plenty. The horizontal green line represents the average relative exploitation rate during the period used to define the reference points (depicted by vertical dotted lines).

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. There was an increase from low levels in 1996–97 to a peak in 2000–01, and a subsequent decline to similarly low levels in 2002-03. The index has since increased and is currently near the target.
Recent Trend in Fishing Intensity or Proxy	Relative exploitation rate has fluctuated without trend around the long-term mean since 1995–96.
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 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 if the catch were to increase to the level of the TACC

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: 2017	Next assessment: 2020
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. This makes it difficult to predict future trends without recruitment information. Given that the catch levels observed from 1986–87 to 2015–16 has been relatively consistent 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.

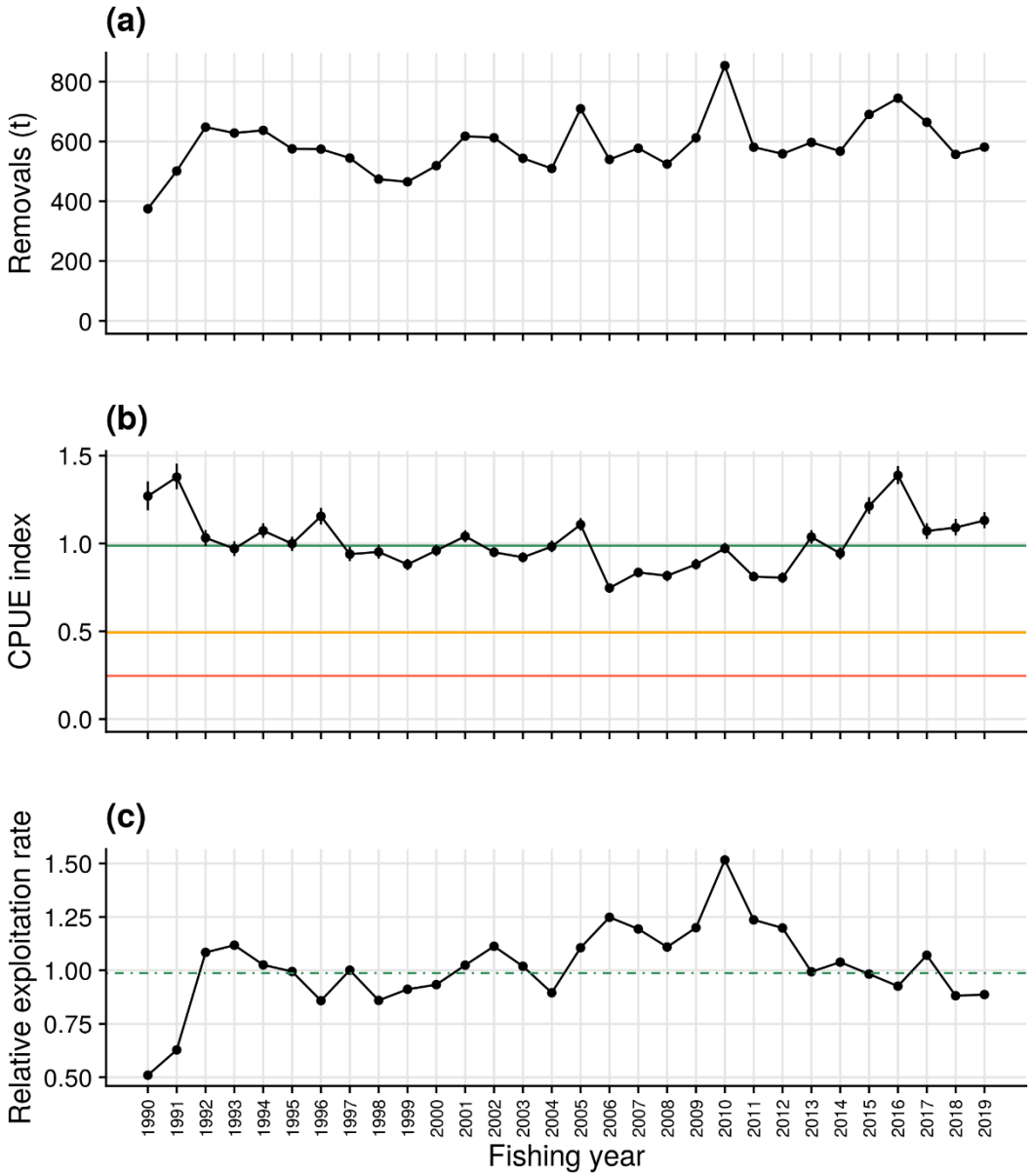
Fishery Interactions
Red gurnard is taken as a bycatch in the Bay of Plenty mainly by bottom longline targeted at snapper, with the balance taken almost equally by bottom trawl and Danish seine targeting snapper and John dory. Interactions with other species are currently being characterised.

- **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	2020
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 2017–18 Soft Limit: 50% of target Hard Limit: 25% of target Overfishing threshold: F_{MSY} compatible proxy based on the mean relative exploitation rate for the period 1990–91 to 2017–18
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: Very Unlikely (< 10%) to be below Hard Limit: Very Unlikely (< 10%) to be below
Status in relation to Overfishing	Overfishing is About as Likely as Not (40–60%) to be occurring

Historical Stock Status Trajectory and Current Status



(a) annual removals for GUR 2; (b) the standardised catch per unit effort (CPUE) index, relative to the agreed reference points, for GUR 2 from bottom trawling targeting gurnard, snapper and trevally (BT-MIX) and combining data from all form types at a daily aggregation; (c) annual relative exploitation rate (catch/CPUE) gurnard in GUR 2.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	CPUE indices generally trended downwards between 1990 and 2007, then flattened to 2012, with a strong increase to 2016. Standardised CPUE decreased to just above the target in 2016–17 and showed a slight increase to 2018–19.
Recent Trend in Fishing Intensity or Proxy	Relative exploitation rate increased gradually from 1989–90 to 2009–10, dropped to around the long-term average in 2013–14, and has been below the long-term average since 2017–18.
Other Abundance Indices	Tow based analysis of 2007–08 to 2018–19 data closely resembles the mixed form type analysis.
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 Biomass to remain below or to decline below Limits	Soft Limit: Unlikely (< 40%) Hard Limit: Very Unlikely (< 10%) Unknown if the catch were to increase to the level of the TACC
Probability of Current Catch or TACC causing Overfishing to continue or to commence	About as Likely as Not (40–60%) for current catch Unknown if the catch were to increase to the level of the TACC

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE	
Assessment Dates	Latest assessment: 2020	Next assessment: 2021
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	BT-Mix CPUE series	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	-	

Qualifying Comments
Most of the GUR2 commercial catch is made in Hawke Bay, and the index of abundance is naturally weighted to abundance of GUR in this area.

Fishery Interactions
Red gurnard is taken in FMA 2 by the bottom trawl fishery targeting gurnard and tarakihi.

- **GUR 3**

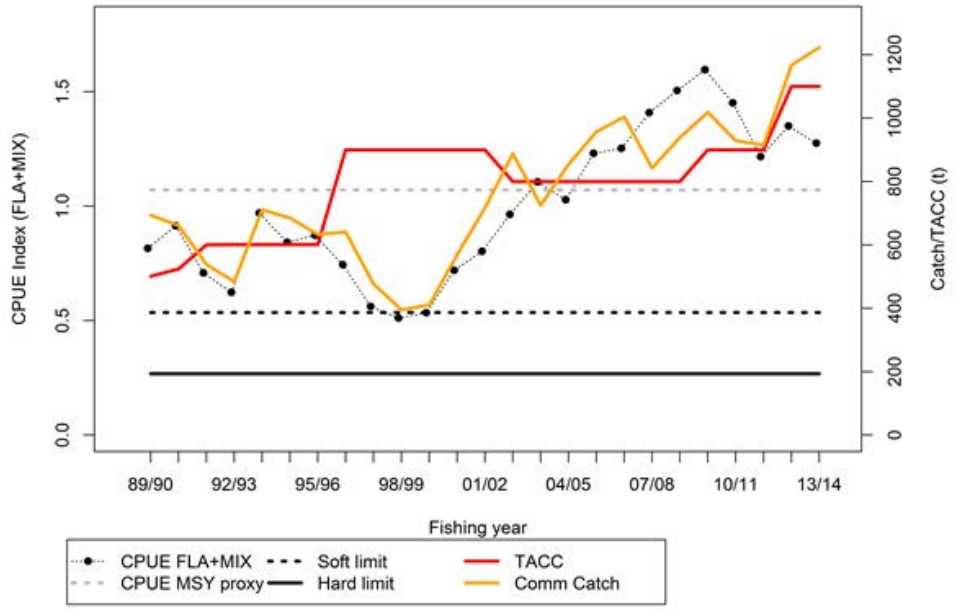
Stock Structure Assumptions

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

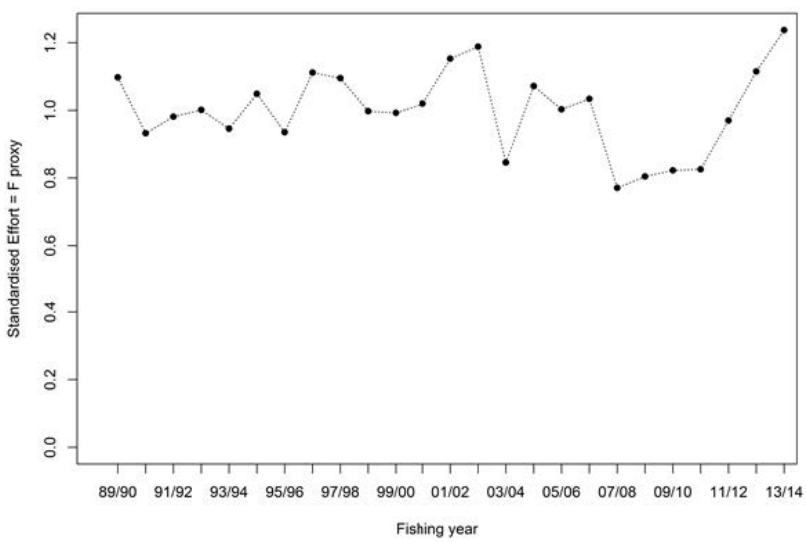
Stock Status	
Year of Most Recent Assessment	2015
Assessment runs presented	The CPUE series BT(MIX+FLA), which is the mean of two standardised bottom trawl CPUE series: one based on bottom trawls targeting mixed species (RCO, STA, BAR, TAR, GUR) and the other based on flatfish targeting.
Reference Points	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 (2013) 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 RCO, STA, BAR, TAR, GUR), 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 (30–400 m) shows a substantial increase since the early 1990s, declining in 2016, but increasing again in 2018. The expanded survey (10–400 m) shows a marked increase from 2007–2014, but declining in 2016 and then increasing in 2018 (n = 5).
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: 2021
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. A variable proportion of the population in the previously unsurveyed 10–30 m depth range suggests that survey catchability varies between years in the core survey area (30–400 m).	

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. Interactions with other species are currently being characterised.

- **GUR 7**

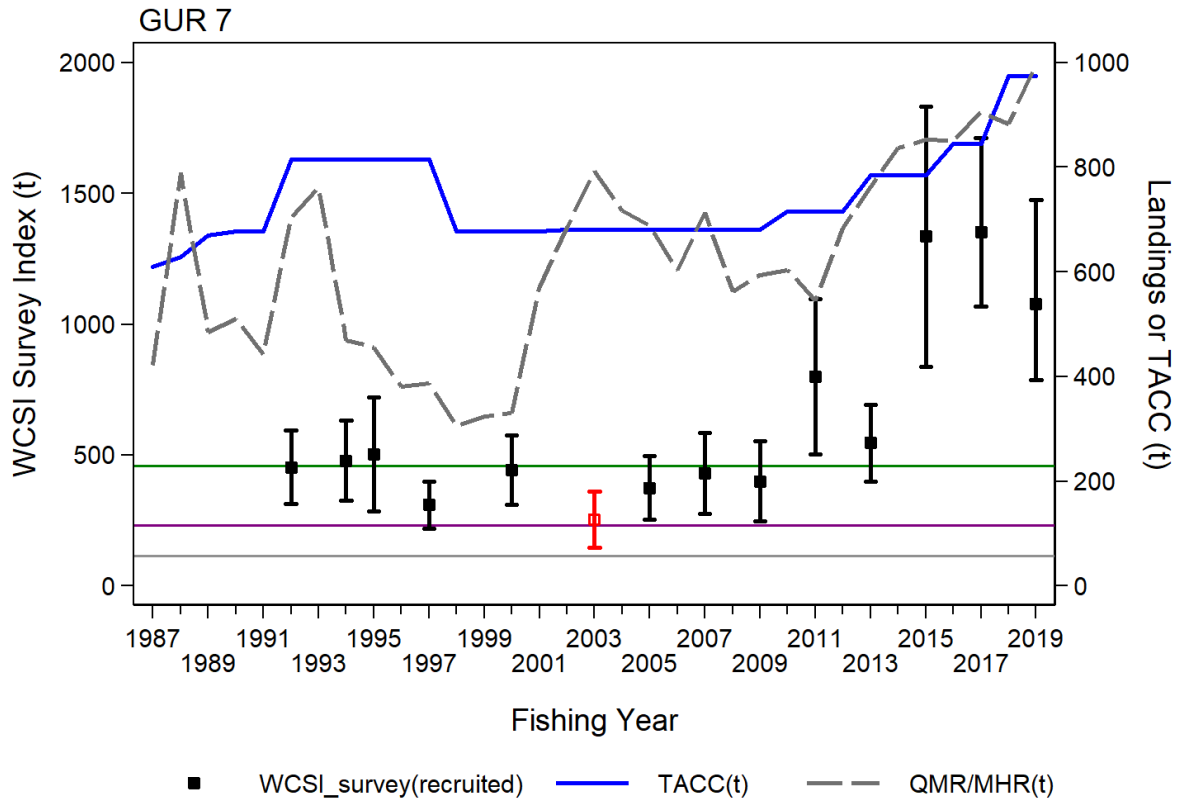
Stock Structure Assumptions

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

Advice for GUR 7 is based on the biomass series for the recruited portion of the total WCSI trawl survey.

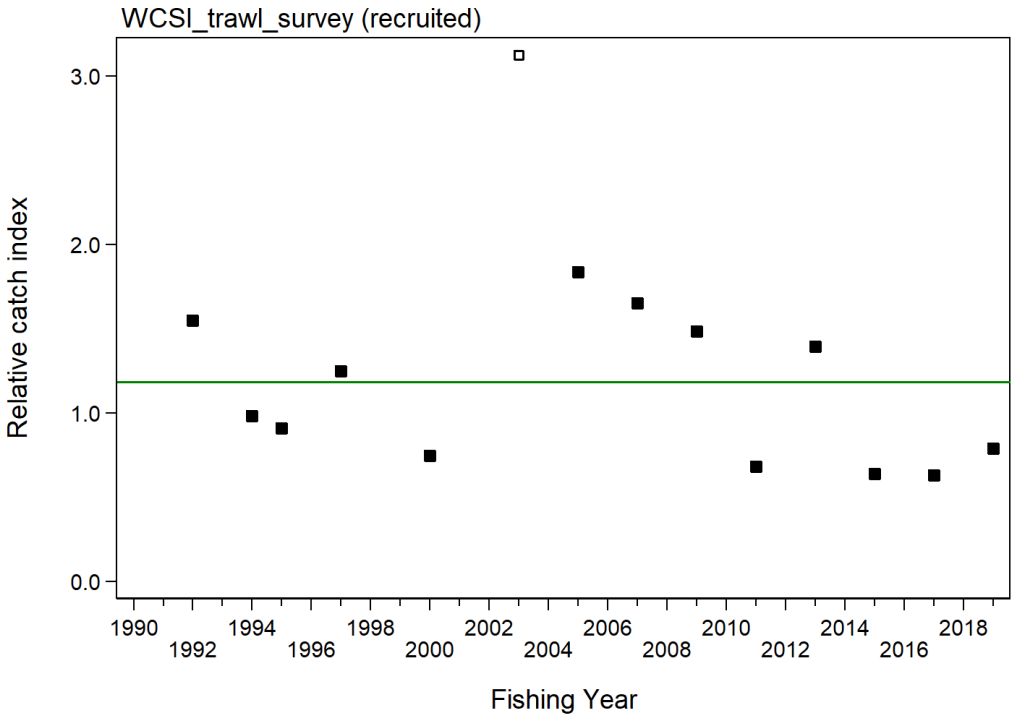
Stock Status	
Year of Most Recent Assessment	2019
Assessment runs presented	West Coast South Island trawl survey
Reference Points	Target: B_{MSY}-compatible proxy based on the mean WCSI trawl survey indices from 1992 to 2013, but excluding the 2003 index Soft Limit: 50% target Hard Limit: 25% target Overfishing threshold: F_{MSY} compatible proxy based on the WCSI trawl survey mean relative exploitation rate from 1992 to 2013, excluding the 2003 index
Status in relation to Target	Very Likely (> 90%) to be at or 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	Overfishing is Unlikely (< 40%) to be occurring

Historical Abundance and Catch Trajectories

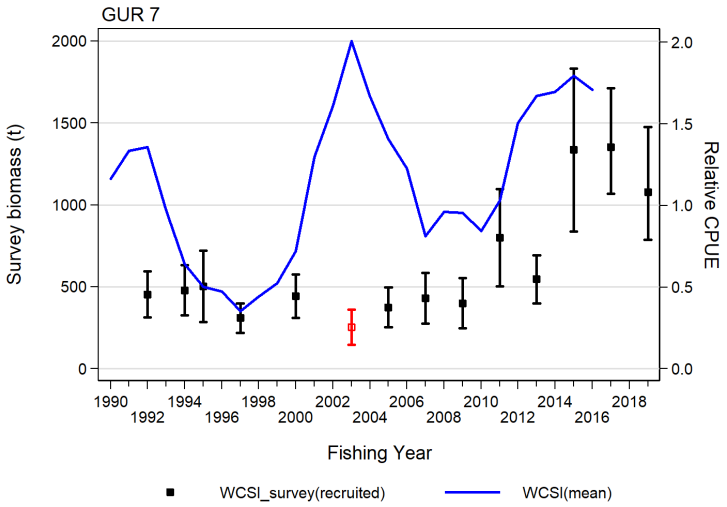


Comparison of the GUR WCSI trawl survey indices with the QMR/MHR landings and TACC for GUR 7. The agreed BMSY proxy (geometric average: 1992–2013 (excluding 2003) WCSI survey biomass estimates=460 t) is shown as a green line; the calculated Soft Limit (=0.5xBMSY proxy) is shown as a purple line; the calculated Hard Limit (=0.25xBMSY proxy) is shown as a grey line. The excluded 2003 survey is shown in red with a hollow marker.

Fishing Intensity Trajectories



Relative fishing pressure for GUR 7 based on the ratio of QMR/MHR landings relative to the WCSI trawl survey (recruited). Horizontal green line is the geometric mean fishing pressure from 1992 to 2013, excluding 2003. Fishing pressure for the excluded 2003 survey is shown as a hollow marker.

Fishery and Stock Trends	
Recent trend in Biomass or Proxy	The west coast South Island trawl survey relative biomass indices from 2015 and 2017 were by far the highest of the entire time series. While the 2019 index dropped relative to the 2017 index, it still remains well above the B_{MSY} proxy target.
Recent trend in Fishing Intensity or Proxy	Unlikely (< 40%) that overfishing is occurring as biomass has increased considerably since 2009–10 while there has been only a moderate increase in annual catches.
Other Abundance Indices	WCSI CPUE indices increased from 2009–10 to 2015–16.  **Mean WCSI-BT(FLA+MIX) CPUE series compared with WCSI(recruited) trawl survey. Excluded 2003 survey index shown in red with hollow marker.**
Trends in Other Relevant Indicators or Variables	Estimates of pre-recruit fish from the West Coast South Island inshore trawl survey indicate that recruitment has been increasing since about 2005 and is currently well above average.

Projections and Prognosis	
Stock Projections or Prognosis	Quantitative stock projections are unavailable. However, above average recruitment is likely to ensure continuing high biomass at current catch levels, at least in the short term.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Very Unlikely (< 10%) 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	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: 2019	Next assessment: 2021 (trawl survey)
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	- Tasman and Golden Bay survey data combined into the WCSI survey series - WCSI trawl survey series given precedence over the CPUE series for monitoring abundance - Use of the WCSI survey only to derive reference points CPUE used to provide corroboration
Major Sources of Uncertainty	- Choice of the period used to derive reference points

Qualifying Comments
Red gurnard are a survey target of the west coast South Island trawl survey and the Plenary regards the series as a reliable index of abundance. Trends in CPUE indices are broadly consistent with trends in trawl survey biomass, particularly since the late 2000s, corroborating the recent increase.

Fishery Interactions
Red gurnard are primarily taken in conjunction with the following QMS species: flatfish, barracouta, stargazer, red cod, tarakihi and other species in the West Coast South Island target bottom trawl fishery. Interactions with other species are currently being characterised.

6. FOR FURTHER INFORMATION

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