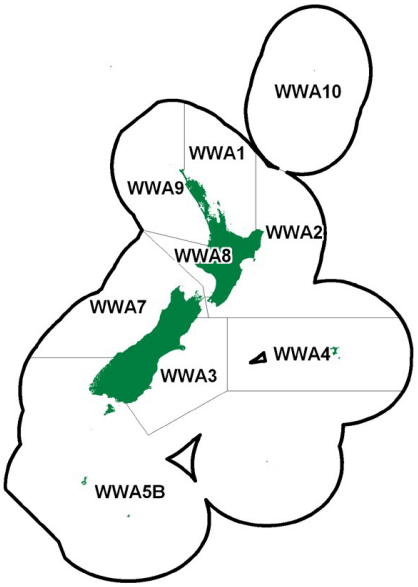
WHITE WAREHOU (WWA)

(Seriolella caerulea)
Warehou



1. FISHERY SUMMARY

1.1 Commercial fisheries

White warehou are predominantly taken as bycatch from target trawl fisheries on hoki and silver warehou, and to a lesser extent, hake, ling, and scampi. White warehou are mostly caught in 150 to 800 m depth by larger vessels owned or chartered by New Zealand fishing companies.

Prior to the establishment of the EEZ on 1 March 1978, white warehou landings were combined with both silver and blue (or common) warehou as 'warehous'. An estimate of total white warehou catches for 1970 to 1977 calendar years has been made (Table 1). From 1978–79 to 1982–83 annual catches of up to 900 t during the fishing year were reported, mainly from Southland and the Chatham Rise (Table 2).

Table 1: Estimated catch (t) of white warehou for years 1970 to 1977.

Vessel nationality	1970*	1971*	1972	1973	1974	1975	1976	1977
Japanese	17	25	222	447	234	1 453	1 558	334
Russian	NA	NA	1 300	1 200	1 480	40	440	1 260
Korean	-	-	-	-	-	-	-	400
Total	17	25	1 522	1 647	1 714	1 493	1 998	1 994

* Japanese data only.

Annual catches of white warehou have been variable, ranging from 315 t in the 1978–79 fishing year to 3694 t in 1996–97 (Tables 2 and 3). White warehou entered the Quota Management System on 1 October 1998, with an initial Total Allowable Commercial Catch (TACC) of 3374 t. The TACCs for each QMA are given in Table 3. A nominal allowance of 1 t was made for both recreational and customary catch in each of WWA 2–7. TACCs were increased from 1 October 2006 in WWA 3 to 583 t, in WWA 4 to 330 t, and in WWA 7 to 127 t. In these stocks, landings had previously been above the TACC for a number of years; the TACCs were increased to the average of the previous 7 years plus an additional 10%. Despite this change the catch in WWA 3 in 2006–07 was well above the new TACC, but has been under the TACC since 2007–08. From 1 October 2007, WWA 5 was merged with WWA6 to create WWA 5B, with a TACC of 2617 t. TACCs have been under-caught in WWA 4 and 5B in

recent years. In WWA 7 landings have fluctuated, approaching the available quota in the fishing years 2012–13 and 2013–14, and exceeding it in 2017–18. In contrast, landings have been less than 50 t since 2018–19, and were only 9 t in 2021–22, the lowest reported annual landing in the series. Figure 1 shows the historical landings and TACC values for the main white warehou stocks.

Table 2: Reported landings (t) of white warehou by fishing year and area, by foreign licensed and joint venture vessels, 1978–79 to 1983–83. The EEZ areas correspond approximately to the QMAs as indicated. Fishing years are from 1 April to 31 March. The 1983–83 is a six month transitional period from 1 April to 30 September. No data are available for the 1980–81 fishing year.

EEZ area	B	C(M)	C(1)	D	E(B)	E(P)	E(C)	E(A)	F(E)	F(W)	G	H	
QMA area	1& 2		3	4				6		5	7	8 & 9	Total
1978–79	1	20	10	1	0	5	0	141	86	26	20	6	315
1979–80	2	8	5	230	57	5	4	312	34	97	42	0	795
1980–81	-	-	-	-	-	-	-	-	-	-	-	-	-
1981–82	0	41	2	53	0	2	5	153	27	248	10	1	542
1982–83	0	375	1	88	0	11	0	198	39	137	33	0	882
1983–84	0	167	5	49	0	0	0	12	9	34	24	0	300

Note: The EEZ area E(A) also included part of QMA 5, south of 48º30' S.

Table 3: Reported landings (t) of white warehou by fishstock and fishing year, 1982–83 to 2019–20. The data in this table has been updated from that published in previous Plenary Reports by using the data through 1996–97 in table 44 on p. 296 of the "Review of Sustainability Measures and Other Management Controls for the 1998–99 Fishing Year - Final Advice Paper" dated 6 August 1998. Data since 1997–98 are based on catch and effort returns. There are no landings reported from QMA 10. [Continued on next page]

Fishstock	WWA 1		WWA 2		WWA 3		WWA 4		WWA 5(5B)*	
FMA	1		2		3		4		5 (&6)*	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1982–83	0	-	35	-	179	-	69	-	248	-
1983–84	0	-	28	-	111	-	33	-	282	-
1984–85	0	-	2	-	123	-	39	-	150	-
1985–86	0	-	5	-	589	-	61	-	277	-
1986–87	0	-	10	-	239	-	29	-	167	-
1987–88	< 1	-	9	-	431	-	26	-	113	-
1988–89	6	-	1	-	118	-	43	-	843	-
1989–90	1	-	9	-	484	-	16	-	555	-
1990–91	2	-	12	-	695	-	88	-	568	-
1991–92	6	-	22	-	589	-	113	-	833	-
1992–93	2	-	13	-	281	-	106	-	560	-
1993–94	6	-	34	-	197	-	23	-	1 235	-
1994–95	4	-	41	-	327	-	243	-	1 936	-
1995–96	2	-	68	-	566	-	137	-	1 555	-
1996–97	3	-	89	-	508	-	220	-	2 309	-
1997–98	2	-	31	-	516	-	153	-	1 217	-
1998–99	< 1	4	34	73	398	399	120	220	1 269	2 127
1999–00	< 1	4	48	73	559	399	277	220	1 112	2 127
2000–01	< 1	4	21	73	661	399	303	220	703	2 127
2001–02	0	4	8	73	446	399	262	220	921	2 127
2002–03	< 1	4	20	73	852	399	397	220	1 462	2 127
2003–04	< 1	4	47	73	458	399	365	220	1 141	2 127
2004–05	< 1	4	24	73	347	399	365	220	1 568	2 127
2005–06	< 1	4	35	73	589	399	312	220	1 176	2 127
2006–07	< 1	4	10	73	733	583	304	330	1 484	2 127
2007–08	< 1	4	43	73	345	583	207	330	*1 431	*2 617
2008–09	< 1	4	22	73	302	583	85	330	1 644	2 617
2009–10	< 1	4	7	73	355	583	179	330	1 106	2 617
2010–11	< 1	4	12	73	391	583	81	330	787	2 617
2011–12	< 1	4	3	73	204	583	112	330	978	2 617
2012–13	< 1	4	6	73	174	583	117	330	1 037	2 617
2013–14	< 1	4	8	73	302	583	110	330	1 373	2 617
2014–15	< 1	4	7	73	225	583	69	330	447	2 617
2015–16	< 1	4	5	73	269	583	51	330	699	2 617
2016–17	< 1	4	5	73	288	583	52	330	637	2 617
2017–18	< 1	4	6	73	282	583	57	330	649	2 617
2018–19	< 1	4	5	73	212	583	91	330	681	2 617
2019–20	< 1	4	3	73	185	583	72	330	336	2 617
2020–21	< 1	4	6	73	123	583	34	330	633	2 617
2021–22	< 1	4	2	73	204	583	47	330	437	2 617
2022–23	< 1	4	2	73	120	583	88	330	413	2 617

Table 3 [Continued]:

Fishstock	WWA 6		WWA 7		WWA 8		WWA 9			
FMA	6		7		8		9		Total	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1982–83	7	-	24	-	<1	-	0	-	562	-
1983–84	24	-	29	-	<1	-	0	-	510	-
1984–85	12	-	15	-	<1	-	0	-	342	-
1985–86	43	-	81	-	<1	-	0	-	1 058	-
1986–87	144	-	15	-	<1	-	0	-	573	-
1987–88	20	-	28	-	<1	-	0	-	629	-
1988–89	16	-	10	-	0	-	0	-	1 040	-
1989–90	291	-	83	-	0	-	0	-	1 438	-
1990–91	278	-	69	-	1	-	0	-	1 713	-
1991–92	1 028	-	45	-	0	-	0	-	2 636	-
1992–93	645	-	125	-	2	-	0	-	1 734	-
1993–94	592	-	69	-	0	-	0	-	2 156	-
1994–95	185	-	80	-	0	-	0	-	2 816	-
1995–96	50	-	62	-	0	-	0	-	2 440	-
1996–97	494	-	71	-	0	-	0	-	3 694	-
1997–98	126	-	98	-	< 1	-	< 1	-	2 155	-
1998–99	412	490	73	60	< 1	1	0	0	2 306	3 374
1999–00	211	490	153	60	< 1	1	0	0	2 351	3 374
2000–01	119	490	90	60	< 1	1	0	0	1 897	3 374
2001–02	219	490	85	60	< 1	1	< 1	0	1 941	3 374
2002–03	457	490	158	60	0	1	0	1	3 346	3 374
2003–04	211	490	135	60	0	1	0	1	2 357	3 374
2004–05	436	490	123	60	< 1	1	0	1	2 863	3 374
2005–06	250	490	133	60	0	1	0	1	2 495	3 374
2006–07	563	490	121	127	0	1	0	0	3 215	3 735
2007–08	N/A	N/A	90	127	0	1	< 1	0	2 116	3 735
2008–09	N/A	N/A	110	127	< 1	1	< 1	0	2 164	3 735
2009–10	N/A	N/A	44	127	< 1	1	0	0	1 691	3 735
2010–11	N/A	N/A	52	127	< 1	1	0	0	1 324	3 735
2011–12	N/A	N/A	77	127	< 1	1	< 1	0	1 375	3 735
2012–13	N/A	N/A	118	127	< 1	1	0	0	1 452	3 735
2013–14	N/A	N/A	115	127	< 1	1	< 1	0	1 908	3 735
2014–15	N/A	N/A	98	127	0	1	0	0	846	3 735
2015–16	N/A	N/A	44	127	0	1	< 1	0	817	3 735
2016–17	N/A	N/A	87	127	0	1	0	0	1 069	3 735
2017–18	N/A	N/A	139	127	0	1	0	0	1 134	3 735
2018–19	N/A	N/A	40	127	< 1	1	< 1	0	1 029	3 735
2019–20	N/A	N/A	47	127	0	1	0	0	643	3 735
2020–21	N/A	N/A	21	127	0	1	< 1	1	818	3 736
2021–22	N/A	N/A	9	127	< 1	1	< 1	1	700	3 736
2022–23	N/A	N/A	27	127	0	1	< 1	1	651	3 736

* In 2007–08 WWA 5 was merged with WWA 6 to create WWA 5B. The landings and TACC for WWA 5B are presented after2007–08 in the WWA 5(5B)* column.

White warehou are almost entirely caught from 300–700 m bottom trawls targeted on hoki, squid, ling and silver warehou (Ballara & Baird 2012), with a smaller amount caught by midwater trawl. Until the introduction of electronic reporting by the > 28m trawl fleet on 1 October 2017, most catch was recorded on Trawl Catch Effort and Processing Returns. In 2013 and 2014, about 20% of the west coast South Island (WCSI) white warehou catch was reported on the TCER form (Ballara 2015). From 1990 to 2014, 52 238 t of white warehou catch was reported: 70% from the Sub-Antarctic area, 24% from off the east coast South Island (ECSI) and across the Chatham Rise, and 4% from the WCSI (Ballara 2015).

Target fishing on white warehou has been reported from around Mernoo Bank, the Stewart-Snares shelf, Puysegur Bank and on the west coast of the South Island, with the best catch rates recorded in the southern areas. Target fisheries accounted for only 8% of the total white warehou catch for the years from 1988–89 to 1994–95. In the Sub-Antarctic, 36% of catches are from target fishing, although since 2003 this has been over 50% in most years; the remainder was primarily from tows targeting ling, hoki, and silver warehou (Ballara 2015). The greatest catches in this area are from waters off the Stewart-Snares shelf, near the Puysegur Bank, and off the Auckland Islands Shelf. About 63% of the catch from off the ECSI and the Chatham Rise was from hoki target tows, with only 1% from white warehou targeted tows (Ballara 2015). The highest catches were from the east coast statistical areas. There appeared to be no definite season for white warehou catches in those areas. Catches off the WCSI were from bottom and mid-water hoki and hake tows, and were restricted to the months in which those target fisheries operated (June–September).

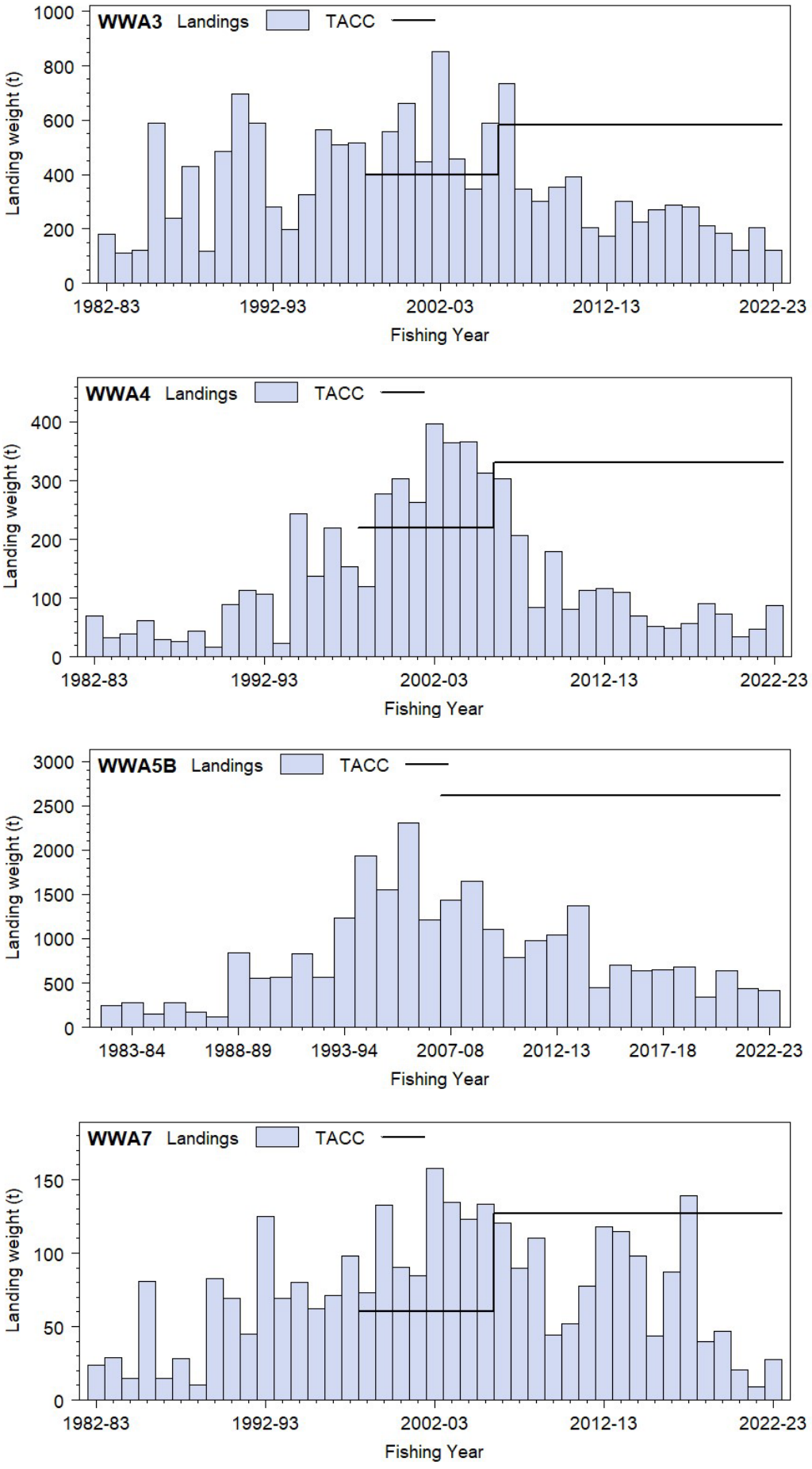


Figure 1: Reported commercial landings and TACC for the four main WWA stocks. WWA 3 (South East Coast), WWA 4 (South East Chatham Rise) and WWA 5B* (Southland, Sub-Antarctic) and WWA 7 (Challenger).

1.2 Recreational fisheries

The recreational take of white warehou is likely to be very small given its distribution and depth preferences.

1.3 Customary non-commercial fisheries

Quantitative information on the current level of customary non-commercial catch is not available but is likely to be negligible.

1.4 Illegal catch

Silver warehou were reported as white warehou when the latter was a non QMS species. Compliance investigations in 1988 successfully proved that substantial quantities of silver warehou were reported as white warehou, but catch statistics were not altered as a result. The true extent of misreporting is unknown.

1.5 Other sources of mortality

No information is available on other sources of mortality.

2. BIOLOGY

Adult white warehou range between 40 and 60 cm fork length (FL) and reach a maximum length and weight of 67 cm and 5.7 kg respectively. White warehou were aged by Gavrilov (1979) who gives the maximum age as 12 years, but this was likely to be an underestimate because he read whole otoliths and scales (Horn & Sutton 1996). Ageing of white warehou was partially validated by Horn (1999, 2001), based on a dataset of otoliths, covering all months of the year, collected during 1992–98 from the Chatham Rise and Sub-Antarctic. Growth of females is significantly faster than that of males and thus females are significantly larger at age than males (Horn 2001). Females also attain larger maximum size than males. Fish grow rapidly until they spawn (at about 3 or 4 years), and growth is much slower after 6–8 years (Horn 2001). Chong et al (2019) estimated length at 50% maturity for females at 43.5 cm from a study of white warehou in the austral zone off Chile. This result is consistent with Horn (2001) and Bagley & Hurst (1997) who estimated mean length at age in New Zealand waters as 38–39 cm at age 3 and 47 cm at age 4.

Table 4: Estimates of biological parameters of white warehou.

Fishstock									Estimate Source
1. Weight = a(length)^b (Weight in g, length in cm, total length).									
	Female				Male				Both sexes			
	a				b				a		b	
Chatham Rise	0.0177				3.069				0.0200		3.037	Horn (1999)
Sub-Antarctic	0.0106				3.197				0.0138		3.132	Horn (1999)
	0.0111				3.188							
2. von Bertalanffy growth parameters (4-parameter curve)												
	Female					Males						
	L_∞	k	t_0	P		L_∞	k	t_0	P			
Chatham Rise	61.0	0.131	0.14	0.350		57.1	0.153	0.19	0.328			Horn (2001)
Sub-Antarctic	70.2	.058	0.22	0.281		62.4	0.098	0.14	0.297			Horn (2001)

Instantaneous natural mortality (*M*) was estimated (using several methods) to be between 0.20 and 0.28, and to be higher for males than for females (Horn 1999). The Working Group considered the data inadequate for establishing a difference in M by sex and recommended the use of 0.25 for both sexes in stock assessment modelling with sensitivity tests of plus or minus 0.05.

Ripe and running ripe fish have been recorded from the ECNI, Chatham Rise, WCSI, off Puysegur, and in the Sub-Antarctic, especially off the Stewart-Snares shelf. Most ripe and running ripe females were seen in waters off the WCSI in July–October, in the Sub-Antarctic (off Puysegur and between the Stewart-Snares shelf and the Auckland Islands Shelf) in March–December, and the western Chatham Rise from May–October) (Ballara 2015). These data suggest that the spawning season may extend from winter to late spring, or that there are multiple stocks with differences in the timing of their spawning seasons.

Sex ratio data derived from scaled length frequencies appear to show a slight bias towards males. On the Chatham Rise sex ratios vary from 1.0:1 to 1.4:1 (males to females). In the southern area, ratios vary from 0.7:1 to 4.2:1, but sample sizes at either extreme of the range are very small. There are insufficient data to enable detection of any changes in sex ratio with season.

Feeding records from the Fisheries New Zealand research database *trawl* show salps as the predominant prey item observed in white warehou stomachs. Gavrilov & Markina (1979) noted salps (*Iasis*) and the tunicate *Pyrosoma* as major food items. Horn et al (2011) found that the diet on the Chatham Rise was dominated by pelagic tunicates (mainly *Iasis* and *Salpa* species), with the remainder comprising mostly small crustaceans (amphipods, copepods, and euphausiids). An unknown but small component of the crustacean prey was ingested unintentionally owing to a common commensal relationship between some crustaceans (primarily amphipods) and tunicates.

3. STOCKS AND AREAS

The existence of three possible spawning areas for white warehou (Mernoo Bank, Puysegur Bank and the west coast of the South Island) at the same time of year, suggests the possibility of three separate stocks. Bagley & Hurst (1997) proposed the following Fishstock areas: WWA 1 (QMAs 1, 2, 3 and 4), WWA 5 (QMAs 5 and 6) and WWA 7 (QMAs 7, 8 and 9) for white warehou. However, TACs were set for each QMA (1–9) in 1998 and each Fishstock is managed separately (note WWA 5 and WWA 6 were merged to form Fishstock WWA 5B in 2007–08).

4. STOCK ASSESSMENT

No assessments are available for any stocks for white warehou, therefore estimates of biomass and yield are not available.

4.1 Estimates of fishery parameters and abundance

Several time series of relative abundance estimates are available from trawl surveys (Table 5), but these estimates may not be reliable indicators of relative abundance because of large fluctuations between years and moderate to high CVs. The larger biomass estimates are generally associated with moderate to high CVs (i.e., over 40%), having resulted from one or two large catches. Smaller biomass estimates have lower CVs, but this could be because the survey missed the main white warehou schools.

Table 5: Biomass indices (t) for white warehou from trawl surveys. Trip codes starting 'KAH': *Kaharoa* surveys; trip codes starting 'TAN': *Tangaroa* surveys. [Continued on next page]

Trip code	Depth Range (m)	Survey dates	Biomass index (t)	CV (%)
QMA 3				
ECSI				
KAH9105	30–400	May–Jun 1991	-	-
KAH9205	30–400	May–Jun 1992	1	100
KAH9306	30–400	May–Jun 1993	11	49.2
KAH9406	30–400	May–Jun 1994	32	45.3
KAH9606	30–400	May–Jun 1996	2	48.0
KAH0705	10–400	May–Jun 2007	1	86.7
KAH0806	10–400	May–Jun 2008	5	53.2
KAH0905	10–400	May–Jun 2009	1	68.2
KAH1207	10–400	Apr–Jun 2012	13	68.6
KAH1402	10–400	Apr–Jun 2014	8	98.9
KAH1605	10–400	Apr–Jun 2016	6	44.9
KAH1803	10–400	Apr–Jun 2018	1	100
KAH2104	10–400	Apr–Jun 2021	0	100
Chatham Rise	Core strata			
TAN9106	200–800	Dec 1991–Feb 1992	2 227	29.5
TAN9212	200–800	Dec 1992–Feb 1993	2 827	47.1
TAN9401	200–800	Jan 1994	1 613	27.0
TAN9501	200–800	Jan–Feb 1995	752	25.4

Table 5 [Continued]:

Trip code	Depth Range (m)	Survey dates	Biomass index (t)	CV (%)
Chatham Rise	Core strata			
TAN9601	200–800	Dec 1995–Jan 1996	533	23.6
TAN9701	200–800	Jan 1997	2 287	20.0
TAN9801	200–800	Jan 1998	1 017	23.3
TAN9901	200–800	Jan 1999	3 136	40.7
TAN0001	200–800	Dec 1999–Jan 2000	2 385	23.8
TAN0101	200–800	Dec 2000–Jan 2001	4 262	36.3
TAN0201	200–800	Dec 2001–Jan 2002	6 881	44.7
TAN0301	200–800	Dec 2002–Jan 2003	3 685	33.5
TAN0401	200–800	Dec 2003–Jan 2004	7 932	44.2
TAN0501	200–800	Dec 2004–Jan 2005	4 542	24.6
TAN0601	200–800	Dec 2005–Jan 2006	2 929	29.4
TAN0701	200–800	Dec 2006–Jan 2007	2 853	21.4
TAN0801	200–800	Dec 2007–Jan 2008	1 899	28.3
TAN0901	200–800	Dec 2008–Jan 2009	3 667	33.0
TAN1001	200–800	Jan 2010	983	20.9
TAN1101	200–800	Jan 2011	1 861	53.9
TAN1201	200–800	Jan 2012	1 925	32.0
TAN1301	200–800	Jan 2013	2 030	32.7
TAN1401	200–800	Jan 2014	1 299	33.7
TAN1601	200–800	Jan 2016	2 760	23.5
TAN1801	200–800	Jan 2018	2 102	36.0
TAN2001	200–800	Jan 2020	1 683	48.6
TAN2201	200–800	Jan 2022	2 403	31.6
QMA 5				
Sub-Antarctic				
TAN9105	300–1000	Nov–Dec 1991	1 605	58.1
TAN9211	300–1000	Nov–Dec 1992	243	25.7
TAN9310	300–1000	Nov–Dec 1993	293	27.9
TAN0012	300–1000	Nov–Dec 2000	266	38.7
TAN0118	300–1000	Nov–Dec 2001	2 433	53.7
TAN0219	300–1000	Nov–Dec 2002	863	23.9
TAN0317	300–1000	Nov–Dec 2003	709	58.4
TAN0414	300–1000	Nov–Dec 2004	1 061	30.8
TAN0515	300–1000	Nov–Dec 2005	538	38.5
TAN0617	300–1000	Nov–Dec 2006	646	25.8
TAN0714	300–1000	Nov–Dec 2007	1 707	61.3
TAN0813	300–1000	Nov–Dec 2008	2 293	39.6
TAN0911	300–1000	Nov–Dec 2009	2 093	35.3
TAN1117	300–1000	Nov–Dec 2011	393	26.5
TAN1215	300–1000	Nov–Dec 2012	1 259	28.7
TAN1412	300–1000	Nov–Dec 2014	211	39.5
TAN1614	300–1000	Nov–Dec 2016	-	-
TAN1811	300–1000	Nov–Dec 2018	781	34.8
TAN2014	300–1000	Nov–Dec 2020	429	35.9
QMA 7				
WCSI inshore				
KAH9006	20–400	Mar–Apr1990	-	-
KAH9204	20–400	Mar–Apr1992	2	35.7
KAH9404	20–400	Mar–Apr1994	-	-
KAH9504	20–400	Mar–Apr1995	9	47.0
KAH9701	20–400	Mar–Apr1997	-	-
KAH0004	20–400	Mar–Apr2000	-	-
KAH0304	20–400	Mar–Apr2003	-	-
KAH0503	20–400	Mar–Apr2005	0	100
KAH0704	20–400	Mar–Apr2007	-	-
KAH0904	20–400	Mar–Apr2009	-	-
KAH1104	20–400	Mar–Apr2011	-	-
KAH1305	20–400	Mar–Apr2013	-	-
KAH1503	20–400	Mar–Apr2015	-	-
KAH1703	10–400	Mar–Apr2017	-	-
KAH1902	10–400	Mar–Apr2019	-	-
KAH2103	10–400	Mar–Apr2021	-	-
WCSI offshore				
TAN0007	300–650	Jul–Aug 2000	12	50.9
TAN1210	200–800	Jul–Aug 2012	65	34.2
TAN1308	200–800	Jul–Aug 2013	26	26.9
TAN1609	200–1000	Aug 2016	20	38.2
TAN1807	200–1000	Jul–Aug 2018	14	44.6
TAN2107	200–1050	Aug 2021	51	39.2

Table 5 [Continued]:

Trip code	Depth Range (m)	Survey dates	Biomass index (t)	CV (%)
Discontinued surveys QMA 5				
Sub-Antarctic Autumn				
TAN9204	300–1000	Apr–May 1992	256	
TAN9304	300–1000	May–Jun 1994	907	
TAN9605	300–1000	Mar–Apr 1996	239	
TAN9805	300–1000	Apr–May 1998	2 887	
Sub-Antarctic Spring				
TAN9209	300–800	Sep–Oct 1992	350	
Southland				
TAN9301	30–600	Feb–Mar 1993	18	
TAN9402	30–600	Feb–Mar 1994	46	
TAN9502	30–600	Feb–Mar 1995	2	
TAN9604	30–600	Feb–Mar 1996	102	

Chatham Rise (WWA 4)

No white warehou have been caught outside of the core Chatham Rise strata, suggesting that the core strata adequately encompass the depth range of white warehou on the Chatham Rise. The Chatham Rise trawl surveys show an increase in biomass up until 2004, then a decrease to 2010 and flat since then (Table 5, Figure 2). Although the CVs are quite high, the period of increased abundance coincided with stronger recruitment of small fish to the shallow strata in 2001 and 2002 and to the deeper strata in 2004. The length data from the surveys showed the progression of a mode from 30 cm in 2001 to 45 cm in 2004 (Figure 3). Modes from length frequencies of Chatham Rise fish were considered to represent consecutive year classes by Horn (2001): at 18–21 cm, 30–32 cm, 36–39 cm, and 41–44 cm (Figure 3, years 2013, 2018 and 2022). In years where the survey is not dominated by younger ages, fish at all lengths up to the estimated $L\infty$ are represented. Length distributions of males and females are similar within a survey. The survey time series may be an adequate monitoring tool, despite the high CVs.

CPUE analyses were carried out for Chatham Rise, Sub-Antarctic fisheries and west coast South Island areas (Ballara 2015). The Chatham Rise stock showed increased CPUE from 1994 to 2006, but flatter since then (Table 6). The pattern did not match the trawl survey but neither series indicated a problem with WWA abundance in this area.

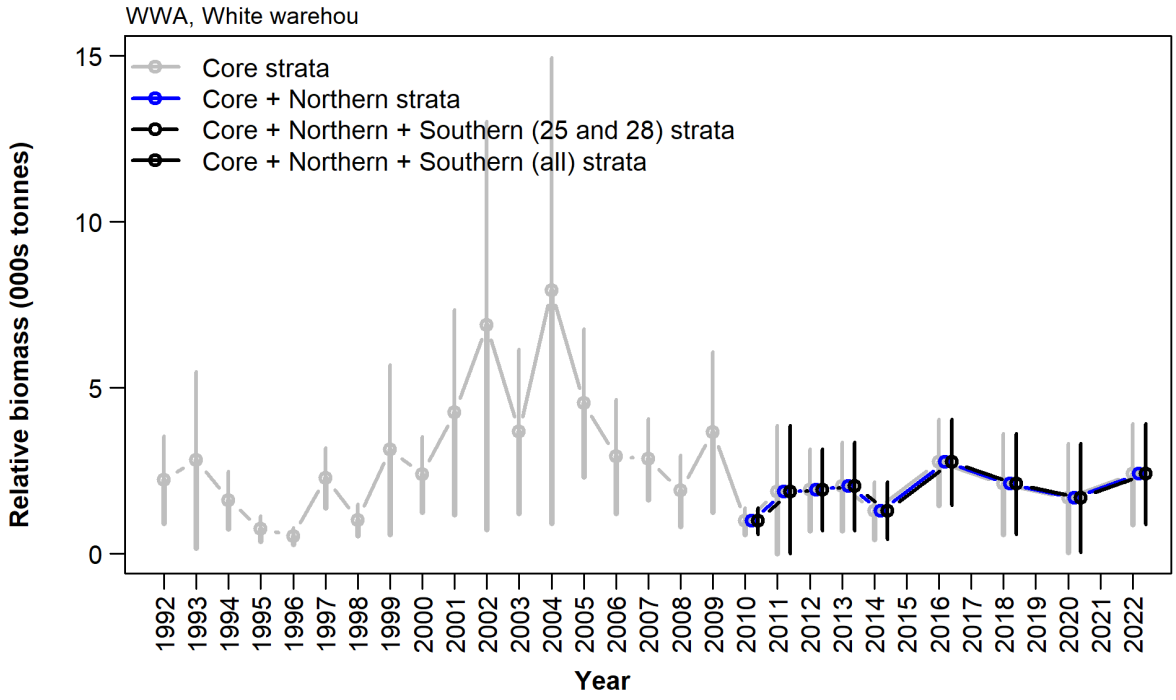


Figure 2: Doorspread biomass estimates, for all white warehou (± CV) from the Chatham Rise *Tangaroa* surveys from 1991–2014 and 2016, 2018, 2020 and 2022.

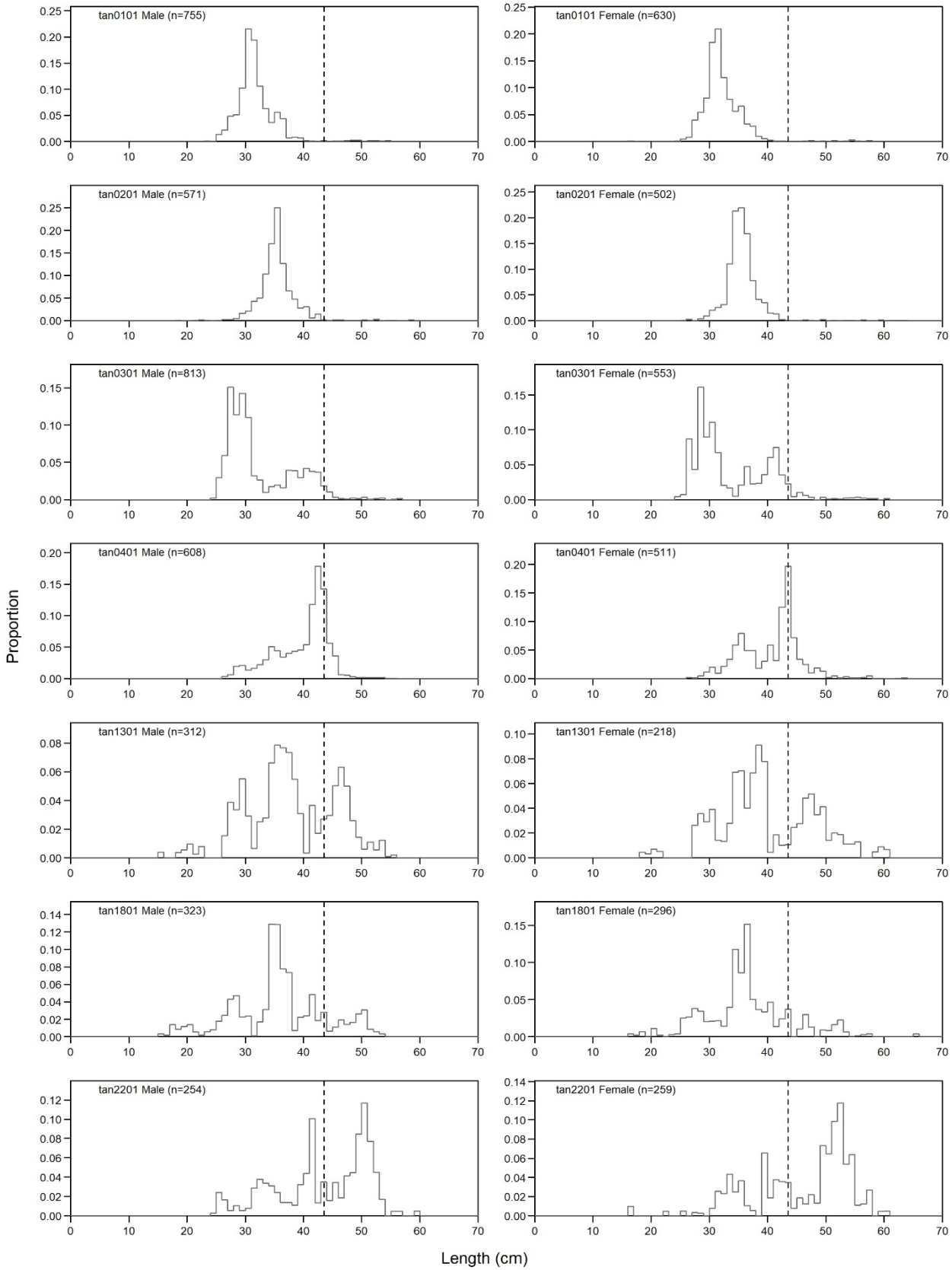


Figure 3: White warehou length frequencies from the Chatham Rise *Tangaroa* surveys. Length frequencies are shown from 2001-2004 to show progression of a mode from 30 cm in 2001 to 45 cm in 2004, then from 2013, 2018 and 2022 (years showing multiple length modes). Vertical line is at 43.5 cm (length at 50% maturity given by Chong et al 2019 for females).

Southland and Sub-Antarctic (WWA 5B)

The Sub-Antarctic summer biomass survey series does not appear to be useful to monitor abundance. Length modes donot follow through the series and CVs are high from occasional large catches. There is a concentration of catches along the edge of the Stewart-Snares shelf and the proportion of tows with positive catches is greatest at the shallowest depth of the survey, suggesting that the survey does not sample at sufficiently shallow depths (Figure 4). The minimum depth of tows in the Sub-Antarctic survey is 300 m while the Chatham Rise survey catches white warehou between 200 and 300 m depth. The autumn, spring, and Southland surveys have been discontinued.

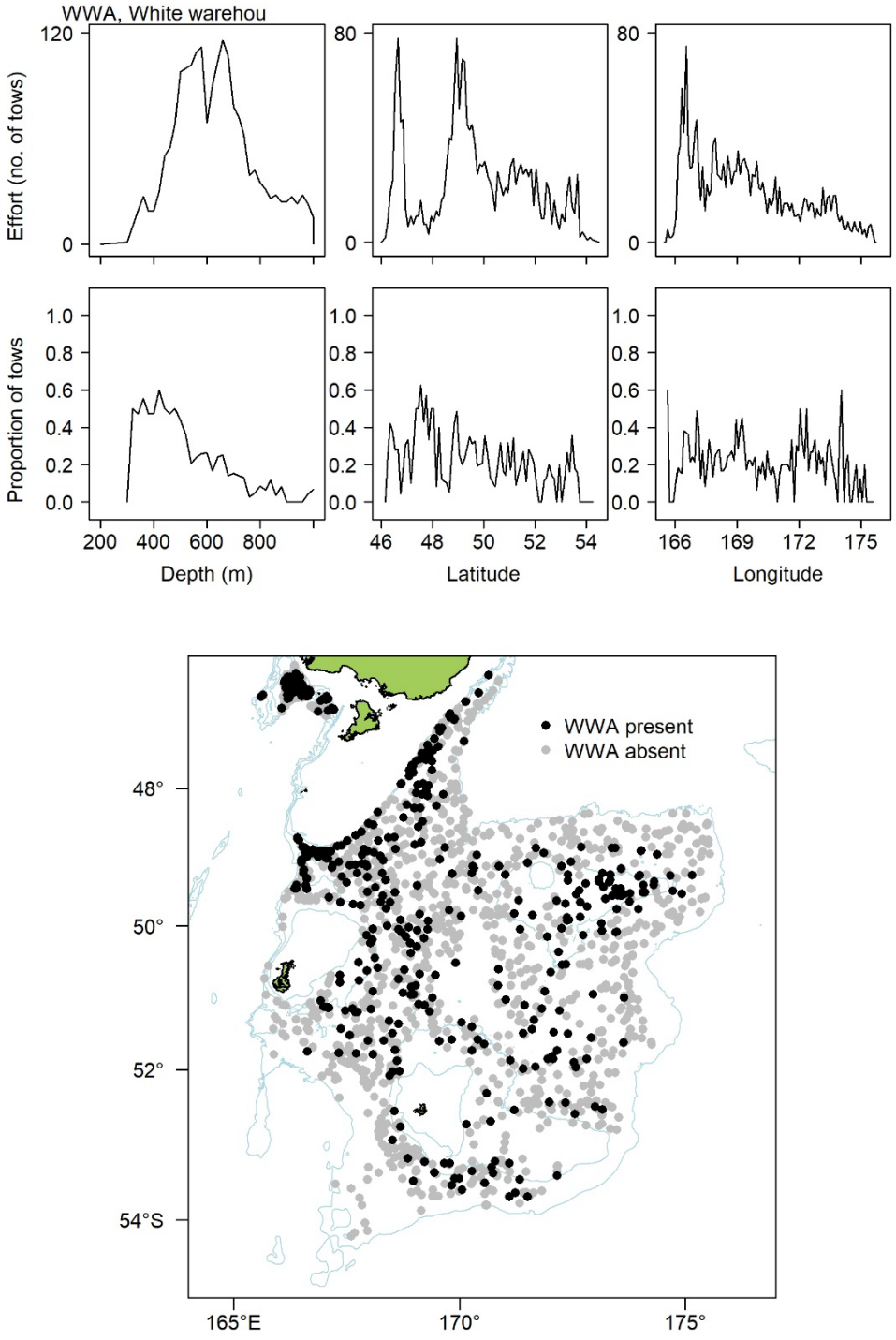


Figure 4: Distribution of positive white warehou catches from the summer sub-Antarctic survey.

CPUE analyses were carried out for Chatham Rise, Sub-Antarctic fisheries and west coast South Island areas (Ballara 2015). The Sub-Antarctic fishery showed an initial decline to 1997 but was relatively flat subsequently (Table 6). There are quite strong impacts of varying vessels and target species and the WG queried the reliability of the CPUE as abundance indicators.

Table 6: Chatham Rise, Sub-Antarctic, and west coast South Island TCEPR tow-by-tow lognormal, binomial and delta-lognormal CPUE indices by fishing year, where 1993– 94 is 1994.

Year	Chatham Rise			Sub-Antarctic			West coast South Island		
	Lognormal	Binomial	Delta lognormal	Lognormal	Binomial	Delta lognormal	Lognormal	Binomial	Delta lognormal
1992	-	-	-	1.73	0.32	2.11	-	-	-
1993	-	-	-	1.26	0.34	1.59	1.04	0.05	0.76
1994	0.67	0.03	0.22	2.00	0.20	1.53	1.12	0.10	1.44
1995	0.79	0.05	0.55	2.57	0.19	1.79	1.34	0.12	2.23
1996	0.71	0.05	0.42	2.69	0.19	1.96	1.29	0.07	1.25
1997	0.75	0.06	0.62	1.03	0.34	1.32	1.16	0.05	0.71
1998	0.75	0.06	0.58	0.80	0.24	0.72	1.22	0.08	1.33
1999	0.73	0.04	0.38	1.24	0.18	0.82	1.88	0.08	2.05
2000	0.82	0.06	0.62	0.93	0.18	0.64	1.26	0.12	2.05
2001	0.95	0.08	0.97	0.79	0.16	0.46	1.07	0.06	0.84
2002	0.87	0.07	0.82	0.67	0.21	0.53	1.07	0.07	1.05
2003	1.23	0.12	1.95	0.75	0.22	0.61	0.77	0.13	1,32
2004	1.34	0.12	2.01	0.75	0.20	0.55	0.95	0.09	1.17
2005	1.14	0.09	1.30	0.82	0.34	1.06	0.67	0.07	0.64
2006	1.45	0.10	1.94	0.87	0.31	1.02	0.81	0.09	1.00
2007	1.39	0.14	2.51	0.94	0.42	1.48	0.77	0.09	0.95
2008	1.10	0.09	1.30	0.93	0.40	1.39	1.14	0.05	0.75
2009	1.04	0.06	0.79	0.78	0.37	1.08	0.93	0.05	0.67
2010	1.22	0.05	0.77	0.79	0.38	1.11	0.75	0.04	0.42
2011	1.11	0.07	1.06	0.71	0.33	0.89	0.71	0.04	0.40
2012	1.16	0.05	0.75	0.63	0.31	0.73	0.99	0.05	0.70
2013	1.15	0.06	0.88	0.80	0.31	0.93	0.84	0.05	0.52
2014	1.20	0.07	1.12	0.83	0.32	1.01	0.90	0.04	0.43

West coast South Island (WWA 7)

The WCSI Tangaroa survey estimates low relative biomasses with large CVs (Figure 5). Given the prevalence of white warehou in sub-Antarctic waters it is possible that much of the WWA biomass is south of the southern-most limit of the survey so that these surveys may not be able to monitor thestock abundance in WWA 7.

CPUE analyses were carried out for Chatham Rise, Sub-Antarctic fisheries and west coast South Island areas (Ballara 2015). The CPUE series for west coast South Island indicates some decline between the early and mid to late 2000s (Table 6) but there is little data available for the WCSI fishery with low catches and many years with fewer than 100 records.

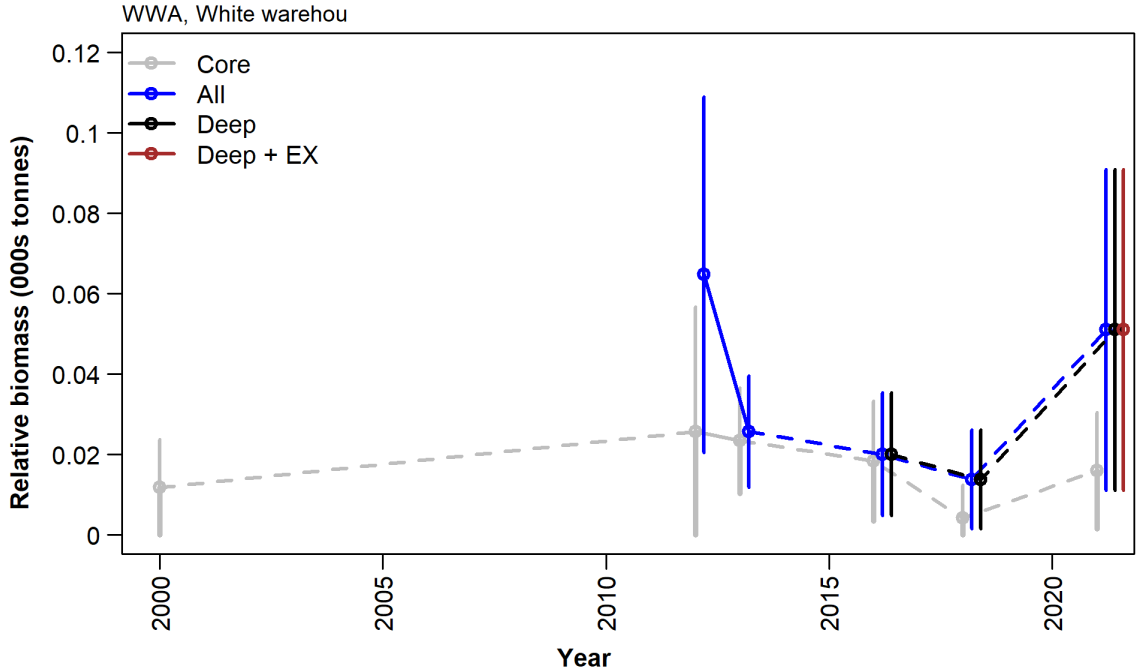


Figure 5: Doorspread biomass estimates, for all white warehou (± CV) from the WCSI *Tangaroa* surveys from 2000, 2012–2013 and 2016, 2018 and 2021.

1.1 Biomass estimates

No biomass estimates are available for white warehou.

1.2 Yield estimates and projections

MCY cannot be determined. Problems with misreporting of silver warehou as white warehou and the lack of consistent catch histories make *MCY* estimates based on catch data alone unreliable. Also the amount of effort on white warehou relates very closely to effort on other target species such as hoki and silver warehou. Large fluctuations in the availability of white warehou to the trawl, as indicated by trawl surveys, are also likely to apply to commercial fishing operations. Estimates of *M* are uncertain.

CAY cannot be estimated because of the lack of current biomass estimates.

1.3 Other factors

None

1.4 Future research considerations

Stock structure: Collection of length and gonad data on the Chatham Rise and Sub-Antarctic by observers could potentially provide a better indication of spawning areas and stock areas.

Establish a maturity ogive: Maturity of white warehou in New Zealand waters is considered to be at age 3 or 4 but no maturity ogive has been established. The only estimate of length at 50% maturity is available from a study on white warehou in Chilean waters.

Update CPUE analyses: Ballara (2015) completed CPUE analyses for the Chatham Rise, Sub-Antarctic and west coast South Island areas. For Chatham Rise the diagnostics of a standardized CPUE on both TCEPR tow-by-tow and observer tow-by-tow data were reasonable. At the time of the analyses it was concluded that the Chatham Rise models did not correlate well with the Chatham Rise trawl survey time series, but this conclusion was possibly influenced by a few large tows of young fish in the 2002 and 2004 surveys. Either of the Chatham Rise lognormal models could potentially be used to complement the Chatham Rise trawl survey time series. A lot of the white warehou CPUE data on Chatham Rise includes tows from the hoki target fishery. Any new CPUE analyses would need to carefully consider any changes in fishing practice in the hoki fishery. In the sub-Antarctic area it may be beneficial to focus on the squid targeted fishery. Effort for this fishery is concentrated along the edge of the Stewart-Snares shelf where white warehou are also concentrated (Figure 4).

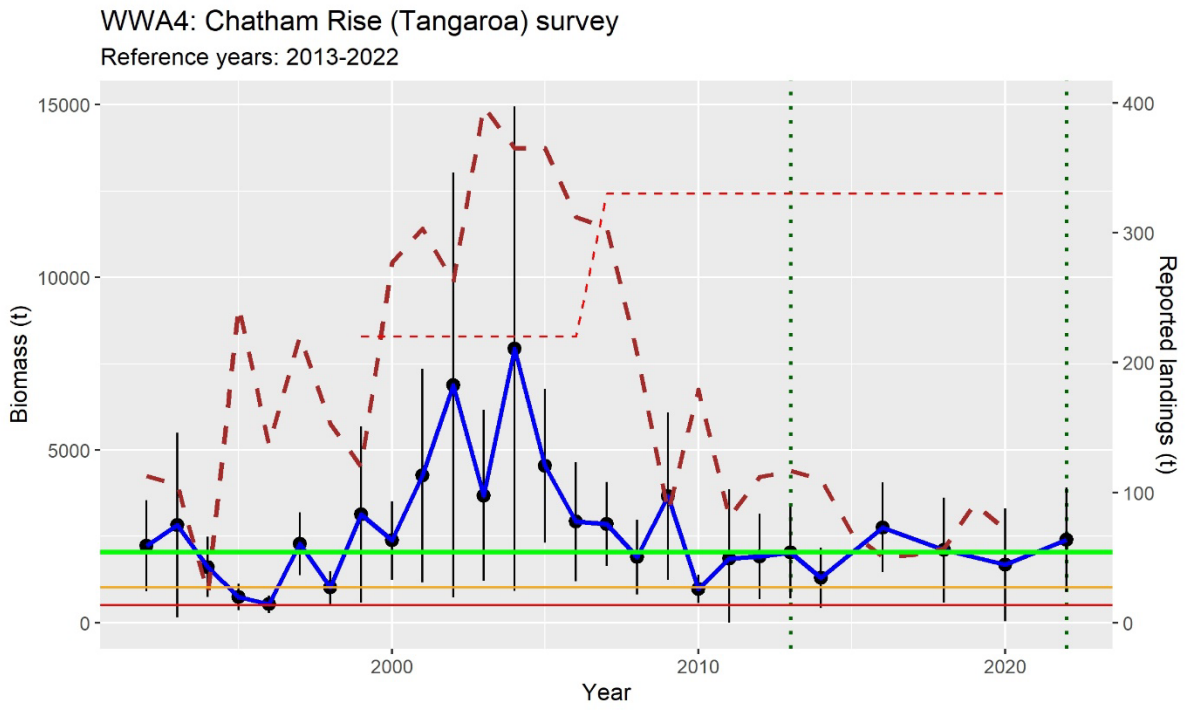
5. STATUS OF THE STOCKS

TACCs were increased from 1 October 2006 in WWA 3 to 583 t, in WWA 4 to 330 t, and in WWA 7 to 127 t. In these stocks, landings were above the TACC for a number of years and the TACCs have been increased to the average of the previous 7 years plus an additional 10%. Since the TACC increases landings have dropped to well below the TACC in WWA 3 and WWA 4.

WWA 4 (Chatham Rise)

Stock Status		
Most Recent Assessment Plenary Publication Year	2023 (corrections made in 2024)	
Catch in most recent year of assessment	Year: 2021–22	Catch: 47 t
Reference Points	Target: Not established but 40% B_0 assumed Soft Limit: 20% B_0 Hard Limit:10% B_0 Overfishing threshold: -	
Status in relation to Target	About as Likely as Not to be at or above	
Status in relation to Limits	Unlikely to be below both the soft and hard limits	
Status in relation to Overfishing	-	

Historical Stock Status Trajectory and Current Status



Relative biomass from Chatham Rise *Tangaroa* trawl survey: blue line plus vertical lines showing ± 2 s.d. (left axis); dashed line, reported QMR/MHR landings (right axis); red dotted line, TACC for WWA 4 (right axis). Horizontal green line marks the target, horizontal orange line the soft limit, and horizontal red line the hard limit. Vertical broken green lines bound the reference period.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Within WWA 4, biomass indices have been fairly flat throughout the time series of Chatham Rise trawl surveys with the exception of 2001 to 2005 where the point estimates were higher than the rest of the series, however CVs for the years 2001–2005 were high.
Recent Trend in Fishing Intensity or Proxy	Unknown
Other Abundance Indices	-
Trends in other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	-
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	-

Assessment Methodology		
Assessment Type	Level 2 - Partial quantitative stock assessment	
Assessment Method	Evaluation of agreed trawl survey indices thought to index FMA 4 abundance	
Assessment Dates	Latest assessment Plenary publication year: 2023	Next assessment: Unknown
Overall assessment quality rank	1 – High Quality	

Main data inputs (rank)	- *Tangaroa* survey estimates	1 – High Quality
Data not used (rank)	-	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	-	

Qualifying Comments
CVs of the Chatham Rise survey are quite high, often over 30%.

Fishery Interactions
In WWA 4 white warehou are mainly caught as bycatch in the hoki target bottom trawl fishery. Interactions are the same as those for the hoki fishery in this area.

6. FOR FURTHER INFORMATION

Bagley, N W; Hurst, R J (1997) A summary of the biology and commercial landings and a stock assessment of white warehou *Seriolella caerulea* Guichenot, 1848 (Stromateoidei: Centrolophidae) in New Zealand waters. New Zealand Fisheries Assessment Research Document 1997/13. 34 p. (Unpublished document held by NIWA library, Wellington.)

Ballara, S L; Baird, S J (2012) Fishery characterisation and standardised CPUE analyses for white warehou, *Seriolella caerulea*, 1989–90 to 2009–10. *New Zealand Fisheries Assessment Report 2012/49*. 265 p.

Ballara, S L (2015) Fishery characterisation and standardised CPUE analyses for white warehou, *Seriolella caerulea*, 1989–90 to 2013–14. *New Zealand Fisheries Assessment Report 2015/66*.

Chong, L; Flores, A; Quiroz, J C; Contreras, F; Wiff, R (2019) Reproductive biology and population structure of white warehou *Seriolella caerulea* and silver warehou *Seriolella punctata* in the austral zone off Chile. *Journal of Fish Biology 95*: 1030–1039. https://doi.org/10.1111/jfb.14094

Cousseau, M B; Fortciniti, L; Ubaldi, G (1993) Species of the Genus *Seriolella* in Southwest Atlantic waters. *Japanese Journal of Icthyology 40(2)*: 183–187.

Gavrilov, G M (1979) *Seriolella* of the New Zealand plateau. Report of the Pacific Ocean Scientific Research Institute of Fisheries and Oceanography (TRINO). (In Russian, English translation held in NIWA, Wellington.)

Gavrilov, G M; Markina, N P (1979) The feeding ecology of fishes of the genus *Seriolella* (fam. Nomeidae) on the New Zealand plateau. *Journal of Ichthyology 19(6)*: 128–135.

Horn, P L (1999) A validated ageing method and updated stock assessment for white warehou (*Seriolella caerulea*) in New Zealand waters. New Zealand Fisheries Assessment Research Document 1999/44. (Unpublished document held by NIWA library, Wellington.)

Horn, P L (2001) Validated ageing methods for blue warehou (*Seriolella brama*) and white warehou (*S. caerulea*) in New Zealand waters. *Marine and Freshwater Research 52*: 297–310.

Horn, P L; Sutton, C P (1996) Validated ages, growth, and productivity parameters for silver warehou (*Seriolella punctata*) off the south and east coasts of South Island, New Zealand. *New Zealand Journal of Marine and Freshwater Research 30*: 301–312.

Horn, P L; Burrell, T; Connell, A; Dunn, M R (2011) A comparison of the diets of silver (*Seriolella punctata*) and white (*Seriolella caerulea*) warehous. *Marine Biology Research 7*: 576–591.

Hurst, R J; Bagley, N W (1992) Results of a trawl survey of barracouta and associated finfish near the Chatham Islands, New Zealand, December 1985. *New Zealand Fisheries Technical Report* 30. 36 p.

Kerstan, M; Sahrhage, D (1980) Biological investigation on fish stocks in the waters off New Zealand. *Mitteilungen aus dem Institut fur Seefischerei der Bundesforschungsanstalt fur Fischerei,Hamburg*: 29. 168 p.

McDowall, R M (1980) *Seriolella caerulea* Guichenot, 1884 in New Zealand waters (Stromateoidei: Centrolophidae). *Journal of the Royal Society of New Zealand 10(1)*: 65–74.

McDowall, R M (1982) The centrolophid fishes of New Zealand (Pisces: Stromateoidei). *Journal of the Royal Society of New Zealand 12*: 103–142.

New Zealand Fishing Industry Board (NZFIB) (1996) The New Zealand seafood industry economic review 1994–1996. New Zealand fishing industry board, Wellington. 65p.