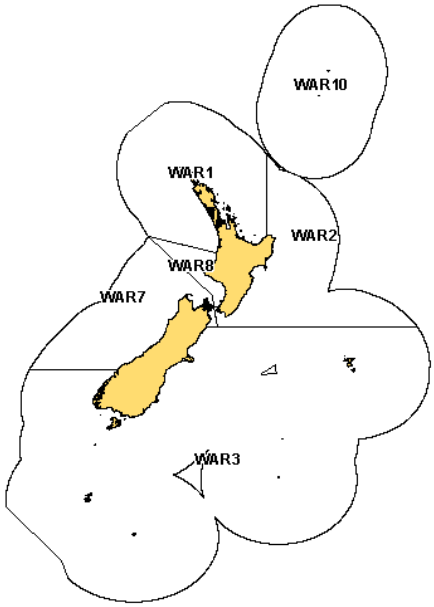
BLUE WAREHOU (WAR)

(Seriolella brama)
Warehou



1. FISHERY SUMMARY

1.1 Commercial fisheries

Blue (or common) warehou are caught in coastal waters of the South Island and lower North Island down to depths of about 400 m. Annual landings were generally less than 100 t up to the early 1960s, increased to about 1000 t by the early 1970s, and peaked at 4387 t in 1983–84 before declining steadily through to 1988–89 (Table 1).

This decline was most notable in WAR 3, from which most of the catch is recorded. A TACC reduction for WAR 3, from 3357 to 2528 t, was approved for the 1990–91 fishing year. In 1990–91, total catch increased substantially. The largest increase was in WAR 3 and catches in this area exceeded 2000 t for the following three years. There is no direct correlation between WAR 3 catches and fluctuations in effort in the Snares squid fishery where blue warehou is mostly taken as bycatch. In 1996–97, total catch increased again to 1990–91 levels and total catch has been maintained at this level since. Increased catches in WAR 2, 3 and 7 contributed to the increased total catch.

Until the mid 1980s, the main domestic fishing method used to catch blue warehou was gill-netting. There has been a reduction in the numbers of commercial gillnetters since the introduction of the QMS, and the majority of the landings are now taken as a bycatch from trawling. Bull & Kendrick (2006) describe the commercial fishery from 1989–90 to 2002–03.

Catches have fluctuated in most stocks but overall the total landings have increased. In 2002–03, total reported landings of blue warehou were the highest on record, with catches in WAR 3 exceeding the TACC by 983 t. Landings in WAR3 continued to be well above the TACC in 2006–07, but in all other areas landings are below the TACCs.

Table 1: Reported landings (t) of blue warehou by Fishstock 1983–84 to 2006–07 and actual TACs (t) from 1986–87 to 2006–07.

Fishstock		WAR 1		WAR 2		WAR 3		WAR 7
FMA		1 & 9		2		3, 4, 5 & 6		7
	Landings	TACC	Landings	TACC	Landings	TACC	Landings‡	TACC
1983–84*	13	–	346	–	3 222	–	702	–
1984–85*	5	–	278	–	1 313	–	478	–
1985–86*	15	–	185	–	1 584	–	955	–
1986–87†	7	30	190	480	1 330	3 210	780	910
1987–88†	7	41	204	560	976	3 223	685	962
1988–89†	12	41	177	563	672	3 348	561	969
1989–90†	17	41	201	570	814	3 357	607	1 047
1990–91†	14	41	250	570	2 097	2 528	758	1 117
1991–92†	25	41	235	570	2 514	2 528	1 001	1 117
1992–93†	15	41	199	578	2 310	2 530	539	1 120
1993–94†	16	41	233	578	688	2 530	436	1 120
1994–95†	15	41	203	578	1 274	2 530	468	1 120
1995–96†	32	41	368	578	1 573	2 530	756	1 120
1996–97†	24	41	563	578	1 814	2 531	1 428	1 120
1997–98†	20	41	402	578	2 328	2 531	860	1 120
1998–99†	15	41	503	578	1 978	2 531	1 075	1 120
1999–00†	9	41	422	578	2 761	2 531	1 147	1 120
2000–01†	12	41	388	578	1 620	2 531	1 572	1 120
2001–02†	7	41	294	578	1 614	2 531	1 046	1 120
2002–03†	5	41	429	578	3 514	2 531	961	1 120
2003–04†	6	41	392	578	3 539	2 531	755	1 120
2004–05†	6	41	402	578	2 963	2 531	756	1 120
2005–06†	4	41	293	578	3 505	2 531	691	1 120
2006–07†	4	41	235	578	3 326	2 531	823	1 120

Fishstock		WAR 8		WAR 10		
FMA		8		10		Total
	Landings	TACC	Landings	TACC	Landings	TACC
1983–84*	104	–	0	–	4 387	–
1984–85*	91	–	0	–	2 165	–
1985–86*	43	–	0	–	2 782	–
1986–87†	40	210	0	10	2 347	4 850
1987–88†	43	218	0	10	1 915	5 014
1988–89†	44	231	0	10	1 466	5 162
1989–90†	57	233	0	10	1 696	5 459
1990–91†	113	233	0	10	3 232	4 499
1991–92†	132	233	0	10	3 905	4 499
1992–93†	152	233	0	10	3 215	4 512
1993–94†	126	233	0	10	1 500	4 512
1994–95†	114	233	0	10	2 074	4 512
1995–96†	186	233	0	10	2 913	4 512
1996–97†	161	233	0	10	3 990	4 513
1997–98†	111	233	0	10	3 720	4 513
1998–99†	168	233	<1	10	3 739	4 513
1999–00†	116	233	0	10	4 455	4 513
2000–01†	143	233	0	10	3 735	4 513
2001–02†	146	233	0	10	3 107	4 513
2002–03†	192	233	0	10	5 101	4 513
2003–04†	129	233	0	10	4 821	4 513
2004–05†	157	233	0	10	4 284	4 513
2005–06†	76	233	0	10	4 569	4 513
2006–07†	59	233	0	10	4 448	4 512

* FSU data.
† QMS data.
‡ Includes landings from unknown areas before 1986–87.

1.2 Recreational fisheries

Estimates of recreational catch in the Ministry of Fisheries Central and South regions are shown in Table 2. Surveys in the North region in 1993–94 indicated that blue warehou were not caught in substantial quantities.

Table 2: Estimated harvest (t) of blue warehou by recreational fishers. Surveys were carried out in the Ministry of Fisheries South region in 1991–92 and in the Central region in 1992–93. – data not available.

Fishstock	Survey	Estimated harvest	CV
1991–92			
WAR 3	Southern	10–20	–
1992–93			
WAR 2	Central	10.0	62%
WAR 7	Central	1.7	65%
WAR 8	Central	0.6	102%

Blue warehou harvest estimates from the 1996 national survey were; WAR 2, 7000 fish; WAR 3, 3000 fish and WAR 7, 1000 fish.

1.3 Customary non-commercial fisheries

No quantitative information is available on the current level of customary non-commercial take.

1.4 Illegal catch

No quantitative information is available on the level of illegal catch.

1.5 Other sources of mortality

No information is available on other sources of mortality.

2. BIOLOGY

Blue warehou average 40–60 cm fork length (FL) and reach a maximum of about 75 cm. Validated ageing of blue warehou shows rapid growth up to the time of first spawning (about 4–5 years), but negligible growth after about 10 years. Female blue warehou grow significantly faster and reach a larger size than males. Maximum recorded ages are 22 years for males, and 21 years for females. The best estimate of M is now considered to be 0.24 (Bagley *et al*. 1997).

Blue warehou feed on a wide variety of prey, mainly salps but also euphausiids, krill, crabs and small squid.

Known spawning areas include the west coast of the South Island (in August-September), Kaikoura (in March, April, May), Southland (in November), and Hawkes Bay (in September). Eggs are found in the surface plankton and juvenile fish are believed to occur in inshore areas.

The seasonal pattern of landings suggest that there is a coastal migration of blue warehou. There is a winter/spring fishery for blue warehou at New Plymouth and north Wairarapa, a summer fishery with a small autumn peak at Wellington and a summer/autumn fishery along the east coast South Island. The west coast South Island has a fishery in August/September which picks up again in summer. There is a summer fishery in Tasman Bay.

Biological parameters relevant to the stock assessment are shown in Table 3.

Table 3: Estimates of biological parameters for blue warehou.

Fishstock	Estimate	Source
1. Natural mortality (*M*)		
WAR 3	0.24	Bagley *et al*. (1997)

2. Weight = a(length) (Weight in g, length in cm total length).

	Females		Males		
	a	b	a	b	
WAR 3	0.016	3.07	0.015	3.09	Bagley *et al*. (1997

3. Von Bertalanffy growth parameters

	Females			Males			
	$L_{¥}$	k	t_0	$L_{¥}$	k	t_0	
WAR 3	66.3	0.209	-0.79	63.8	0.241	-0.46	Bagley *et al*. (1997)
	Both Sexes						
WAR 1, 2, 7, 8 (part)	65.5	0.169	-1.35				Jones (1994)
WAR 8 (New Plymouth)	57.7	0.314	0.02				Jones (1994)

3. STOCKS AND AREAS

No definite stock boundaries are known; however, Bagley *et al*. (1997), after considering known spawning grounds and seasonal fishing patterns, suggested that there may be four stocks:

i. A southern population, mainly off Southland but perhaps extending into the Canterbury Bight. The main spawning time is November in inshore waters east and west of Stewart Island.
ii. A central eastern population, located on the northeast coast of the South Island and south east coast of the North Island (including Wellington), spawning mainly in the northern area in winter/early spring and also in autumn off Kaikoura.
iii. A south western population which spawns on the west coast of the South Island in winter.
iv. A north western population which may spawn off New Plymouth in winter/spring.

The proposed stock structure is tentative and there may be overlap between stocks. The available age and length frequency data are insufficient to compare by area and tagging studies have been minimal (about 150 fish tagged) with no returns.

For modelling WAR 3, the area on the east coast of the South Island south of Banks Peninsula including Southland was assumed to be a single stock. Movement between the west coast of the South Island and Southland is possible but there was no evidence for this from Southland seasonal trawl surveys. Also, the existence of two spawning periods, from August to September off the west coast of the South Island and from November to December in Southland, suggests two separate stocks.

4. STOCK ASSESSMENT

There are no new assessment results presented for blue warehou stocks in 2007. The 1998 assessment of WAR 3 (south of Banks Peninsula) incorporating catch history, relative abundance indices and estimates of growth parameters is presented. For the other blue warehou Fishstocks, a revised estimate of *M* (from 0.3 to 0.24) resulted in a change in c (from 0.7 to 0.8) in the MCY formula, $MCY = cY_{AV}$ (Method 4). This 1998 analysis resulted in new (higher) yield estimates for all stocks although there was no new analysis of the catch data.

4.1 Estimation of fishery parameters and abundance

Model input parameters used in the base case assessments and parameters used in sensitivity tests are given in Table 4. The age data from the *Tangaroa* Southland trawl surveys, 1993–96 were not incorporated into the model as apparently strong year classes did not follow through the time series of surveys. It appears that these surveys did not sample the population consistently. The proportion spawning and the proportion of recruited biomass available to the spawning season fishing fleet (p_{out})

were estimated from a trawl survey conducted in November 1986 during the spawning season (*Akebono Maru*). This was used to determine biomass outside the 12 n. mile limit and Solander Corridor closed area.

Table 4: Model input parameters for the WAR 3 base case and sensitivity runs.

Parameters	Estimate	Sensitivity tested
Proportion available (p_{out})	0.20 (1970–85) 0.25 (1986–97)	1.00
M	0.21	0.31
Minimum exploitation when largest catch (r_{MMX})	0.05	0.10
Steepness (SRR)	0.75	–
Proportion spawning	1.00	–
Plus group	17 years and older	–
Maturity ogive (ages 2 to 6)	0.10, 0.25, 0.50, 0.75, 1.00	–

The spawning and pre-spawning periods used in the catch history (Table 5) were based on trawl survey biological observations; spawning period, October to December; non-spawning, January to September. Foreign catches before 1978 were estimated from the combined catch of all warehou species by area (Bagley & Hurst 1997).

Table 5: Catch history (t) for the years 1970 to 1997 used in the WAR 3 model.

Year	Non spawning Jan-Sep	Spawning Oct-Dec	Total catch
1970	40	20	60
1971	50	20	70
1972	490	150	640
1973	600	200	800
1974	480	170	650
1975	580	200	780
1976	1 290	390	1 680
1977	1 380	420	1 800
1978	38	58	96
1979	225	581	806
1980	508	1 000	1 508
1981	600	1 752	2 352
1982	699	1 061	1 760
1983	963	2 159	3 122
1984	1 440	864	2 304
1985	715	273	988
1986	1 553	556	2 109
1987	722	232	954
1988	618	162	780
1989	294	90	394
1990	506	20	656
1991	1 707	620	2 582
1992	1 674	67	2 097
1993	1 950	162	2 222
1994	365	1 054	1 197
1995	66	795	861
1996	425	467	892
1997*	425	467	892

* Assumed the same as 1996 catch.

Two time series of relative abundance indices were incorporated into the model; the *Shinkai Maru* trawl surveys (1981 to 1986) and February to March *Tangaroa* trawl surveys (1993–96) (Table 6). The coefficients of variation (CVs) applied in the model were 60% for the *Shinkai Maru* and 40% for the *Tangaroa* series. Biomass indices were calculated for recruited fish (above 50 cm).

Table 6: Trawl survey biomass indices (t) and coefficients of variation (CV) for recruited blue warehou.

Fishstock	Area	Vessel	Trip code	Date	Biomass (t)	CV (%)
WAR 3	Southland	*Shinkai Maru*	SHI8101	Jan-Mar 81	2 100	43
			SHI8201	Mar-May 82	800	62
			SHI8302	Apr-83	4 700	72
			SHI8601	Jun-86	2 000	59
WAR 3	Southland	*Tangaroa*	TAN9301	Feb-Mar 93	2 297	36
			TAN9402	Feb-Mar 94	1 629	38
			TAN9502	Feb-Mar 95	1 103	38
			TAN9604	Feb-Mar 96	1 615	40

4.2 Biomass estimates

Estimates of current and reference biomass are available for blue warehou Fishstock WAR 3.

South-East/Southland (WAR 3)

The base case MIAEL estimates of mid-season virgin biomass (B_0), biomass in mid-1997 as a percentage of virgin biomass(B_{MID97}), total biomass at the start of 1998 (B_{BEG98}) are given in Table 7. The biomass trajectories for the base case and the sensitivity test where the proportion available to fleet was set to 1.0 are shown in Figure 1. Increased availability to the fleet caused B_{MIN} to go well below B_{MAY}. The base case produced minimum and maximum estimates of B_0 of 22000 and 51100 t, 54 to 82% for $B_{MID97}$and 16 000 to 53 000 t for B_{BEG98} respectively. The zero values for the MIAEL information indices indicate that virgin and current biomass are not known within their ranges. Under the base case assumptions the stock is above 54% B_0. However, all biomass estimates were particularly sensitive to changes in the proportion of fish available to the spawning season fleet (p_{OUT}).

Table 7: MIAEL estimates of biomass, B_0 (t), $B_{MID97)}$ (%B_0) and B_{BEG98} (t), and information indices (Info.index) for the base case and sensitivity runs.

Estimate		B_{MIN} - B_{MAX}	MIAEL	Info. Index
B_0	Base case	22 100–51 100	32 400	0 %
	Proportion available (p_{OUT}) = 1.0	14 400–51 100	24 100	5 %
	M = 0.31	20 500–49 500	30 900	0 %
	Minimum exploitation when largest catch (r_{MMX}) = 0.1	22 100–29 600	25 400	0 %
B_{mid97}	Base case	54–82	66	0 %
	Proportion available (p_{OUT}) = 1.0	11–82	24	4 %
	M = 0.31	67–88	76	0 %
	Minimum exploitation when largest catch (r_{MMX}) =0.1	54–67	60	0 %
B_{beg98}	Base case	16 100–53 000	27 300	0 %
	Proportion available (p_{OUT}) = 1.0	2 800–53 000	8 300	6 %
	M = 0.31	20 200–62 700	33 300	0 %
	Minimum exploitation when largest catch (r_{MMX}) = 0.1	16 100–25 900	20 200	0 %

4.3 Estimation of Maximum Constant Yield (MCY)

MCY was estimated using the equation MCY = cY_{AV} (Method 4) for all stocks. The value of c was set equal to 0.8 based on the revised estimate of M = 0.24 from the validated ageing work completed in 1997. For WAR 3 the range of MCY estimated from the model results is also presented. The MIAEL estimates of MCY were not calculated because the information indices were zero.

Auckland, Central (East) (WAR 1 and 2)

Average landings into Wellington over the period 1977 to 1983 were relatively stable at 300 t. Landings along the east coast of the North Island have shown large fluctuations. At Gisborne landings increased from 2 t in 1978 to 140 t in 1979 before declining to 2 t again in 1983. In Napier landings fluctuated from 1 t in 1960 to 87 t in 1972, decreased to less than 20 t in 1975 before peaking at 123 t in 1978 and then declining to 30–40 t. Y_{AV} for Central (East) (FMA 2) was estimated as 300–350 t.

$$\begin{aligned} MCY &= 0.8 * (300 – 350\ t) \\ &= 240–280\ t \end{aligned}$$

South-east (south of Banks Peninsula), Southland, and Sub-Antarctic (WAR 3)

The range of estimates of MCY using the technique of Cordue (1995) was 1100 to 2550 t. The average level of B_{MCY} as a percentage of B_0 was 54% and MCY was 5% of B_0. Reliable biomass indices, age class estimates and better definition of stock structure are required to improve yield estimation.

Challenger (WAR 7)

The catches from 1983–84 to 1985–86 were considered to be a sustainable level of catch. Y_{AV} = 710 t.

$$\begin{aligned} MCY &= 0.8 * 710 \text{ t} \\ &= 570 \text{ t} \end{aligned}$$

Central (West) (WAR 8)

The average domestic landings in the Central (West) zone from 1977 to 1983 were 70 t, and the average (declining) catch over 1983–84 to 1985–86 was 79 t. An MCY of 80 t is suggested for this area. New Plymouth has a peak seasonal catch in July, the season extending from June to September.

$$MCY = 80 \text{ t}$$

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

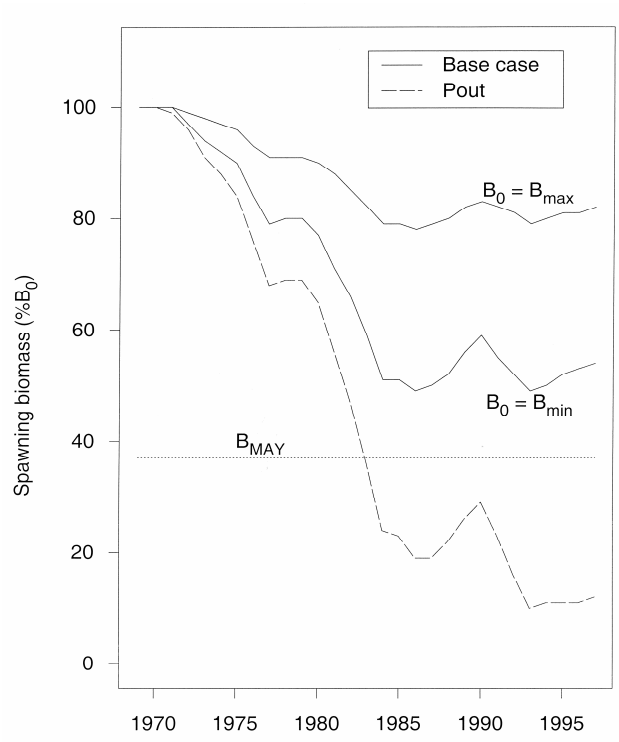


Figure 1: Trajectories for minimum (B_{MIN}) and maximum (B_{MAX}) estimates of biomass for the base case and B_{min} for the sensitivity run where proportion available to the fleet (p_{OUT}) is 100%.

4.4 Estimation of Current Annual Yield (CAY)

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

4.5 Other yield estimates and stock assessment results

No information available.

4.6 Factors modifying yield estimates

No information available.

5. STATUS OF THE STOCKS

Estimates of reference and current biomass are not available.

For all Fishstocks, it is not known if recent landings or TACC's are at levels which will allow the stocks to move towards a size that will support the maximum sustainable yield. Landings in 2002–03 were the highest on record, but landings have since decreased. However, catches in WAR 3 have continued to be higher than the TACC over the last 5 years.

Yield estimates, TACCs and reported landings for the 2006–07 fishing year are summarised in Table 8.

Table 8: Summary of yield estimates (t), TACCs (t) and reported landings (t) for blue warehou for the most recent fishing year.

Fishstock		QMA	MCY	2006–07 Actual TACC	2006–07 Reported landings
WAR 1	Auckland (East) (West)	1 & 9	240-280	41	4
WAR 2	Central (East)	2		578	235
WAR 3	South-east (Coast) (Chatham), Southland & Sub-Antarctic	3,4,5 & 6	1 100–2 550	2 531	3 326
WAR 7	Challenger	7	570	1 120	823
WAR 8	Central West)	8	80	233	59
WAR 10	Kermadecs	10	0	10	0
Total				4 513	4 448

6. FOR FURTHER INFORMATION

Bagley NW., Hurst RJ. 1995. Trawl survey of middle depth and inshore bottom species off Southland, February-March 1994 (TAN 9402). New Zealand Fisheries Data Report: 57, 50p.

Bagley NW., Hurst RJ. 1996. Trawl survey of middle depth and inshore bottom species off Southland, February-March 1995 (TAN 9502). New Zealand Fisheries Data Report: 73, 47p.

Bagley NW., Hurst RJ. 1996. Trawl survey of middle depth and inshore bottom species off Southland, February-March 1996 (TAN 9604). New Zealand Fisheries Data Report: 77, 51p.

Bagley NW., Hurst RJ. 1997. A summary of 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 *199*7/13: 34p.

Bagley NW., Ballara SL., Horn PL., Hurst RJ. 1998. A summary of commercial landings and a validated ageing method for blue warehou, *Seriolella brama* (Centrolophidae), in New Zealand waters, and a stock assessment of the Southern (WAR 3) Fishstock. New Zealand Fisheries Assessment Research Document 1998/20: 46p.

Bull B., Kendrick TH. 2006. Fishery characterisations and CPUE analyses for blue warehou (Seriolella brama). Draft New Zealand. Fisheries Assessment Report.

Cordue PL. 1995. MIAEL estimation of biomass and fishery indicators for the 1995 assessment of hoki stocks. New Zealand Fisheries Assessment Research Document 1995/13: 38p.

Gavrilov GM. 1979. *Seriolella* of the New Zealand plateau. TINRO, Vladivostok, 1979: 1–79. (Translation No. 204 held in MAF Fisheries Greta Point library, Wellington.)

Gavrilov GM., Markina NP. 1970. The feeding ecology of fishes of the genus *Seriolella* (fam. Nomeidae) on the New Zealand plateau. Journal of Ichthyology 19(6): 128–135.

Horn PL. 1999. Stock assessment of blue warehou *Seriolella brama* in New Zealand waters. New Zealand Fisheries Assessment Research Document. 1999/26.

Hurst RJ. 1985. Common warehou. In: Colman JA., McKoy JL., and Baird GG. (Comps. and Eds.) 1985: Background papers for the 1985 Total Allowable Catch recommendations. (Unpublished report, held in MAF Fisheries Greta Point library, Wellington.) 63–65pp.

Hurst RJ., Bagley NW. 1994. Trawl survey of middle depth and inshore bottom species off Southland, February-March 1993 (TAN 9301). New Zealand Fisheries Data Report: 52, 58p.

Jones JB. 1988. Blue warehou. N.Z. Fisheries Assessment Research Document 1988/11: 19p.

Jones JB. 1994. Notes on warehou age determination. Draft New Zealand Fisheries Assessment Research Document. 15p.

Jones JB., Hurst RJ. 1988. Common warehou. In: Baird GG., and McKoy JL. (Comps. and Eds.). Papers from the workshop to review fish stock assessments for the 1987–88 New Zealand fishing year. 67–73pp.

McKoy JL. 1988. (Comp.) Blue warehou. Report from the fishery assessment meeting April-May, 1988. 37–39pp.

Tsarev VT. 1971. Short notes on *Seriolella brama* (Gunther) in the south western part of the Pacific Ocean. Izvestiya TINRO [Transactions of the Pacific Ocean Scientific Research Institute for Fisheries and Oceanography] 79: 165–167.[In Russian]