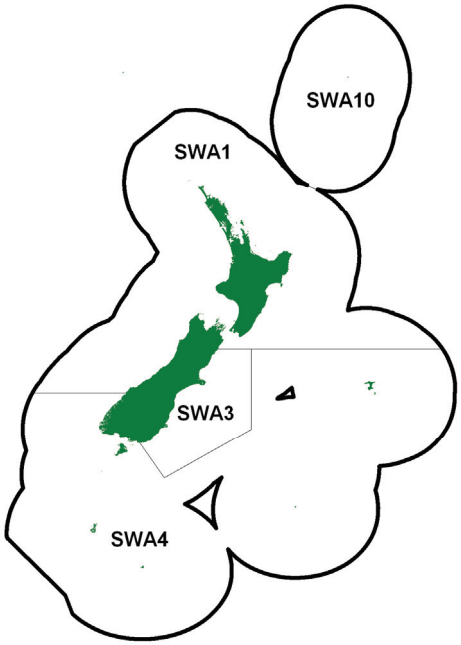
SILVER WAREHOU (SWA)

(*Seriolella punctata*)
Warehou



1. FISHERY SUMMARY

1.1 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*								7 412
1975*								6 869
1976*		estimated as 70% of total warehou landings						13 142
1977*								12 966
1978*								12 581
1978–79**	?	629	629	3 868	122	212	4 203	4 832
1979–80**	?	3 466	3 466	4 431	217	196	4 843	8 309
1980–81**	?	2 397	2 397	1 246	–	13	1 259	3 656
1981–81**	?	2 184	2 184	1 174	186	3	1 363	3 547
1982–83**	?	3 363	3 363	1 162	265	189	1 616	4 979
1983†	?	1 556	1 556	510	98	3	611	2 167
1983–84§	303	3 249	3 552	418	194	3	615	4 167
1984–85§	203	4 754	4 957	1 348	387	15	1 749	6 706
1985–86§	276	5 132	5 408	1 424	217	5	1 646	7 054
1986–87§	261	4 565	4 826	1 169	29	100	1 299	6 125
1987–88§	499	7 008	7 507	431	111	39	581	8 088

* 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 "warehous". 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 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 are shown in Table 2, while Figure 1 shows the historical landings and TACC values for the main SWA stocks.

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 as reductions in the hoki quota have resulted in much less effort on the WCSI in winter.

In most years from 2000–01 to 2006-07 catches in SWA 3 and SWA 4 were well above the TACCs as fishers landed catches well in excess of ACE holdings and paid deemed values for the overcatch. From 1 October 2007 the deemed values were increased to $1.22 per kg for all SWA stocks and two differential rates were also introduced. The second differential rate applies to all catch over 130% of ACE holding at which point the deemed value rate increased to $3 per kg. The effect of these measures was seen immediately in 2007–08 as fishing without ACE was reduced and catch fell well below the TACCs in both SWA 3 and SWA 4.

Table 2: Reported landings (t) of silver warehou by Fishstock from 1983–84 to 2008–09 and TACCs (t) from 1986–87 to 2008–09. QMS data from 1986–present.

Fishstock	SWA 1		SWA 3		SWA 4		SWA 10			
FMA (s)	1, 2, 7, 8 & 9		3		4, 5 & 6		10		Total	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1983–84*	541	–	725	–	1 829	–	0	–	3 095	–
1984–85*	587	–	1 557	–	4 563	–	0	–	6 707	–
1985–86*	806	–	2 284	–	3 966	–	0	–	7 056	–
1986–87	1 337	1 800	1 931	2 600	2 779	3 600	0	10	6 047	§8 010
1987–88	2 947	1 815	3 810	2 601	2 600	3 600	0	10	9 357	§8 026
1988–89	1 605	1 821	1 476	2 640	2 789	3 745	0	10	5 870	8 216
1989–90	2 316	2 128	2 713	3 140	3 596	3 855	0	10	8 625	9 133
1990–91	2 121	2 128	1 889	3 144	3 176	3 855	0	10	7 186	9 137
1991–92	1 388	2 500	2 661	3 144	3 018	3 855	0	10	7 066	9 509
1992–93	1 231	2 504	2 432	3 145	3 137	3 855	0	10	6 800	9 514
1993–94	2 960	2 504	2 724	3 145	2 993	3 855	0	10	8 677	9 514
1994–95	2 281	2 504	2 336	3 280	2 638	4 090	0	10	7 255	9 884
1995–96	2 884	2 504	2 939	3 280	3 581	4 090	0	10	9 404	9 884
1996–97	3 636	2 504	4 063	3 280	5 336	4 090	0	10	13 035	9 884
1997–98	3 380	2 132	3 721	3 280	3 944	4 090	0	10	11 045	9 512
1998–99	1 980	2 132	2 796	3 280	4 021	4 090	0	10	8 797	9 512

Table 2 Continued:

	SWA 1		SWA 3		SWA 4		SWA 10		Total	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1999–00	2 525	2 132	4 129	3 280	4 606	4 090	0	10	11 260	9 512
2000–01	3 025	2 132	3 664	3 280	4 650	4 090	0	10	11 339	9 512
2001–02	1 004	2 132	2 899	3 280	4 648	4 090	0	10	8 551	9 512
2002–03	1 029	3 000	3 772	3 280	4 746	4 090	0	10	9 547	10 380
2003–04	1 595	3 000	3 606	3 280	5 529	4 090	0	10	10 730	10 380
2004–05	1 467	3 000	3 797	3 280	4 279	4 090	0	10	9 543	10 380
2005–06	1 023	3 000	4 524	3 280	5 591	4 090	0	10	11 138	10 380
2006–07	2 093	3 000	6 059	3 280	6 022	4 090	0	10	14 174	10 380
2007–08	1 679	3 000	2 918	3 280	3 510	4 090	0	10	8 107	10 380
2008–09	1 366	3 000	3 264	3 280	4 213	4 090	0	10	8 843	10 380

*FSU 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.

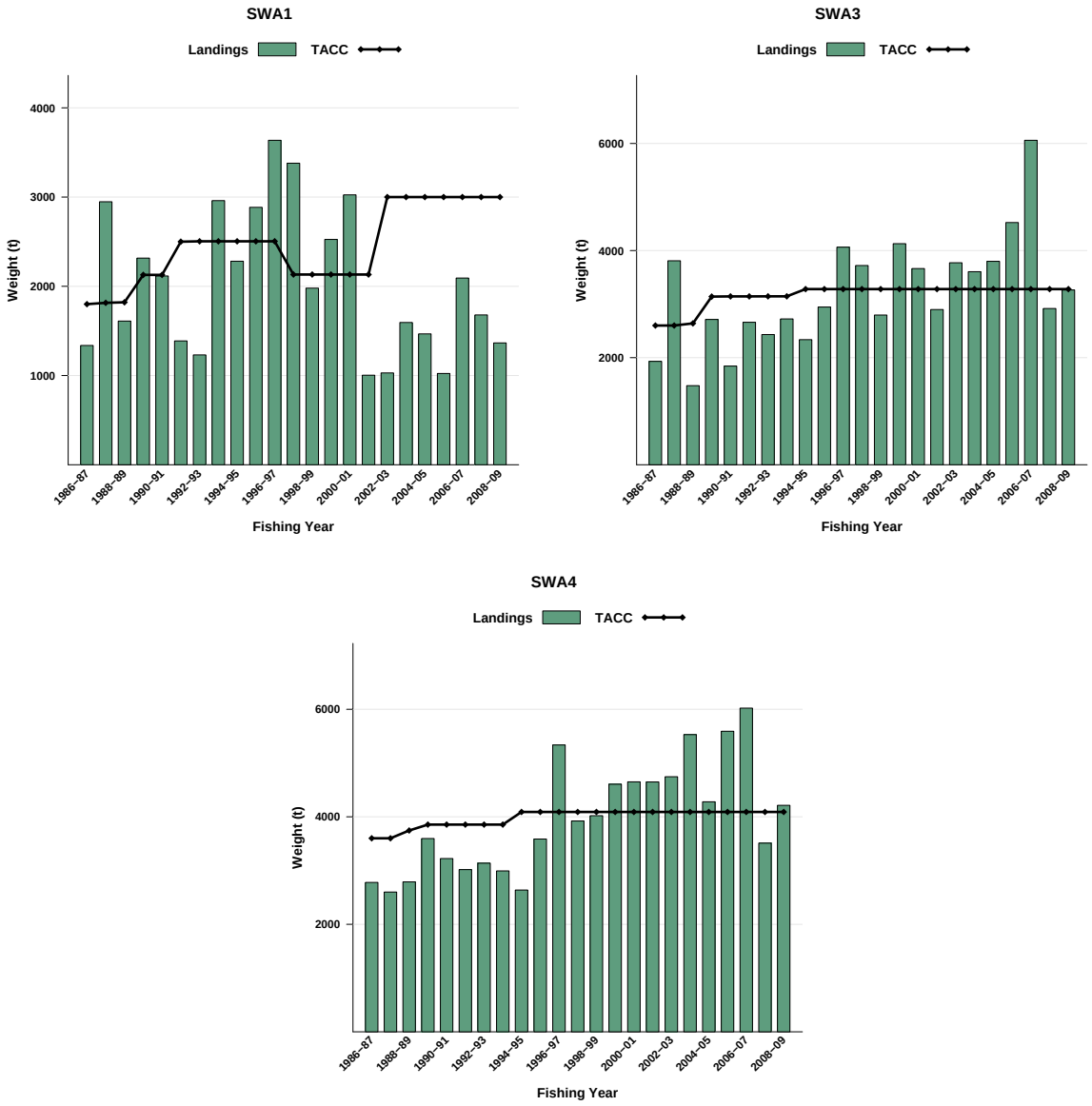


Figure 1: Historical landings and TACC for the three main SWA stocks. From top left: SWA1 (Auckland East), SWA3 (South East Coast), and SWA4 (South East Chatham Rise). Note that these figures do not show data prior to entry into the QMS.

1.2 Recreational fisheries

There are no current recreational fisheries for silver warehou.

1.3 Customary non-commercial fisheries

Quantitative information on the current level of customary non-commercial take is not available.

1.4 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.

1.5 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 is considered to be 23 years for females and 19 years for females. 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. Based on these results *M* is likely to fall within the range 0.2–0.3.

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.

Fishstock	Estimate						Source
1. Weight = a(length)^b (Weight in g, length in cm, total length).							
	Both sexes						
	a	b					
Chatham Rise	0.00848	3.214					
Southland	0.00473	3.380					
3. von Bertalanffy growth parameters							
	Female			Males			
	L_∞	k	t_0	L_∞	k	t_0	
	54.5	0.33	-1.04	51.8	0.41	-0.71	Horn & Sutton (1995)

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 2009 but a mid-term review was carried out for the SWA 1 AMP. 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.

4.1 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 1992–05 suggested that fishing mortality is lower than natural mortality (SeaFIC 2007).

4.2 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.

4.3 Estimation of Maximum Constant Yield (MCY)

MCY cannot be determined. Problems with mis–reporting of warehou catches and the lack of consistent catch histories make MCY estimates based on catch data alone unreliable.

4.4 Estimation of Current Annual Yield (CAY)

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

4.5 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). A full-term review of the LIN 1 AMP was carried out in 2007.

Mid-term review 2009 (AMP WG/09/10, 11)

Characterisation

- Silver warehou were introduced into the QMS from 1 Oct 1986 as four fishstocks, the SWA 1 fishstock including the waters around the North Island and the west coast of the South Island (FMAs 1, 2, 7, 8 and 9). The SWA 1 TACC rose from 1,800t in 1986-97 to 2,128t in 1989-90 as a result of quota appeals and was increased to 2,500t in 1991-92 upon entry into an AMP. A further 4t increase in 1992-93 resulted from a quota appeal. The TACC was reduced to 2,132t for 1997-98 and increased to 3,000t (within a TAC of 3,003t) from 2002-03 onwards under a second AMP.
- The early catch history for SWA 1 has been reconstructed from historical data collected by the Fisheries Statistical Unit (FSU) data from January 1979 onwards. While total New Zealand SWA catches are reported in these data to be highest in the 1970s, most of this catch is thought to have been made on the Chatham-Rise and Stewart-Snares Shelf by Japanese vessels, with only a small proportion made in SWA 1. Estimated annual SWA 1 catches averaged about 260t per year over the period 1979 - 1982.
- Subsequent catches increased from around 500t - 1000t in 1983-84 to 2,948t in 1987-88, declined to 1,231t in 1992-93 and then increased to a historic peak of 3,636t in 1996-87. Catches remained at high levels through to 2000-01, exceeding the TACC in all but two years from 1993-94 to 2000-01. Catches then dropped sharply to only 1004t in 2001-02 due to reduction in the hoki TACC, of which SWA is primarily a by-catch, and have continued to fluctuate below the TACC, between 1,023t and 2,093t up to 2007-08. Increased catches over 2006-07 to 2007-08 have resulted from increased active targeting of SWA
- From 1989-90 to 2000-01 82% of the SWA 1 catch was taken by midwater trawl off the west coast of the South Island. However, 87% of the catch since 2001-02 in the WCSI fishery is now taken by bottom trawl. In other regions, bottom trawl catches have dominated throughout the entire period 1989-90 to 2007-08. The proportion of catch taken by midwater trawl has not decreased to the same extent as the WCSI fishery. Catches by bottom longline and other methods have been sporadic.
- SWA 1 has primarily been a bycatch of trawls targeting hoki. As catches of hoki have declined since 2000-01, the proportion of SWA target trawls has increased. Since 2006-07 target SWA catches have dominated, with bycatch in barracouta and hake target trawls also increasing in importance.
- Peak catches in the WCSI fishery are taken in July to September. In other parts of the SWA 1 fishery, the seasonal pattern has shown more variation.

Length-frequency & catch at age

- SWA have been biologically sampled by Ministry of Fisheries observers from 1989-90 to 2007-08. Sampling has generally been representative of areas where SWA are caught, but length-frequency samples have varied in the extent to which they represented catches from which they came, with the majority of samples prior to 2006-07 comprising < 10 fish. Catch-weighted length-frequency distributions were calculated from these samples.
- There is little variation in the mean length of SWA in the WCSI fishery. Smaller fish tend to occur in the north of the area, and in shallower depths, with larger fish in deeper areas to the west and south.
- Length distributions show dominance of fish 45cm - 55cm in catches, but with evidence of strong year classes (modes of smaller fish 40cm - 45cm) in 1993-94, 1997 and 2002 - 2005.
- Observers also collect otoliths from measured fish. Of the otoliths collected, 2,240 from 1991-92 to 1995-96 and 4,350 from 1995-96 to 2004-05 have been aged by NIWA and the Central Ageing Facility, Victoria, Australia (CAF) respectively. There is generally good agreement between age readings by these two facilities. Age frequency distributions were then estimated for the WCSI fishery from weighted length frequency distributions and applying an annual age-length key.

Catch curve estimation of total mortality

- Resulting annual age-frequency distributions by sex were used to generate annual total mortality (Z) estimates from 1992 to 2005 using catch curves and either regression-based or Chapman-Robson estimators. These estimates of Z are unchanged from the previous report on SWA 1 made to the AMP WG in 2007 (Middleton *et al*. 2007).
- The 224 mortality estimates calculated using the Chapman Robson estimator span a range from 0.22 to 0.63. Eleven are less than 0.25, the current estimate of natural mortality for silver warehou (Horn & Sutton, 1996; Ministry of Fisheries, 2006) and 172 (77%) are less than 0.4. Strong year classes entering the fishery appear to produce a temporary upward shift in the estimated total mortality, especially for younger assumed ages at full recruitment, but otherwise no particular trends in the estimates are apparent.

CPUE analysis

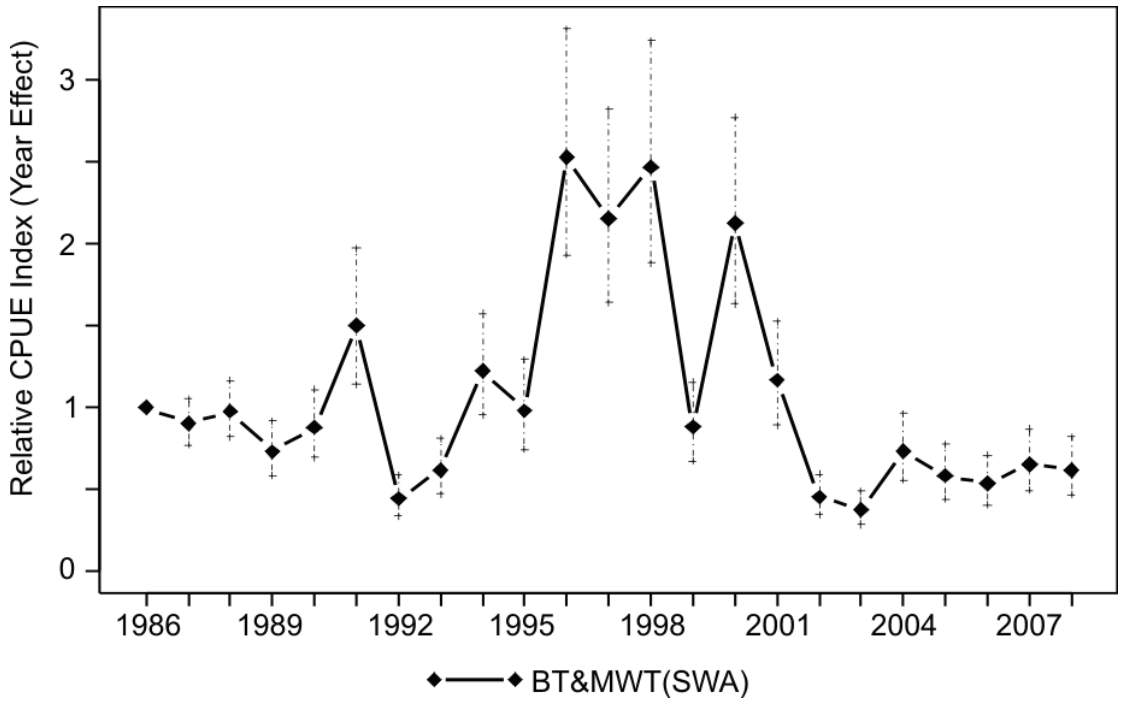


Figure 2: Standardised CPUE index (year effects) for SWA 1 from an analysis of Scientific Observer Programme trawl records (Cordue 2009).

- Previous SWA 1 CPUE analyses based on the MFish catch/effort returns were rejected as being unreliable as indices of SWA 1 abundance.
- A CPUE analysis for this stock was conducted in 2009 using selected observer catch and effort data for positive bottom and midwater trawl SWA catches in area FMA 7 for winter fishing within a WCSI box (40.2°S - 43.3°S).
- The data were groomed and records were selected for a core fleet (vessels which fished in at least 2 years with at least 20 tows in each year). The core fleet records were checked to ensure there was adequate linkage of vessels across years. The final data selection included 74 vessels that fished at some time over the period 1986 to 2008.
- CPUE for this data selection was standardised using a variety of lognormal models, including an all categorical variables model, a partly continuous (depth and tow duration) model, and complex models with interactions and year * latitude interactions. An adequate fit was obtained with a model that includes year, duration, month, latitude and vessel; specifying continuous variables and complex interactions offered little improvement over the all categorical model. Strongest effects on the standardisation were by target, vessel, month and tow duration.
- The resulting index (Figure 2) is noisy but shows a general trend of slow CPUE decline from 1986 to 1992, a steep increase from 1992 to 1996 and high levels through to 2000, followed by a steep decline back to low levels by 2002 and a stable trend at slightly above historically lowest levels since then.

- The WG considered that this CPUE index was possibly consistent with strong year classes in 1993-94 and in 1997 (evident in the length frequency data), and resulting increased abundance over the ensuing few years.
- The WG considered that this CPUE standardisation might be indexing SWA 1 abundance and, given the substantial amount of catch-at-age data for this stock, recommended that a stock assessment should now be conducted to investigate the coherence between catch-at-age data and this abundance index.

Status of the stock

Analysis recommendations

The following analyses were recommended following the 2009 review:

- Given the amount of length-frequency and catch-at-age data, and the availability of a potential CPUE abundance index for SWA 1, the WG suggested that a stock assessment now be conducted for this stock. The WG noted that a stock assessment would require updating the age frequencies since 2005.

Abundance indices

CPUE indices have previously been considered to be unreliable for SWA 1. However, the WG considered that the BT&MWT(SWA) index prepared in 2009 using observer data seems to be consistent with observed good recruitment in 1993-94 and in 1997, with ensuing strong year classes contributing to increased catch rates over the ensuing few years. The WG concluded that this CPUE index was potentially indexing SWA 1 abundance.

This index shows a period of slowly declining CPUE from 1986 - 1992, followed by a rapid increase in CPUE to levels twice the long-term average by 1996. High catch rates continued to 1998, dipped in 1999 and rose to high levels again in 2000. Thereafter CPUE declined back to about half historic average levels, and appears to have remained stable at that level since 2004.

Sustainability of current catches

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, indicating that the stock was not being overfished.

Annual catches have averaged 1,480t since the increase in TACC to 3,000t in 2002-03 and catches at this level are likely sustainable in the short to medium term. However, the TACC is double the current catch and it is not known whether catches at the level of the TACC are sustainable.

The WG noted that this Fishstock sustained catches which averaged 2,800 t/year from 1993-94 to 2000-01 without resulting in high *Z* estimates, but that this occurred over a period where CPUE indices indicate abundance of more than double current levels. A stock assessment is considered to be a more appropriate methodology to assess this Fishstock than relying on analyses of catch curves.

Stock status

This stock is most likely above B_{MSY} as the average F over the last 10 years has been below *M*. Estimates of B/B_{MSY} should be provided by the recommended stock assessment.

6. STATUS OF THE STOCKS

Since the 2008 Plenary report was published, no new stock assessments have been competed for SWA stocks but a mid-term review has been completed for the SWA 1 AMP.

SWA 1

SWA 1 has been managed with a TACC of 3000 t since October 2002 under the AMP.

CPUE indices have previously been considered to be unreliable for SWA 1. However, the SWA bottom and midwater trawl index prepared in 2009 seems to be consistent with indications of good

recruitment in 1993, 1994 and 1997, with strong year classes contributing to increased catch rates over the ensuing few years. The WG concluded that this CPUE index may be indexing SWA 1 abundance.

This index shows a period of stable or slowly declining CPUE from 1986 - 1992, followed by a rapid increase in CPUE to levels twice the long-term average by 1996. High catch rates continued to 1998, dipped in 1999 and rose to high levels again in 2000. Thereafter CPUE declined back to about half historic average levels, and appears to have remained stable at that level since 2004.

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, indicating that the stock is not being overfished.

Annual catches have averaged 1480 t since the increase in TACC to 3000t in 2002–03 and catches at this level are likely sustainable in the short to medium term. However, it is not known whether catches at the level of the TACC are sustainable. The state of the stock in relation to B_{MSY} is unknown. This should be determined by the stock assessment being conducted.

Other stocks
No estimates of reference current absolute biomass are available.

In most years from 2000–01 to 2008–09 catches in SWA 3 and SWA 4 were well above the TACCs as fishers landed catches well in excess of ACE holdings. 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 2008–09 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	2008–09 Actual TACC	2008–09 Reported landings
SWA 1	Auckland (East) (West), Central (East) (West), & Challenger	1, 2, 7, 8, & 9	650–1400	3 000	1 366
SWA 3	South–East (Coast)	3	–	3 280	3 264
SWA 4	South–East (Chatham), Southland, and Sub–Antarctic	4, 5 & 6	–	4 090	4 213
SWA 10	Kermadec	10	–	10	0
Total			–	10 380	8 843

7. FOR FURTHER INFORMATION

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