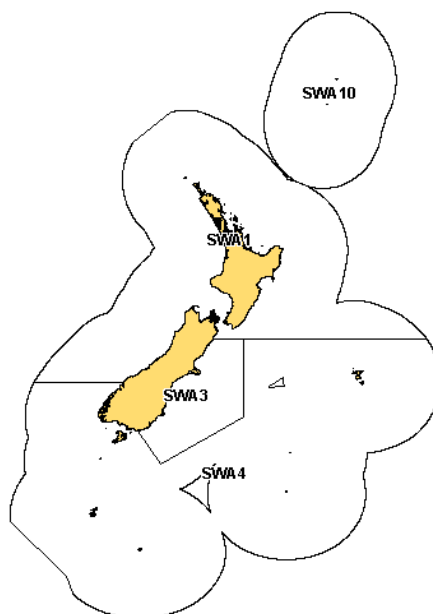


SILVER WAREHOU (SWA)*(Seriolella punctata)***1. FISHERY SUMMARY****(a) Commercial fisheries**

Silver warehou are common around the South Island and on the Chatham Rise in depths of 200–800 m. The majority of the commercial catch is taken from the Chatham Rise, Canterbury Bight, southeast of Stewart Island and the west coast of the South Island. Reported landings by nation from 1974 to 1987–88 are shown in Table 1.

Table 1: Reported landings (t) by nation from 1974 to 1987–88. Source: 1974–1978 (Paul, 1980); 1978 to 1987–88 (FSU).

Fishing Year	New Zealand			Foreign Licensed				Grand Total
	Domestic	Chartered	Total	Japan	Korea	USSR	Total	
1974*								7412
1975*								6869
1976*		estimated as 70% of total warehou landings					13 142	
1977*								12 966
1978*								12 581
1978–79**	?	629	629	3868	122	212	4203	4832
1979–80**	?	3466	3466	4431	217	196	4843	8309
1980–81**	?	2397	2397	1246	–	13	1259	3656
1981–81**	?	2184	2184	1174	186	3	1363	3547
1982–83**	?	3363	3363	1162	265	189	1616	4979
1983†	?	1556	1556	510	98	3	611	2167
1983–84§	303	3249	3552	418	194	3	615	4167
1984–85§	203	4754	4957	1348	387	15	1749	6706
1985–86§	276	5132	5408	1424	217	5	1646	7054
1986–87§	261	4565	4826	1169	29	100	1299	6125
1987–88§	499	7008	7507	431	111	39	581	8088

* Calendar year.

** 1 April to 31 March.

† 1 April to 30 September.

§ 1 October to 30 September.

Before the establishment of the EEZ, silver warehou landings were lumped with white and blue warehou landings under the title "warehou". Between 1974 and 1977, 70% of the "warehou" landings are estimated to have been silver warehou because of the areas fished. The depth distributions of silver warehou and blue warehou are reasonably distinct, and white warehou form a very small proportion of more recent warehou catches and biomass estimates from trawl surveys.

The estimated catches of silver warehou before the declaration of the EEZ were particularly high in 1976, 1977 and 1978 (Table 1). Concern about overfishing on the eastern Stewart–Snares shelf led to closure of this area to trawlers between October 1977 and January 1978. The high catch in 1978 represents a shift in effort, particularly by Japan, to the Chatham Rise, presumably because of the restriction on the Stewart–Snares shelf. Total reported catches since 1978–79 have been generally lower than estimated landings before 1978.

In recent years, most of the silver warehou catch has been taken as a bycatch of the hoki, squid, barracouta and jack mackerel trawl fisheries. Catches from SWA 1 increased substantially after 1985–86 following the development of the west coast South Island hoki fishery. Overruns of the TAC probably partly reflected the hoki fleet fishing in relatively shallow water (northern grounds) in the later part of the season, but could also reflect have reflected changes in abundance. Some target fishing for silver warehou does still occur, predominantly on the Mernoo Bank and along the Stewart–Snares shelf. Recent reported landings and actual TACs are shown in Table 2.

The TACC in SWA 1 was increased in 1991–92 under the "adaptive management" programme (AMP). A review of this fishstock at the completion of 5 years in the AMP concluded that it was not known if the current TACC would be sustainable and an appropriate monitoring programme was not in place. Under the criteria developed for the AMP the Minister therefore removed this fishstock from the AMP in October 1997 and set the TACC at 2132 t. A new AMP proposal in 2002 resulted in the TACC being increased to 3000 t from 1 October 2002, within a TAC of 3003 t. Catches have not approached the new TACC level in recent years.

In 2005–06 catches decreased further in SWA 1 as the hoki quota was reduced and less fishing occurred on the WCSI. However, in SWA3 and SWA 4 catches increased to levels well above the TACCs.

Table 2: Reported landings (t) of silver warehou by Fishstock from 1983–84 to 2005–06 and TACCs (t) from 1986–87 to 2005–06.

Fishstock FMA (s)	SWA 1		SWA 3		SWA 4		SWA 10		Total	
	1, 2, 7, 8 & 9		3		4, 5 & 6		10		Landings	TACC
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1983–84*	541	–	725	–	1829	–	0	–	3095	–
1984–85*	587	–	1557	–	4563	–	0	–	6707	–
1985–86*	806	–	2284	–	3966	–	0	–	7056	–
1986–87†	1337	1800	1931	2600	2779	3600	0	10	6047	§ 8010
1987–88†	2947	1815	3810	2601	2600	3600	0	10	9357	§ 8026
1988–89†	1605	1821	1476	2640	2789	3745	0	10	5870	8216
1989–90†	2316	2128	2713	3140	3596	3855	0	10	8625	9133
1990–91†	2121	2128	1889	3144	3176	3855	0	10	7186	9137
1991–92†	1388	2500	2661	3144	3018	3855	0	10	7066	9509
1992–93†	1231	2504	2432	3145	3137	3855	0	10	6800	9514
1993–94†	2960	2504	2724	3145	2993	3855	0	10	8677	9514
1994–95†	2281	2504	2336	3280	2638	4090	0	10	7255	9884
1995–96†	2884	2504	2939	3280	3581	4090	0	10	9404	9884
1996–97†	3636	2504	4063	3280	5336	4090	0	10	13 035	9884
1997–98†	3380	2132	3721	3280	3944	4090	0	10	11 045	9512
1998–99†	1980	2132	2796	3280	4021	4090	0	10	8797	9512
1999–00†	2525	2132	4129	3280	4606	4090	0	10	11 260	9512
2000–01†	3025	2132	3664	3280	4650	4090	0	10	11 339	9512
2001–02†	1004	2132	2899	3280	4648	4090	0	10	8551	9512
2002–03†	1029	3000	3772	3280	4746	4090	0	10	9547	10 380
2003–04†	1595	3000	3606	3280	5529	4090	0	10	10 730	10 380
2004–05†	1467	3000	3797	3280	4279	4090	0	10	9543	10 380
2005–06†	1023	3000	4524	3280	5591	4090	0	10	11 138	10 380

* FSU data.

† QMS data.

§ Totals do not match those in Table 1 as the data were collected independently and there was under-reporting to the FSU in 1987–88.

(b) Recreational fisheries

There are no current recreational fisheries for silver warehou.

(c) Maori customary fisheries

Quantitative information on the current level of Maori customary take is not available.

(d) Illegal catch

Silver warehou have been misreported as white and blue warehou in the past. The extent of this practice is unknown and could lead to under-reporting of silver warehou catches.

(e) Other sources of mortality

Other sources of mortality are unknown.

2. BIOLOGY

Initial growth is rapid and fish reach sexual maturity at around 45 cm fork length in 4 years. Based on a study of ageing methodology and growth parameters (Horn & Sutton, 1995), maximum age has been revised to 23 years for females and 19 years for males. An estimate of instantaneous natural mortality (M) was derived by using the equation $M = \log_e 100/A_{\max}$, where A_{\max} is the age reached by 1% of the virgin population. From their study, A_{\max} of 19 years for female silver warehou and 17 years for males produced estimates of M of 0.24 and 0.27 respectively. Horn & Sutton (1995) qualified this result as the samples used in their study were not from virgin populations and the sampling method did not comprehensively sample the whole population. They concluded that whilst M is likely to fall within the range 0.2–0.3, 0.25 is probably a satisfactory estimate at this stage.

Horn & Sutton also calculated von Bertalanffy growth curve parameters from their sample of fish from off the south and southeast coasts of the South Island (Table 3). Other biological parameters relevant to the stock assessment are shown in Table 3. Length weight regressions were calculated from two series of random trawl surveys using *Tangaroa*. One series was conducted on the Chatham Rise in January, 1992–97 and the other in Southland during February–March, 1993–96.

Silver warehou is a schooling species, aggregating to both feed and spawn. During spring-summer, both adult and juvenile silver warehou migrate to feed along the continental slope off the east and southeast coast of the South Island. Late-stage silver warehou eggs and larvae have been identified in plankton samples, and the early life history of silver warehou appears typical of many teleosts. Juvenile silver warehou inhabit shallow water at depths of 150–200 m and remain apart from sexually mature fish. Few immature fish are consequently taken by trawlers targeting silver warehou. Juveniles have been caught in Tasman Bay, on the east coast of the South Island and around the Chatham Islands. Once sexually mature, fish move out to deeper water along the shelf edge.

Table 3: Estimates of biological parameters of silver warehou.

1. Weight = a (length)^b (Weight in g, length in cm Total Length)

	a	b
Chatham Rise	0.00848	3.214
Southland	0.00473	3.380

2. Von Bertalanffy growth parameters

	Female	Male	Source
L_{∞}	54.5	51.8	Horn & Sutton (1995)
k	0.33	0.41	
t_0	-1.04	-0.71	

3. STOCKS AND AREAS

The stock structure is unknown. However, there is no new data which would alter the stock boundaries given in previous assessment documents. Horn et al. (2001) found no differences in growth rates of silver warehou from the Southern Plateau, Chatham Rise and WCSI, and reached the same conclusions as Livingston (1988) based on an analysis of gonad stages (ripe female samples) and juvenile distribution.

Livingston (1988) found that spawning occurs on the Chatham Rise (Mernoo), east coast North Island and west coast South Island in late winter and at the Chatham Islands in late spring-early summer. There is some evidence for another spawning ground on the Stewart-Snares shelf, also in late winter. It is uncertain whether the same stock migrates from one area to another, spawning whenever conditions are appropriate, or if there are several separate stocks. The current boundaries bear little relation to known spawning areas and silver warehou distribution.

4. STOCK ASSESSMENT

The assessment of silver warehou stocks was not updated in 2007. There are no new data that would alter the yield estimates given in the 1997 Plenary Report. Yield estimates are based on commercial landings only.

(a) Estimates of fishery parameters and abundance

CPUE data of silver warehou from the west coast South Island hoki fishery were analysed as a possible means of monitoring abundance in this part of SWA 1. However, the Middle Depths FAWG did not accept that the CPUE from the WCSI fishery were an index of abundance.

Age frequency distributions from otoliths collected by the Scientific Observer Programme from the west coast south island hoki fishery indicate that a wide range of year classes were present in the catch for all seasons 1992–96. Catch curve analysis based on the age structure of annual catches made from 1992–2005 suggested that fishing mortality is lower than natural mortality (SeaFIC, 2007).

(b) Biomass estimates

Estimates of reference and current biomass are not available for any Fishstock.

Biomass indices from *Tangaroa* trawl surveys in QMAs 3 (part), 4 and 5 since 1991 are variable between years and have high CVs, and are therefore unsuitable for stock assessment.

(c) Estimation of Maximum Constant Yield (MCY)

(i) Auckland, Central, Challenger (SWA 1)

MCY was estimated using the equation $MCY = cY_{av}$ (Method 4). Two values for Y_{av} were determined from distinct periods in the catch history. Y_{av} values were calculated from landings for 1983–84 to 1986–87 (818 t) and from the estimated catch for 1983–84 to 1990–91 (1713 t). These values were used to calculate two alternative estimates for MCY. The value of c was set equal to 0.8, based on an M of 0.25.

$$MCY = 0.8 * 818 \text{ t} = 654 \text{ t (rounded to 650 t)}$$

$$MCY = 0.8 * 1713 \text{ t} = 1370 \text{ t (rounded to 1400 t)}$$

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

(d) Estimation of Current Annual Yield (CAY)

An estimate of current biomass is not available, and CAY cannot be estimated.

(e) **Other Factors**

The degree of interdependence between Fishstocks is unknown. The 1996–97 landings were the highest on record but catches have decreased in both 1997–98 and 1998–99.

5. ANALYSIS OF ADAPTIVE MANAGEMENT PROGRAMMES (AMP)

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

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

SWA 1

The SWA 1 TACC was increased from 2132 to 3000 t in October 2002 under the Adaptive Management Programme (AMP). The AMP was reviewed in 2007.

Full-term Review of SWA 1 AMP in 2007

In 2007 the AMP FAWG reviewed the performance of the AMP after 4 years at the higher TACC (SeaFIC, 2007).

Characterisation

- The majority of the catch from 1989/90 to 2005/06 has been taken on the WCSI while targeting hoki using mid-water and bottom trawl. With reduced hoki quota in recent years the SWA catch has dropped to 1000-1600 t.

Biological Data

- Length data and otoliths are collected from the WCSI spawning fishery by observers
- Spatial and temporal coverage was good in some years but inadequate in others.
- Although the tows from which observers sampled SWA in the WCSI fishery were broadly representative of the fishery, individual length frequency samples tended to be small – often just a few fish. This has probably arisen through the observers using a middle depths form. It was thought that the forms had been changed but the observers seem to have gone back to using the middle depth forms.
- It appears that the otoliths collected were not a random sample of the fish measured. Therefore the age frequency was not determined directly from the otoliths but from a scaled length frequency and age-length key. Because of the small size of the length frequency samples, scaling was carried out using trip (rather than tow by tow) ratios of sampled weight to catch weight.
- Consistency in the size and age structure of the catch and the ability to track strong year classes indicates that the catch was adequately sampled across years.
- If the age data are to be used in the stock assessment they may need to be redefined as the year assigned to a cohort may be one year out currently.

Abundance Indices

- CPUE analysis is not used in this fishery. The WG considered that previous CPUE analyses were unlikely to reflect changes in abundance, however, some CPUE indices (e.g. using observer data) could still have potential.
- Given that CPUE is unlikely to track abundance, SWA 1 is monitored using biological information and mortality (Z) estimates based on the age structure of the catch (catch curves).
- The Chapman and Robson estimate of total mortality was not sensitive to age at full recruitment, but strong year classes influence the estimates of mortality. This analysis suggested that fishing mortality was substantially lower than natural mortality and that total mortality had not increased from 1992 to 2005.

Effects of Fishing

- The AMP has not led to any increase in effort.
- SWA is primarily a bycatch of the hoki fishery and environmental issues are dealt with there.

Conclusions

- Catch curve analyses indicate that the average exploitation rate on silver warehou in the WCSI hoki fishery is probably less than the natural mortality rate.
- The WG recommended that a stock assessment be undertaken for the WCSI fishery.

AMP review Checklist

1. Direct stock abundance indices are not available but an alternative methodology (catch curve analysis) has been used to estimate fishing mortality.
2. Scientific observer coverage is adequate on the WCSI but sampling needs to be improved.
3. Length frequency analyses may be further explored. The available data could be used in an assessment model.
4. Current landings are thought to be sustainable but the TACC is double the current harvest level.
5. The stock is most likely above MSY as the average F over the last 10 years has been below M .
6. Effects of fishing are adequately monitored in the hoki fishery of which SWA 1 is a part.
7. Bycatch is adequately monitored in the hoki fishery.
8. This AMP does not need to be reviewed by the Plenary.

6. STATUS OF THE STOCKS

No estimates of reference current absolute biomass are available.

The TACC for SWA 1 was increased to 3000 t from 1 October 2002 under the AMP, however, recent catches have been well below the TACC. Estimates of average fishing mortality from catch curve analysis were lower than the assumed rate of natural mortality and therefore the stock is likely to be above B_{MSY} .

In SWA 3 and SWA 4 landings have been well above the TACCs in the last 4 years. The sustainability of current TACCs and recent catch levels for these Fishstocks is not known, and it is not known if they will allow the stocks to move towards a size that will support the maximum sustainable yield.

Yield estimates, TACCs and reported landings for the 2005/06 fishing year are summarised in Table 4.

Table 4: Summary of yields (t), TACCs (t), and reported landings (t) of silver warehou for the most recent fishing year.

Fishstock		FMA	MCY	2005–06 Actual TACC	2005–06 Reported landings
SWA 1	Auckland (East) (West), Central (East) (West), & Challenger	1, 2, 7, 8, & 9	650–1400	3000	1023
SWA 3	South–East (Coast)	3	–	3280	4524
SWA 4	South–East (Chatham), Southland, and Sub–Antarctic	4, 5 & 6	–	4090	5591
SWA 10	Kermadec	10	–	10	0
Total			–	10 380	11 138

7. FOR FURTHER INFORMATION

- Gavrilov, G.M. (1975). Natural death rate and theoretical prerequisites for the optimum intensity of fishing, using as an example the population of *Seriollella maculata* Forster, which is not being fished. *News of the Pacific Ocean Scientific Research Institute of Fishing and Oceanography (TINRO)*. 96: 187–195 (in Russian, English translation held at MAF Fisheries Greta Point library, Wellington).
- Gavrilov, G.M. (1974). The age and rate of growth in the silver warehou (*Seriollella maculata* Forster). From "Investigations into the biology of fish and productivity of oceanography" Part 5: Vladivostock, 1974. *TINRO report* (in Russian, English translation held at MAF Fisheries Greta Point library, Wellington).
- Horn, P.H.; Bagley, N.W.; Sutton, C.P. (2001). Stock structure of silver warehou (*Seriollella punctata*) in New Zealand waters, based on growth and reproductive data. *N.Z. Fisheries Assessment Report 2001/13*. 29 p.
- Horn, P.H.; Sutton, C.P. (1995). An ageing methodology, and growth parameters for silver warehou (*Seriollella punctata*) from off the southeast coast of the South Island, New Zealand. *N.Z. Fisheries Assessment Research Document 95/15*. 16 p.
- Langley, A.D. (1992). Analysis of silver warehou (*Seriollella punctata*) catch and effort data from the WCSI hoki fishery (SWA 1). *New Zealand Fisheries Assessment Research Document 92/7*. 5 p.
- Livingston, M.E. (1988). Silver warehou. *New Zealand Fisheries Assessment Research Document 88/36*.
- Phillips, N.L. (2001). Analysis of silver warehou (*Seriollella punctata*) catch-per-unit-effort (CPUE) data. *New Zealand Fisheries Assessment Report 2001/73*. 48 p.
- SeaFIC (2002). SWA 1 Adaptive Management Programme proposal – 2002 (dated 19 February 2002). Copy held by MFish.
- SeaFIC (2007). Silver Warehou: SWA 1 Adaptive Management Programme Full-term Review Report.. AMP-WG-2007/22. Copies held by MFish.