

**Review of Sustainability Measures and Other Management  
Controls for the 2004-05 Fishing Year**

**Initial Position Paper**

**22 January 2004**

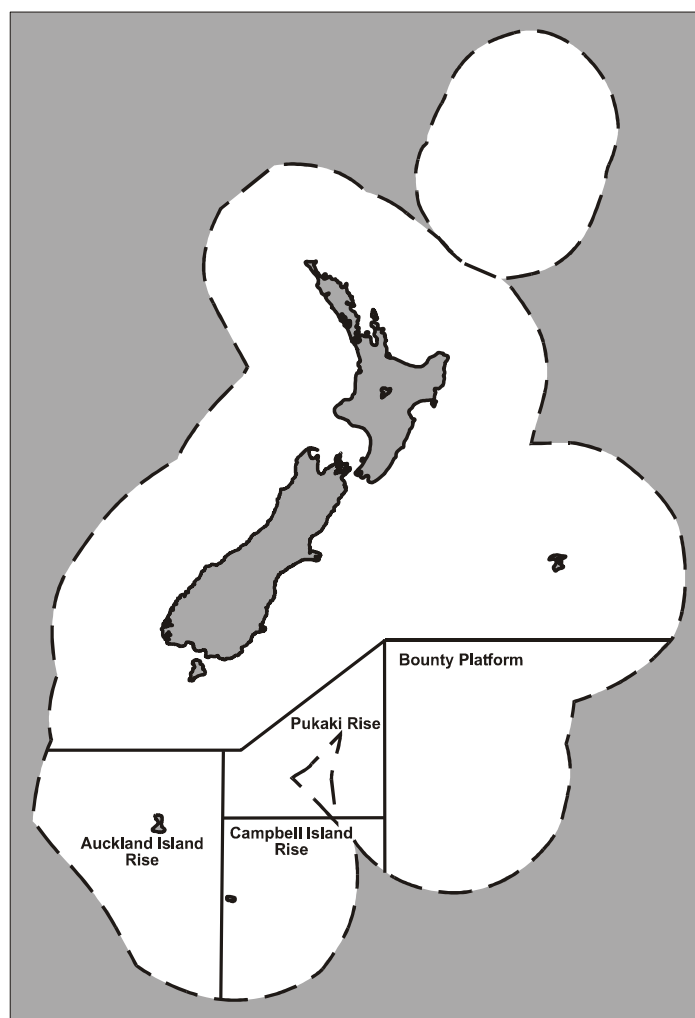
**Southern Blue Whiting – Campbell Island Rise (SBW 6I)**



# SOUTHERN BLUE WHITING - CAMPBELL ISLAND RISE (SBW 6I)

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Figure 1: Quota Management Areas (QMAs) for Southern Blue Whiting.



## Key issues to be considered

- 1 The key sustainability and management issues to be considered for the Campbell Island Rise southern blue whiting stock (SBW 6I) are:
  - a) the Minister's decision made in May 2003 to manage southern blue whiting fisheries based on stock assessment information delayed by one fishing year, necessitated by the relative timing of fishing activity, stock surveys, the plenary assessment, and the fishing year;
  - b) the biology of southern blue whiting (a schooling species that is caught during spawning aggregations), that is relatively long-lived (possibly reaching 25 years), with several year classes in the fishery, and displays high inter-annual recruitment variability; other details are provided in Appendix One;

- c) the reduction to the TACC for SBW 6I that was made for the current (April 2003 to March 2004) fishing year (reduced from 30 000 tonnes to 25 000 tonnes);
- d) the updated stock assessment available for SBW 6I (based on the acoustic survey of 2002) that indicates declining biomass under catches at the level of the current TACC (stock assessment details are provided in Appendix Two);
- e) the stock assessment trajectories that indicate the probability of the biomass dropping below the reference threshold 1991 biomass ( $B_{1991}$ ) reaches 10 % by 2005 at catches of about 15 000 tonnes for basecase 1, or 10 000 to 15 000 tonnes for basecase 2. The probability of biomass falling below  $B_{1991}$  by 2005 reaches 18 % for basecase 1 and 34 % for basecase 2 if catches at the level of the current TAC/TACC of 25 000 tonnes are taken.

## **Initial management proposal**

2 The following management actions are proposed:

- a) a staged response to the current assessment, whereby the Minister would:
  - i) reduce the TAC and TACC for SBW 6I for the April 2004 – March 2005 fishing year to 20 000 t;
  - ii) consider a further reduction of the TAC and TACC for the April 2005 – March 2006 fishing year, to be informed by updated information, including that from industry acoustic surveys and data from the 2003 and 2004 fishing seasons (after review by the relevant working groups);
- b) set zero allowances within the TAC for customary Māori and recreational fishery interests, and for other sources of fishing-related mortality - the TAC would therefore equal the TACC.

## **Rationale for management proposal**

### ***Stock assessment results***

- 3 The proposed reduction to the TAC/TACC is based on the updated stock assessment that is reported in the “Report from the Fishery Assessment Plenary, May 2003: stock assessments and yield estimates” (Annala *et al.* 2003), as extracted in Appendix Two. The stock assessment represents the best available information on the projected performance of the SBW stock under a range of constant catch levels, including the current 25 000 tonnes TACC.
- 4 The current assessment reveals similar trends to the 2000 assessment, and indicates that the SBW 6I stock biomass showed a steady decline from the early 1980s until 1993, followed by a large increase to 1996, and a slight decline thereafter. The very strong 1991 year class still makes a large contribution to the commercial catch (especially by weight), and has been joined by the 1995, 1996, and 1998 year classes, all of which also appear to be moderately strong.

- 5 The key element of uncertainty in the assessment is the much higher coefficient of variation (CV) from the 2002 acoustic survey than from previous surveys. The greater CV resulted mainly because high density aggregations of fish were found on only a few transects within each of the two ‘snapshot’ surveys of spawning and post-spawning aggregations. It is not possible to determine whether fish were there, but not found, or if they were absent.
- 6 MFish is aware that industry collected acoustic data during the 2003-04 fishing season. This information has not yet been submitted to the appropriate working group and therefore does not inform this management advice. Industry is invited to present relevant findings, once reviewed by the appropriate working group, as part of the consultation process.
- 7 The 2003 assessment model was used to make forward projections of stock biomass, assuming fixed future catch levels from 10 000 tonnes to 30 000 tonnes per year, and assuming that the TACC of 25 000 tonnes for SBW 6I will be taken in the current SBW fishing year (reported landings to date indicate that this assumption is realistic). Recruitments were drawn randomly from the distribution of year class strengths estimated by the model over the period 1977 to 2000.
- 8 As an alternative to the CAY estimates reported in previous assessments, the results from the 2003 assessment have been presented in the form of decision tables. For the SBW 6I stock, the probability of biomass remaining above the reference year (1991) is presented for alternative fixed catch levels and for each of two basecase model runs (see Table 1).

**Table 1: Probability that the projected mid-season vulnerable biomass for 2004 and 2005 will be less than the mid-season vulnerable biomass in 1991, and the median projected biomass as a%  $B_{1991}$ , for different constant catch levels for the two basecase runs for the Campbell stock, assuming a 25 000 tonne catch in 2003.**

Constant catch (t)	Probability ( $B_{proj} < B_{1991}$ )*		Median biomass as % $B_{1991}$ *	
	2004	2005	2004	2005
Basecase 1				
10 000	0.08	0.07	200	217
15 000	0.09	0.10	196	202
20 000	0.09	0.13	191	187
25 000	0.11	0.18	185	173
30 000	0.12	0.24	180	157
Basecase 2				
10 000	0.13	0.09	166	181
15 000	0.15	0.16	160	164
20 000	0.17	0.26	155	146
25 000	0.21	0.34	149	130
30 000	0.23	0.43	144	113

\* extracted from “Report from the Fishery Assessment Plenary, May 2003: stock assessments and yield estimates” (Annala *et al.* 2003)

- 9 Table 1 shows that the probability of the biomass dropping below the threshold (the 1991 biomass,  $B_{1991}$ ) reaches 10 % by 2005 at catches of about 15 000 tonnes for basecase 1, or 10 000 to 15 000 tonnes for basecase 2. The probability of biomass falling below  $B_{1991}$  by 2005 reaches 18 % for basecase 1 and 34 % for basecase 2 if catches at the current TAC/TACC of 25 000 tonnes are taken.

### **TAC and TACC**

- 10 The TAC/TACC for SBW 6I was reduced from 30 000 tonnes to 25 000 tonnes for the April 2002- March 2003 fishing year in response to the assessed decline in the biomass after two years of catch at the 30 000 tonne level. MFish's initial proposal for the fishing year beginning on 1 April 2004, is that the Minister considers a staged response to the current assessment, and sets the TAC at 20 000 tonnes, makes zero allowances for Māori customary interests, recreational interests, or other sources of fishing-related mortality, and therefore sets the TACC at 20 000 tonnes. The second stage of the proposal would be to consider a further reduction of the TAC and TACC for the April 2005 fishing year, to be informed by updated information from industry acoustic surveys and data from the 2003 and 2004 fishing seasons. MFish believes that this represents the preferred response to the stock assessment results.
- 11 The biomass in 1991 ( $B_{1991}$ ) was the minimum biomass observed, yet subsequently gave rise to good recruitment and stock recovery. On that basis,  $B_{1991}$  was chosen as a safe reference threshold biomass. Future management should aim to maintain the SBW 6I biomass above the reference level, rather than managing to that level. The likelihood that the current biomass might fall below the reference biomass under alternative harvest levels provides the probabilistic information used for risk assessment.
- 12 An important finding from the assessment results is that a substantial risk is predicted of biomass declining to below  $B_{1991}$  (probability of 18 or 34 % under basecase 1 and 2 assumptions, respectively) should catches remain at the current TACC level of 25 000 tonnes. The stock assessment established a probability of 10% as the threshold for comparison. On that basis, MFish proposes that a reduction to the current TAC/TACC is required for the 2004-05 SBW fishing year in order to achieve the management aim of maintaining the SBW 6I biomass above the reference biomass level.
- 13 The current assessment projects that there is a 10 % probability of the biomass declining below  $B_{1991}$  by 2005 under catch levels of 15 000 tonnes (basecase 1) or 10 000 tonnes to 15 000 tonnes (basecase 2). However, there is uncertainty in the assessment (as described in Appendix Two), and there are substantial economic implications of a TAC reduction to 15 000 tonnes. Reducing the TACC to 20 000 tonnes for the April 2004 year, as part of a phased reduction, is considered to be an appropriate response to the assessment in order to achieve the management objective of maintaining the stock above the established  $B_{1991}$  threshold level. Interpreting Table 1, a 20 000 tonnes TACC implies a 13 % to 26 % probability that the projected 2005 biomass will fall below the reference 1991 biomass.
- 14 The risk to the management objective could be re-evaluated before the start of the April 2005 fishing year. A stock assessment for SBW 6I is to be reviewed on an annual basis and presented in the 2004 Plenary. Information from the fishery in 2004

(including catch-at-age data from 2003 and 2004) would be available to update the assessment model and inform the decision maker about appropriate catch levels for the 2005-06 fishing year. At present, there are no plans for additional acoustic surveys in the SBW fishery.

### *Economic and social implications*

- 15 The SBW 6I fishery is characterised by high volumes of catch and relatively low per unit raw product values. All vessels targeting SBW in the Campbell fishery are believed to be charter vessels, many of which rely upon SBW as one of several fisheries undertaken during the year. The availability of fishing opportunities such as SBW sequenced over the year allows New Zealand fishing companies to efficiently augment harvest capacity with charter vessels where it may not be economically practical to invest in additional vessels. Coordinating charter vessels can require commitments a year in advance.
- 16 The predictability of SBW fishing opportunities thus becomes an important consideration in a more complex array of charter vessel arrangements in other fisheries over the course of a year. The majority of the SBW 6I fishery is conducted in a relatively short time span during September and October when spawning aggregations occur. If SBW cannot be taken in sufficiently high volumes, the economic incentive for fishers to operate in the fishery is reduced.
- 17 MFish recognizes that the proposed 5 000 tonnes reduction to the SBW 6I TACC will have a direct economic effect on industry, also acknowledging the 5 000 tonnes reduction in the TACC from the 2002-03 to 2003-04 fishing years. The 2003-04 port price for SBW is \$100 per tonne based on the 2003 Licensed Fish Receiver survey, down from \$590 tonnes reported in the 2002 survey.<sup>1</sup> The proposed 5 000 tonnes reduction in catch would represent a further 20% decline (\$ 0.5 million at \$100 per tonne) in gross raw product value based on the reported port price.
- 18 A reduction in the TACC would be expected to reduce export earnings, as well. A significant portion of SBW is processed into higher valued forms, primarily surimi and frozen fillets. The reported New Zealand FOB export value of SBW products for the 2002 calendar year totalled approximately \$29.3 million, indicating relatively high value added contributions relative to the greenweight value. The SBW 6I fishery accounts for about 90 % of total SBW catch in New Zealand, and is thus an important contributor to these export earnings.
- 19 The economic effect would also extend to losses that might be associated with vessel lease (and other) costs if catching and processing capacity goes unused. Preliminary analysis of fishing activity as at January 2004 indicates the number of vessels targeting southern blue whiting in SBW 6I declined from 18 vessels during 2002-03, to 15 vessels in the 2003-04 season, possibly due to the 5 000 tonnes reduction in TACC last season.
- 20 MFish is also aware that catch reductions can have social implications when employment opportunities for catching and processing staff are reduced. However,

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<sup>1</sup> The 2003 port price is set in 2003 from data collected from the 2002 fishing year, and used in the 2003/04 levy order.

MFish has no estimates of the scale of effects on cultural or social factors such as employment or income that might arise from the proposed decrease in then TACC.

- 21 Further analysis of economic implications is provided in Appendix One.

### *Recreational and Māori customary interests*

- 22 There is no known recreational or Māori customary fishery for SBW 6I. MFish proposes that the Minister sets allowances of 0 tonnes for recreational and Māori customary fishing.

### *Other sources of fishing-related mortality*

- 23 MFish proposes that the known level of other sources of fishing-related mortality is sufficiently low that the Minister does not need to set an allowance to account for it within the TAC. Further information on other sources of fishing-related mortality is provided in Appendix One.

### *Environmental considerations*

#### Marine Mammals

- 24 MFish considers that the proposed reduction of the TACC for SBW 6I will have no adverse implications for fur seals and other marine mammals. Further information on fur seal capture is provided in Appendix One.

#### Seabirds

- 25 MFish considers that the proposed reduction in the TACC for SBW 6I has no adverse implications for seabirds. Further information on seabird capture issues is provided in Appendix One.

#### Fish bycatch

- 26 The SBW 6I is a midwater trawl fishery with very low bycatch of other species. The proposed reduction in the TACC has no adverse implications for fish bycatch. Details of fish bycatch are provided in Appendix One.

### ***Statutory considerations***

- 27 MFish considers that the proposed management actions are consistent with the statutory considerations under the Fisheries Act 1996, as discussed below.

**Section 8** – sets out the purpose of the 1996 Act as being “*to provide for the utilisation of fisheries resources while ensuring sustainability*”. The initial proposal seeks to achieve that purpose by setting a TAC and TACC for the SBW 6I stock. The level of the proposed TAC/TACC will provide for utilisation while ensuring sustainability. Achieving the sustainability obligation is guided by the agreed management objective for the stock (to maintain biomass above the reference threshold level of the biomass in 1991).

**Section 13** – prescribes the considerations for setting the TAC in order to obtain the maximum sustainable yield from the stock.

**Section 13(2)** - requires that the TAC should be set at a level that maintains the stock at or above the level that can produce the maximum sustainable yield (MSY), or moves it towards or above that level, having regard to the interdependence of stocks. The details of the current stock assessment and the implications for setting the TAC are discussed above.

While there are likely to be interactions between southern blue whiting and other species/stocks, there is no evidence of interdependence between stocks that is of significant magnitude to impact on the setting of the TAC.

MFish considers that the proposed TAC options satisfy the requirements of s 13.

**Section 13(2)(b)(ii)** – requires that, where a stock is determined to be below the level that would produce the MSY, the TAC is set to restore the stock to or above the  $B_{MSY}$  level within a period appropriate to the stock, having regard to the biological characteristics of the stock and any environmental conditions affecting the stock.

The *biological* characteristics of the stock mean that SBW 6I can experience marked inter-annual changes in recruitment, and subsequent biomass levels. The longevity of the species (maximum age of up to 25 years) means that there are several year classes in the fishery - recruits to the fishery contribute to the biomass for several years. Natural mortality is low after maturity, so after strong recruitment, the biomass can be fished down progressively over time. Recovery of a depleted stock will, however, be strongly dependent on the relatively unpredictable recruitment.

The Plenary report provides no indication of specific environmental conditions having been identified as affecting the stock or recruitment.

**Section 13(3)** – requires the Minister to have regard to the social, cultural, and economic factors he considers to be relevant, when considering the way in which, and rate at which, to move a stock towards the  $B_{MSY}$  level.

There will be social and economic consequences from the proposed reduction to the TAC/TACC for SBW 6I. The expected economic effects have been noted in the relevant part of this advice (see paragraphs 15 to 21, and Appendix One), but the precise extent of those effects has not been quantified. Economic effects can result in social effects, following on from the reduction in catching and processing capacity that would be likely to accompany a reduction in the TAC/TACC of the scale proposed. The proposal to reduce the TAC/TACC in stages should serve to mitigate the economic and social effects of reduced catch limits.

**Section 11(1)(c)** – requires that the Minister takes into account the natural variability of the stock. Southern blue whiting stocks can display large inter-annual variability in recruitment, which can give rise to substantial fluctuations in biomass. The fishery in recent years appears to have been supported by a very large recruitment in 1991,

followed by moderately strong recruitment in 1995, 1996, and 1998. Further information is contained in the stock assessment results presented in Appendix Two.

**Section 9** – requires that decisions take into account the environmental principles set out in:

*s 9(a)* - specifies that associated or dependent species should be maintained above a level that ensures their long-term viability. The recorded bycatch in the SBW 6I fishery shows that the fishery takes relatively little bycatch (it is a 'clean' fishery). There are no known concerns regarding the viability of associated or dependent species.

*s 9(b)* – requires that the biological diversity of the aquatic environment should be maintained. SBW 6I is relatively has low bycatch as discussed above, and there is no evidence of adverse effects of the SBW 6I fishery on the maintenance of biodiversity.

*s 9(c)* – stipulates that habitats of particular significance to fisheries management should be protected. Midwater trawling generally is not known to have effects on the benthos, as the gear comes into contact with the sea floor only accidentally. No habitats of particular significance for fisheries management have been identified within SBW 6I.

**Section 11(1)(a)** – requires that the Minister takes into account any effects of fishing on the stock and the aquatic environment before setting or varying any sustainability measure. The direct effects of target fishing on the SBW 6I stock are considered in the assessment, and support the proposed management action. The fishery is relatively discrete, and the known effects of other target fisheries on the SBW 6I stock or its environment, and any environmental effects of the target SBW fishery, are not considered to have particular significance for setting the TAC/TACC at this time.

**Section 5** – requires that decisions should be consistent with New Zealand's international obligations relating to fishing, and the provisions of the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992. There is a wide range of international obligations relating to fishing (including sustainability and utilisation of fishstocks and maintaining biodiversity). MFish considers issues arising under international obligations and the provisions of the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992 are adequately addressed in the management proposal for SBW 6I.

**Section 11(1)(b)** – requires that the Minister shall set or vary a sustainability measure only after taking into account any existing controls that apply to the stock or area concerned. A TAC and TACC (25 000 tonnes) are in place for SBW 6I. Those are the key controls under consideration for change. Other existing controls are a minimum trawl mesh size of 60 mm within the Sub-Antarctic Fishery management area (including SBW 6I). General restrictions regarding the use of trawl net mesh layers, liners, etc., also apply. Trawling in specified seamount areas is prohibited, and one specified area lies within SBW 6I (at the southern extent of the QMA). The use of net-sonde monitor cables is prohibited on all New Zealand fishing vessels or foreign-owned New Zealand fishing vessels. Those restrictions on trawling have applied for

some time and MFish does not consider that they materially affect the Minister's consideration of the proposed change to the TAC/TACC. No changes to existing controls beyond the TAC/TACC are proposed.

**Section 11(2A)(b)** - requires that, before setting any sustainability measure, the Minister must take into account any relevant fisheries plan approved under s 11. No existing or proposed fisheries plan for SBW 6I is known to MFish.

**Section 11(2A)(a) & (c)** – before setting a sustainability measure, the Minister must take into account any conservation services or fisheries services, and any decisions not to require conservation or fisheries services. Any relevant conservation or fisheries services have been considered in this paper (see Appendix One – observer coverage, seabirds, fur seals, research). No decision has been made not to require a service in this fishery.

**Section 11(2)(a) and (b)** – stipulate that the Minister, before setting or varying any sustainability measure, must have regard to the provisions applicable to the coastal marine area known to exist in any policy statement or plan under the Resource Management Act 1991, or any relevant management strategy or plan under the Conservation Act 1987. No such statements, strategies or plans that are relevant to the setting or varying of any sustainability measure for SBW 6I are known to MFish.

**Sections 21(1)(a and b), (4)(i and ii), and (5)** – prescribes the matters to be taken into account when setting or varying the TACC, including making allowances within the TAC for non-commercial Māori customary fishing, recreational fishing, and other sources of fishing-related mortality.

The nature of the SBW 6I fishery and the interests of the respective fishing sectors have been considered in setting the TACC. There are no known Māori customary or recreational fishing interests in the SBW 6I fishery, and no and allowances are proposed. The known fishing-related mortality beyond the landed catch is small, and an allowance is not proposed.

No mātaimai exists in the SBW 6I QMA. No area has been closed or fishing method restricted under s 186A for customary fishing purposes in SBW 6I. No restrictions have been placed on fishing in any area within the QMA for recreational interests.

**Section 10** – prescribes the information principles that are to be taken into account when exercising powers and functions under the Act. Decision makers should use the best available information, consider uncertainty in that information, be cautious when information is uncertain, unreliable, or inadequate, and that the absence or uncertainty of information should not be used as a reason to postpone or fail to make decisions.

MFish considers that the primary information supporting the proposed management action is provided by the current stock assessment for SBW 6I, as reported in the May 2003 Plenary report (Annala *et al.* 2003). That assessment represents the best available information about the performance of the fishery under the presented range of future catch levels. MFish notes that there is uncertainty in the assessment. A contributor to that uncertainty is the high CV associated with the most recent 2002 reported acoustic biomass estimate. MFish notes that more recent acoustic data might

be presented by industry in time for it to be included in final advice, once the relevant working groups have considered that information.

Despite the uncertainty in the information, MFish considers that the assessment provides adequate indication of the need to reduce the TAC/TACC in order to achieve the agreed sustainability objective for SBW 6I (to maintain biomass above the threshold  $B_{1991}$  level).

## ***Future management***

### ***Management framework***

- 28 MFish considers that the TAC/TACC for SBW 6I is managed on the basis that the current biomass is maintained above the reference year biomass (1991) with a high level of certainty. 1991 is established as the reference year on the recognition that biomass in that year fell to the lowest observed levels, yet subsequently gave rise to good recruitment and stock recovery. Future management should aim to maintain the SBW 6I biomass above the threshold level, rather than managing to that level.
- 29 MFish has previously noted the difficulty in incorporating SBW stock survey information obtained in September/October with the working group fishery assessment process in time to accommodate changes in management actions prior to the beginning of the next SBW season commencing in April. Based on MFish advice and industry submissions from the 2003 review of the SBW fishery, the Minister decided in May 2003 to delay the use of stock assessment information by one fishing year.
- 30 MFish notes the previously expressed stakeholders' views about the planning and resourcing problems presented by the nature of the SBW fishery. MFish encourages rights holders in the SBW 6I fishery to explore the potential of the fisheries plan framework (provided by s 11A of the Act) to deliver solutions to the particular challenges of the SBW fishery.

### ***Observer coverage***

- 31 MFish will continue to monitor the catch of fur seals and seabirds in the SBW fisheries through the observer programme. A total of 240 observer days are programmed for the current business year (July 2003 to June 2004) to be applied across all SBW stocks. These observer services provide various information concerning catch composition, species characteristics, conversion rates, and the bycatch of marine mammals and birds. New information gained over time will be available for consideration in future management decisions.

### ***Research***

- 32 An update of the stock assessment for the SBW 6I stock is planned for the 2003-04 business year (SBW 2004/01). Results should be available by June 2004, and will provide the basis for updated assessment of the SBW 6I fishery applicable to the 2005-06 fishing year. A subsequent stock assessment of SBW has been proposed for 2004/05.

## Conclusion

- 33 The TAC/TACC for SBW 6I was reduced from 30 000 tonnes to 25 000 tonnes for the April 2003- March 2004 fishing year, in response to the assessed decline in the biomass after two years of catch at the 30 000 tonne level.
- 34 The indication from the current stock assessment is that biomass has declined further. A substantial risk (probability of 18 or 34 % from basecases 1 and 2, respectively) of biomass declining to below the  $B_{1991}$  threshold is predicted should catches remain at the current TACC level of 25 000 tonnes. On that basis, MFish proposes that a reduction to the current TAC/TACC is required for the 2004-05 SBW fishing year in order to achieve the management aim of maintaining the SBW 6I biomass above the threshold level.
- 35 MFish's initial proposal for the fishing year beginning on 1 April 2004 is that the Minister considers a staged response to the current assessment, and sets the TAC at 20 000 tonnes, makes zero allowances for Māori customary interests, recreational interests, or other sources of fishing-related mortality, and therefore sets the SBW 6I TACC at 20 000 tonnes.
- 36 The second stage of the proposal would be to consider a further reduction of the TAC and TACC for the April 2005 fishing year, to be informed by updated information, including that from industry acoustic surveys and catch data from the 2003 and 2004 fishing seasons.
- 37 MFish is aware that industry collected acoustic data from the SBW 6I during the 2003-04 fishing season. If that data is analysed to produce an abundance estimate that can be reviewed and agreed on through the middle depth working group, then that will assist with determining the size of the stock available this year, and the relevance of the biomass projections at various catch levels presented in the current assessment. That information is not yet available to inform advice presented here, although industry is invited to present relevant findings as part of the consultation process.
- 38 MFish considers that a 20 000 tonnes TACC represents the preferred response to the stock assessment results based on the best information available.

## Preliminary recommendations

- 39 MFish proposes that a staged reduction of the TAC and TACC be considered for SBW 6I, to be given effect by:
- a) For the fishing year commencing on 1 April 2004, the southern blue whiting TAC be reduced to 20 000 tonnes, and within the TAC;
    - i) an allowance of 0 tonnes be made for non-commercial Māori customary fishing interests;
    - ii) an allowance of 0 tonnes be made for recreational fishing interests;
    - iii) an allowance of 0 tonnes be made for other sources of fishing-related mortality;
    - iv) the TACC be set at 20 000 tonnes.

- b) A further reduction of the TAC and TACC be considered for the fishing year commencing on 1 April 2005, dependent on the results of an updated assessment (available in June 2004) that will incorporate information from the fishery in 2003 and 2004, including available acoustic survey results.

## APPENDIX ONE – FISHERY SUMMARY

### Catch information

40 The following table illustrates the catches from the southern blue whiting fisheries by area for 1978 to 2003-04 from vessel logbooks and fishing returns.

**Table 1:** Estimated catches (t) of southern blue whiting by area for the period 1978 to 2003-04 from vessel logbooks and QMRs. No catch limit was in place until the 1992-93 fishing year. Estimates for 2003-04 are preliminary estimates of reported landings to end November 2003. Before 1997-98 there was no separate catch limit for the Auckland Islands stock.

Fishing Year	Bounty Platform		Campbell Rise		Pukaki Rise		Auckland Is		Total	
	Catch	Limit	Catch	Limit	Catch	Limit	Catch	Limit	Catch	Limit
1978 <sup>f</sup>	0		6 403		79		15		6 497	
1978-79+	1 211		25 305		601		1 019		28 136	
1979-80+	16		12 828		5 602		187		18 633	
1980-81+	8		5 989		2 380		89		8 466	
1981-82+	8 325		7 915		1 250		105		17 595	
1982-83+	3 864		12 803		7 388		184		24 239	
1983-84+	348		10 777		2 150		99		13 374	
1984-85+	0		7 490		1 724		121		9 335	
1985-86+	0		15 252		552		15		15 819	
1986-87+	0		12 804		845		61		13 710	
1987-88+	18		17 422		157		4		17 601	
1988-89+	8		26 611		1 219		1		27 839	
1989-90+	4 430		16 542		1 393		2		22 367	
1990-91+	10 897		21 314		4 652		7		36 870	
1991-92+	58 928		14 208		3 046		73		76 255	
1992-93+	11 908	15 000	9 316	11 000	5 341	6 000	1 143		27 708	32 000
1993-94+	3 877	15 000	11 668	11 000	2 306	6 000	709		18 560	32 000
1994-95+	6 386	15 000	9 492	11 000	1 158	6 000	441		17 477	32 000
1995-96+	6 508	8 000	14 959	21 000	772	3 000	40		22 279	32 000
1996-97+	1 761	20 200	15 685	30 100	1 806	7 700	895		20 147	58 000
1997-98+	5 647	15 400	24 273	35 460	1 245	5 500	0	1 640	31 165	58 000
1998-00†	8 741	15 400	30 386	35 460	1 049	5 500	750	1 640	40 926	58 000
2000-01#	3 997	8 000	18 049	20 000	2 864	5 500	19	1 640	24 929	35 148‡
2001-02#	2 261	8 000	29 999	30 000	230	5 500	10	1 640	32 500	45 148‡
2002-03#	7 438	8 000	28 742	30 000	16	5 500	20	1 640	36 876	45 148‡
2003-04#	3 806	8 000	23 337	25 000	46	5 500	42	1 640	36 876	

<sup>f</sup> 1 April-30 September

<sup>+</sup> 1 October-30 September

<sup>†</sup> 1 October 1998-31 March 2000

<sup>#</sup> 1 April -31 March

<sup>‡</sup> SBW 1 (all EEZ areas outside QMA6) has a TACC of 8 tonnes.

41 Small catches in the Pukaki Rise and Auckland Island fisheries in the 2001-02 and 2002-03 fishing years reflect the amount of effort put into these fisheries rather than any sustainability concerns.

### SBW stock structure

42 For the purposes of stock assessment it is assumed that there are four stocks of SBW with fidelity within stocks: the Bounty Platform stock (SBW 6B), the Pukaki Rise stock (SBW 6R), the Auckland Islands stock (SBW 6A), and the Campbell Island stock (SBW 6I). A decision was made on introduction of this species into the QMS in

1999 to manage the four sub-Antarctic fisheries as separate stocks on the basis of the biological characteristics of the discrete fisheries.

### ***Management strategy for SBW***

- 43 Since 1997, management of the Bounty and Campbell fisheries has been based on a CAY strategy with the  $B_{MAY}$  being used as a proxy for  $B_{MSY}$ . A CAY strategy takes into account the biological characteristics of the stock and the current status of the stock based on, in the case of SBW, bi-annual research undertaken in the fishery. Ageing studies have shown that SBW stocks have very high recruitment variability. This variability translates into large fluctuations in biomass. A management strategy based on CAY provides the opportunity to maximise yield from the fishery over time by taking into account fluctuations in biomass. Regular acoustic surveys (primarily focusing on the principal fishing grounds of Bounty and Campbell) and stock assessments provide estimates of biomass and available yields that minimise risk to the fishery while maximising available yield.

### ***Commercial fishery***

- 44 The fishery for SBW is almost entirely concentrated on the August-September spawning aggregations, with over 90% of the catch taken within six to eight weeks, although, in recent years, fishing has extended into October. The method of catching SBW is trawling (primarily midwater).
- 45 A total commercial catch limit of 32,000 tonnes, with area sub-limits, was introduced for SBW in the 1992–93 fishing year. SBW 6 was introduced into the QMS by legislation on 1 November 1999 after completion of the 1999 fishing season. SBW 1 was introduced into the QMS on 1 April 2000.
- 46 The catch limits for the Bounty and Campbell fisheries have been under-caught in most years since their introduction into the QMS, although catch did increase relative to the TACCs in the 2002-03 season. The under-catch in these fisheries may reflect the relative economic value of the fish and difficulties in timing experienced by operators in this fishery rather than low stock sizes. The SBW fishery is predominantly fished by vessels following completion of the hoki fishery. A poor hoki season may result in vessels remaining longer on the hoki grounds and missing the commencement of the SBW fishing season.
- 47 Industry has noted that the limited duration of the season, coupled with long distances between fishing areas and significant search times to locate fish, works against the ability of the fishing industry to fish effectively in all four SBW 6 QMAs and against all four TACCs in any one season. Even in years of high fish abundance, fleet managers recognise that they lose some fishing time due to poor weather and to exploration in search of suitable fish aggregations.

### ***Economic effects***

- 48 The Campbell fishery is characterised by high volumes of catch and low prices. Thus, if fish cannot be taken in high volumes, the economic incentive for fishers to operate in the fishery is reduced and fishers may look to move into more lucrative fisheries.

- 49 An estimation of the value of the SBW6I fishery can be undertaken by an examination of port prices and TACC level. The 2003-04 port price for SBW is reported to be \$100 per tonne, down significantly from the 2002-03 port price of \$590 per tonne. The landed catch for the SBW 6I fishery in 2002-03 was about 30,000 tonnes, resulting in a gross raw product value of approximately \$17.7 million. Reductions in both port price and TACC for the 2003-04 season are expected to reduce this gross value significantly, due primarily to the sharp decline in port price.
- 50 A comparison of the value of catch over the five years to 2002-03 indicates that the average gross value from the SBW 6I fishery was \$12.9 million (at \$490/tonne). At the 2003-04 estimated port price of \$100 per tonne for the SBW 6I fishery, the 2003-04 port value will decline to \$2.5 million (25 000 tonnes at \$100/tonne), substantially less than the average. The proposed reduction in catch of 5 000 tonnes for 2004-05 would represent a reduction in revenue of \$ 0.5 million at the port price of \$100/tonne.
- 51 SeaFIC figures show that, for the 2002 Calendar year, the total free on board value (FOB, basic value of exports) of SBW was about \$29 million, including surimi, frozen fillet, and frozen head and gutted product. In 2002, SBW 6I contributed roughly 90% of all SBW catch, thus accounting for the vast majority of \$29 million in export earnings.
- 52 MFish has no estimates of the effects on cultural or social factors such as employment or income that would be associated with an increase or decrease in catch levels.

### ***Recreational fishery***

- 53 There is no known recreational fishery for SBW in any stock.

### ***Māori customary fishery***

- 54 There is no known non-commercial Māori customary take of SBW in any stock.

### ***Other Sources of fishing-related mortality***

- 55 Scientific observers have reported discards of undersize fish and accidental loss from torn or burst codends.
- 56 NIWA estimated discards in the SBW fishery for the 1994-95 and 1995-96 fishing years. Some 39,756 tonnes of SBW were landed in those years. NIWA estimated that 616 tonnes (95% confidence intervals 295-1,145 tonnes) or 1.5% of the total SBW catch was discarded in that period.

### **Observer coverage**

- 57 In the 2003-04 fishing year, observer coverage was planned to cover about 350 days (100 of which are DoC CSL observer days). This compares to the 2001-02 fishing year there where there were 408 observer days in the SBW fisheries. Note that an observer day is defined as a 12 hour shift. Normally there are two observers on board a vessel allowing 24 hour coverage to be completed.

- 58 Observer coverage in SBW 6 in the 2001-02 fishing year was at a level in excess of 30% so that a robust assessment can be carried out into the number of fur seals and/or seabirds killed over the whole fishery. In the Campbell Rise (SBW 6I) fishery there were 755 tows for SBW and 403 were observed (53%), while in the Bounty Rise (SBW 6B) fishery there were 34 tows of which 25 were observed (74%).
- 59 MFish will continue to monitor the number of fur seals and seabirds captured in the SBW fishery through the observer programme.

## **Environmental Considerations**

### ***Fur Seals***

- 60 A final research report for the Ministry of Fisheries (FAR 2001/14) reports the number of fur seals killed in the 1999-2000 SBW fishing year. An estimated 14 fur seals (c.v. = 43%) were killed at the Campbell Plateau fishery (SBW 6I), based on four confirmed deaths reported in the 27% observer coverage of the 789 tows conducted in that season. The report concluded that fur sea bycatch rate was significantly lower in the Campbell Plateau compared to the Bounty Platform.
- 61 Application of a marine mammal exclusion device has been trialed in the Auckland Islands squid fishery. Extension of use of this device for other fisheries could be considered subject to the device proving effective. Fishers in the SBW fishery currently implement a voluntary code of practice that is designed to reduce the capture of marine mammals.

### ***Seabirds***

- 62 A final research report for the Ministry of Fisheries shows that for the 1999-2000 fishing year two seabirds were landed dead from tows off the northeastern edge of the Campbell Plateau (Baird S J, Sept 2001). Both birds were identified as male Grey petrels. Grey petrels are considered to have a threat status of “at risk” (draft Seabird National Plan of Action (NPOA) on Seabirds).
- 63 Grey petrels breed at the Campbell Islands group and the Antipodes Islands with New Zealand. In 1984 the New Zealand population was estimated to be 10,000 – 50,000 pairs. The size of the total global population is not currently known. Grey petrels are known to breed on six islands outside New Zealand. In the 1998-99 fishing year one seabird was observed caught and released alive from the Bounty Platform.

### ***Fish bycatch***

- 64 The effects of fishing on any stock and the aquatic environment in general as a consequence of the SBW 6I fishery are unknown. Although there is information on incidental catch of associated or dependent species, this is insufficient information to assess the impact current levels of fishing for SBW 6I might be having on these species or the biological diversity of the aquatic environment of the SBW 6I fishery.
- 65 However, the latest research results (in preliminary form, reporting on project ENV2002/02) confirm that the southern blue whiting fishery is characterized by relatively clean catches of the target species. Based on data collected between 1990

and 2002, preliminary results show that the three main bycatch species in the southern blue whiting fishery are hoki (0.2 % of SBW catch), ling (0.2 %) and hake (0.1 %). Given those data and the estimated target species discard proportion of 1.5 %, the southern blue whiting fishery appears to have the least wasteful of those New Zealand trawl fisheries examined.

## **Research**

- 66 An acoustic survey of the Campbell fishery was completed in winter 2002. This survey has been incorporated into a new stock assessment, reported in the May 2003 Plenary Report (see Appendix Two).
- 67 Industry has reportedly completed acoustic surveys during the current fishing season. Industry could produce abundance estimates from their acoustic data to include in final advice after consideration by the relevant working groups.

## **Compliance information**

- 68 There are unlikely to be significant compliance concerns in this fishery. However, large bags taken in these fisheries are likely to contain damaged and undersized fish, potentially resulting in dumping and high grading of fish. Misreporting of catches between areas is also possible, given the large differences in the catch limits between adjacent fishery areas or stocks.

## APPENDIX TWO – STOCK ASSESSMENT

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- 69 Updated estimates of biomass and yield are provided for the Campbell stock based on analyses using catch-at-age from the commercial fishery, acoustic survey data, and estimates of biological parameters. New information since the 2001 assessment included the results of an acoustic survey carried out in 2002, and two years of observer proportions-at-age data.

### Estimates of fishery parameters and abundance indices

- 70 Acoustic surveys of southern blue whiting have been carried out since 1993. Target strength work has continued each year as part of these acoustic surveys. Additional estimates from in situ data were reported in 2002, which indicate that the slope in the target strength – fish length relationship may be steeper than previously used (Dunford 2001a,b). However, the Working Group was unable to resolve the inconsistencies between the various data sources (swimbladder modelling, in situ data and recent results from work on northern blue whiting). Therefore it was agreed to retain the original relationship between target strength and fish length from the Northern hemisphere for blue whiting (Monstad et al., 1992) as used previously in New Zealand assessments. The Working Group noted that if the slope in this relationship is kept the same, the value of  $q$  changes in the model but relative abundance indices are still valid, whereas if a different slope of the relationship is used the data must be reanalysed.
- 71 A further acoustic survey of the Campbell stock was completed in August/September 2002. Two snapshots were carried out on spawning and post-spawning aggregations on the Campbell Island Rise. The two snapshots biomass estimates were averaged and decomposed to biomass at age (Table 4). This survey gave a much higher CV than previous surveys, mainly because high-density aggregations of fish were found on only a few transects within each snapshot.
- 72 An aggregation east of the survey area was also surveyed acoustically but biomass from this area was not included in the time series of relative abundance indices as this would not be consistent with the spatial coverage of previous surveys. The addition of the extra stratum where this aggregation was found would add only about 2.5% to the 2002 biomass index.

**Table 4: Estimates of biomass (000 t) for age 1, 2, 3 and 4+ fish from acoustic surveys of Bounty Platform, Pukaki Rise, and Campbell Island Rise, and CPUE indices. – no data.**

Year	Bounty Platform				Pukaki Rise				Campbell Island Rise				CPUE
	1	2	3	4+	1	2	3	4+	1	2	3	4+	
1986	–	–	–	–	–	–	–	–	–	–	–	–	1.00
1987	–	–	–	–	–	–	–	–	–	–	–	–	0.72
1988	–	–	–	–	–	–	–	–	–	–	–	–	0.59
1989	–	–	–	–	–	–	–	–	–	–	–	–	0.60
1990	–	–	–	–	–	–	–	–	–	–	–	–	0.52
1991	–	–	–	–	–	–	–	–	–	–	–	–	0.52
1992	–	–	–	–	–	–	–	–	–	–	–	–	0.27
1993	8.81	6.87	1.41	62.86	0.58	26.85	9.32	31.15	1.82	71.90	14.78	24.03	0.69
1994	0.09	5.87	32.07	27.67	0.01	1.19	6.36	35.97	0.33	12.26	139.55	28.84	0.74
1995	59.28	4.86	6.66	30.77	0.00	0.10	0.78	11.74	0.00	11.18	23.23	130.54	1.30
1996	–	–	–	–	–	–	–	–	–	–	–	–	1.54
1997	1.68	4.14	24.60	37.52	0.02	2.84	0.86	34.09	–	–	–	–	1.03
1998	–	–	–	–	–	–	–	–	2.28	13.14	28.02	167.67	0.99
1999	0.43	0.75	4.97	42.72	–	–	–	–	–	–	–	–	–
2000	–	–	–	–	0.06	3.04	2.07	29.45	0.96	10.46	8.42	135.61	–
2001	0.14	2.55	6.01	21.68	–	–	–	–	–	–	–	–	–
2002	–	–	–	–	–	–	–	–	3.06	3.73	11.55	148.19	–

73 The results of a standardised CPUE analysis of the Campbell Island Rise are also shown in Table 4. There is concern that because of the highly aggregated nature of the fishery, and the associated difficulty in finding and maintaining contact with the highly mobile schools in some years, the CPUE series may not be monitoring abundance. This has not been updated since 1998 and the indices are not used in the stock assessment.

## Biomass estimates for the Campbell Island stock

74 The stock assessment model partitions the Campbell stock into two sexes and age groups 2–11, with a plus group at age 11. There are two time steps in the model (Table 5). In the first time step 90% of natural mortality takes place. In the second time step, fish ages are incremented, the 2-year-olds are recruited to the population, which is then subjected to fishing mortality and the remaining 10% of natural mortality.

**Table 5: Annual cycle of the stock model, showing the processes taking place at each step, and the available observations. Fishing mortality (F) and natural mortality (M) that occur within a time step occur after all other processes. M, proportion of M occurring in that time step.**

Period	Process	M	Length at age	Observations
1. Nov–Aug	Natural mortality	0.9	–	–
2. Sep–Oct	Age, recruitment, F, M	0.1	Matrix applies here	Proportion at age, acoustic indices

75 The model assumes that the fishing selectivity after age 4 is 1.0, and estimates selectivity for each sex for ages 2 to 4. Selectivities were assumed constant over all years in the fishery, and hence there was no allowance for annual changes in selectivity. In line with previous assessments no stock-recruitment relationship is assumed in the model. The proportion of males at recruitment (age 2) was assumed to be 0.5 of all recruits. As it is a spawning fishery the maturity ogive was assumed to be the same as the selectivity ogive estimated in the model. Note that the maturity ogive is only used to report spawning stock biomass. The maximum exploitation rate ( $U_{max}$ )

was set at a value of 0.7. The choice of the maximum exploitation rate has the effect of determining the minimum possible virgin biomass allowed by the model. Because of the large inter-annual differences in growth, caused by the occurrence of the strong and weak year classes, length-at-age vectors were calculated for each year, and used in the modelling. Lengths-at-age were converted to weights-at-age in the model using the length-weight relationship given in Table 3.

- 76 The model was fitted to the acoustic biomass estimates of ages 2, 3, and 4+ fish given in Table 6 and the proportions-at-age data from the commercial fishery. The acoustic survey estimates were used as relative estimates of mid-season biomass (i.e., after half the catch has been removed), with associated c.v.s estimated from the survey analysis. Catch-at-age observations were available from the commercial fishery for the period 1979 to 2002. Catch-at-age data were fitted to the model as proportions-at-age, where estimates of the proportions-at-age and associated c.v.s by age were estimated using the NIWA catch-at-age software by bootstrap (Bull & Dunn 2002). Zero values were replaced with the value 0.0002 with an associated c.v. of 1.5. Ageing error was assumed to be zero.
- 77 Lognormal errors, with known c.v.s were assumed for the relative biomass and proportions-at-age data. The c.v.s available for these data allow for sampling error only. However, additional variance assumed to arise from differences between model simplifications and real world variation, was added to the sampling variance. The additional variance, termed process error, was estimated in an initial run of the model using all the available data. A process error of 0.4 was estimated for the proportions-at-age data and was added to each observation for all subsequent model runs. The process error estimated for the acoustic indices was zero.

**Table 6: Decomposed biomass estimates (t) and c.v.s by survey and age group used for the Campbell Island Rise stock assessment.**

Year	Age 2		Age 3		Age 4+	
	Biomass	c.v.	Biomass	c.v.	Biomass	c.v.
1993	71 902	23	14 781	22	24 033	21
1994	12 259	38	139 552	37	28 841	36
1995	11 176	25	23 228	28	130 535	30
1998	13 142	20	28 022	19	167 668	18
2000	10 460	23	8 421	20	135 612	17
2002	3 732	76	11 549	72	148 189	68

## Estimation

- 78 Model parameters were estimated using Bayesian methods implemented using the NIWA stock assessment program CASAL v1.02 (Bull et al., 2002). For initial runs only the mode of the joint posterior distribution was sampled. For the final runs presented here the full posterior distribution was sampled using Markov Chain Monte Carlo (MCMC) methods, based on the Metropolis-Hastings algorithm.
- 79 MCMC chains were estimated using a burn-in length of  $5 \times 10^5$  iterations, with every 5 000<sup>th</sup> sample taken from the next  $5 \times 10^6$  iterations (i.e., a final sample of length 1000 was taken from the Bayesian posterior). Tests for autocorrelations and single chain convergence (Heidelberger & Welch 1983, Geweke 1992) were applied to resulting chains to look for evidence of non-convergence.

80 Equilibrium virgin biomass is equal to the population that there would have been if all the YCS were equal to 1 and there was no fishing. However, there was a period of unknown (and possibly large) catches from the Campbell stock before 1979, and there is high recruitment variability in the stock, so the initial 1979 biomass was allowed to differ from the equilibrium virgin biomass. The initial population in 1979 (ages 3 to 11+) was estimated for each sex. Year class strengths were estimated for all years from 1977 to 2000, under the assumption that the estimates from the model should average one.

## Prior distributions and penalty functions

81 The assumed prior distributions used in the assessment are given in Table 7. Most priors were intended to be uninformed, and had wide bounds. However, a log-normal prior was used for natural mortality and in basecase 2 for the acoustic survey 4+  $q$ .

**Table 7:** The distributions, priors, and bounds assumed for the various parameters being estimated. The parameters are mean and c.v. for lognormal; and mean and s.d. for normal. Note acoustic  $q$ s were treated as nuisance parameters in basecase 1.

Parameter Basecase 1	N	Distribution	Values		Bounds	
			Mean	c.v. / s.d.	Lower	Upper
$B_0$	1	Uniform-log	–	–	30 000	1 000 000
Acoustic $q$ s	3	Uniform-log	–	–	0.1	2.8
YCS	24	Lognormal	1.00	1.30	0.01	10
Initial population	18	Uniform-log	–	–	1	1 000 000
Selectivity ages 2-4 (by sex)	6	Uniform	–	–	0.0001	1
M (average)	1	Lognormal	0.20	0.20	0.07	0.35
M (difference)	1	Normal	0.00	0.05	-0.2	0.2
Basecase 2						
Acoustic 4+ $q$	1	Lognormal	1.40	0.20	0.1	2.8

82 The informed prior for the adult (4+) acoustic  $q$  was obtained using the approach of Cordue (1996). Uncertainty over various factors including mean target strength, acoustic system calibration, target identification, shadow or dead zone correction, and areal availability were all taken into account. In addition to obtaining the bounds, a mean for each factor was also assumed. The factors were then multiplied together. This independent evaluation of the bounds on the acoustic  $q$  suggested a range of 0.65–2.8, with a mean of 1.4 and a c.v. of 0.2. As the 90% confidence bounds of  $q$  from preliminary MCMC runs extended lower than 0.65 the Working Group agreed to extend the lower bound to 0.1.

83 The prior on natural mortality was determined by assuming that the true value could differ from the current value by about 0.05, and not more than 0.1. Natural mortality was parameterised by the average of male and female, with the difference estimated with an associated normal prior with mean 0.0 and standard deviation 0.05. Penalty functions were used to constrain the model so that any combinations of parameters that did not allow the historical catch to be taken were strongly penalised. A small penalty was applied to encourage the estimates of year class strengths to average to 1.

## Basecase runs and sensitivity tests

84 The Working Group considered a number of alternative assessments and agreed on the two basecase runs described in Table 8. In recent stock assessments of SBW the estimates of current biomass have been driven to a large extent by the estimate of the 4+ (adult) acoustic  $q$ . In the 2002 assessments of the Bounty and Pukaki stocks estimated values for the 4+ acoustic  $q$  were considered to be unrealistic by the Working Group and runs with  $q$  fixed (or with informed priors) were used instead. Therefore, in basecase 1 the 4+ acoustic  $q$  was estimated with an uninformed (uniform-log) prior. In the second basecase the 4+ acoustic  $q$  was estimated with an informed (lognormal) prior as described earlier. In both cases natural mortality was estimated within the model.

**Table 8: Model run labels and descriptions for the basecase and sensitivity runs.**

Model label	Description
Basecase 1	Basecase model with uniform-log $q$ , $M$ estimated in the model, lognormal error structure, and selectivity estimated for ages 2–4 for both sexes.
Basecase 2	Basecase model with lognormal $q$ , $M$ estimated in the model, lognormal error structure, and selectivity estimated for ages 2–4 for both sexes.

85 For each model run, MPD fits were obtained and qualitatively evaluated. MCMC estimates of the median posterior and 90% credible intervals are reported for virgin biomass,  $B_{2002}$ , and  $B_{2002}$  (as  $\%B_{1991}$ ).  $B_{1991}$  was chosen as a reference threshold biomass because this biomass was the lowest observed and subsequently gave rise to good recruitment and stock recovery. As such, the WG agreed that it can be regarded as a safe threshold; future management should aim to keep the biomass above this level.

## Results

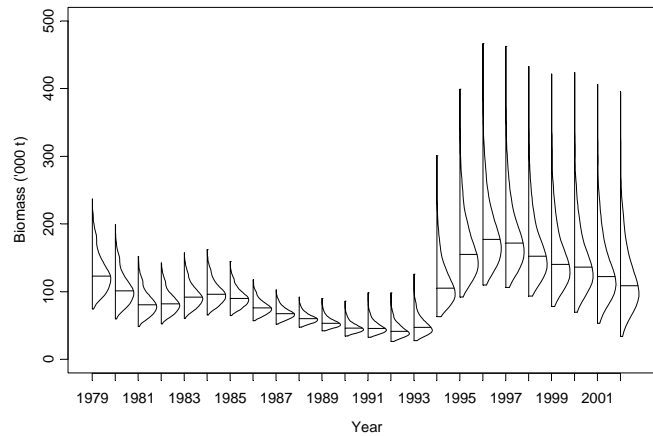
86 The estimated MCMC marginal posterior distributions for spawning stock biomass by year are shown for the two basecases in Figures 1 and 2, and are summarised in Table 9. The population trajectories are very similar for both basecases. The main difference between them lies in the median estimates of current biomass, and the bounds on the biomass estimates since the mid 1990s. In basecase 1,  $q$  was estimated as 0.99, whereas in basecase 2,  $q$  was estimated as 1.24.

87 Both runs suggest that the stock biomass showed a steady decline from the early 1980s until 1993 followed by a large increase to 1996, and a slight decline thereafter. The 1991 year class still makes a large contribution to the commercial catch (especially by weight), and has been joined by the 1995, 1996, and 1998 year classes, all of which also appear to be moderately strong (Figure 3). (Note that the year class strength estimates are almost identical between the two models, so only one of them is shown here.)

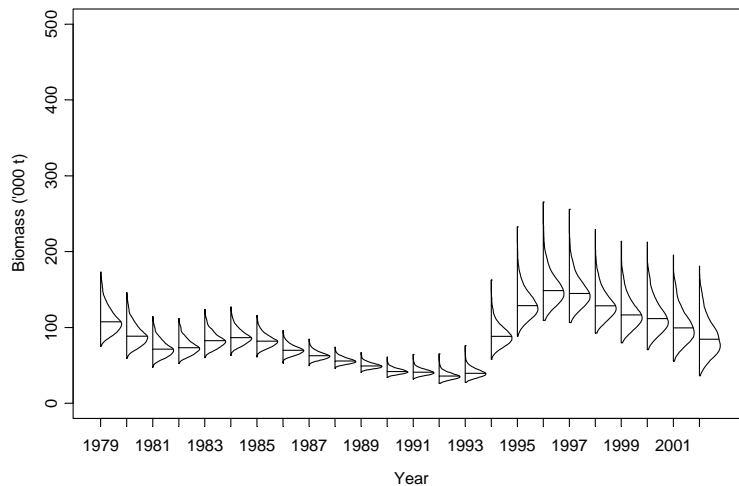
**Table 9: Bayesian median and credible intervals of  $B_0$ ,  $B_{2002}$  (in '000 t), and  $B_{2002}$  as a percentage of  $B_{1991}$  for the reference cases. Median estimates of  $M$  and the adult 4+ acoustic  $q$  are also provided.**

Model run	$B_0$	$B_{2002}$	$B_{2002}$ ( $\%B_{1991}$ )	$M$	$q$
Basecase 1	242 (205–308)	109 (60–216)	234 (145–373)	0.20	0.99
Basecase 2	238 (199–285)	85 (54–137)	205 (134–309)	0.17	1.24

**Figure 1: Estimated posterior distributions of biomass trajectories for the Campbell stock for basecase 1.**

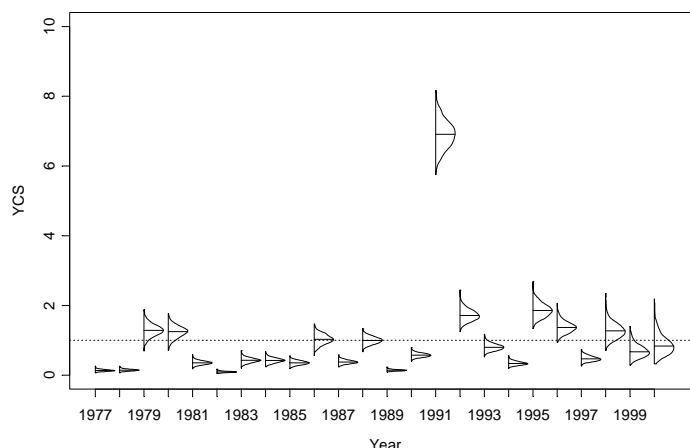


**Figure 2: Estimated posterior distributions of biomass trajectories for the Campbell stock for basecase 2.**



88 Sensitivity runs were made for a number of cases with  $M$  fixed at 0.2; using a multinomial error structure for the age data, having maturity in the partition, and freeing up the age 5+ selectivity for females made little difference to the results. When  $M$  was fixed in the model, median estimates of current biomass were slightly higher for both basecases.

Figure 3: Estimated posterior distributions of year class strengths for the Campbell stock for basecase 1.



89 Projections were made assuming fixed catch levels from 10,000 to 30,000 tonnes per year using the MCMC samples, and assuming the TACC of 25 000 tonnes will be taken in 2003–04. Recruitments were drawn randomly from the distribution of year class strengths estimated by the model over the period 1977 to 2000. The probability that the mid-season biomass for the specified year will be less than the mid-season biomass in 1991 is given for the two basecase runs in Table 10. The probability of dropping below the threshold biomass reaches the 10% level by 2005 at catches of about 15 000 tonnes (basecase 1) or 10 000–15 000 tonnes (basecase 2).

Table 10: Probability that the projected mid-season vulnerable biomass for 2004 and 2005 will be less than the mid-season vulnerable biomass in 1991, and the median projected biomass as a%  $B_{1991}$ , for different constant catch levels for the two basecase runs for the Campbell stock, assuming a 25 000 tonne catch in 2003.

Constant catch (t)	Year	Probability ( $B_{proj} < B_{1991}$ )		Median biomass as % $B_{1991}$	
		2004	2005	2004	2005
Basecase 1					
10 000		0.08	0.07	200	217
15 000		0.09	0.10	196	202
20 000		0.09	0.13	191	187
25 000		0.11	0.18	185	173
30 000		0.12	0.24	180	157
Basecase 2					
10 000		0.13	0.09	166	181
15 000		0.15	0.16	160	164
20 000		0.17	0.26	155	146
25 000		0.21	0.34	149	130
30 000		0.23	0.43	144	113

### Other yield estimates and stock assessment results

90 As an alternative to the CAY estimates, the results have been presented in the form of decision tables. In the Campbell assessment the probability of biomass remaining above a reference year (1991) is presented for alternative catch levels from 10 000 to 30 000 tonnes (Table 10).

## **STATUS OF THE CAMPBELL ISLAND STOCK**

- 91 A new assessment is available for the Campbell Island Rise stock. No new assessments are available for the Bounty Platform, Pukaki Rise, and Auckland Islands stocks. The years given in this section refer to the August-September spawning/fishing season.
  
- 92 The model indicates that biomass in 2002 was more than double the biomass in the reference year (1991). This year was chosen as a reference threshold biomass because biomass in 1991 was the lowest observed but gave rise to good recruitment and subsequent stock recovery. The very strong 1991 year class persisted in the fishery in 2002 but above average recruitment also entered the fishery from the 1995, 1996, and 1998 year classes. The TACC was reduced to 25 000 tonnes from 1 April 2003; at catches at this level the biomass is projected to decline (Table 10).

## LIST OF REFERENCES AND SOURCES OF FURTHER INFORMATION

- Baird, S.J. (2001) estimation of the incidental capture of seabird and marine mammal species in commercial fisheries in new Zealand waters, 1998-99. New Zealand Fisheries Assessment Research Report 2001/14. 43 p. (Unpublished report held by the Ministry of Fisheries, Wellington.)
- Bull, B.; Dunn, A. (2002). Catch-at-age: User manual v1.06.2002/09/12. NIWA Internal Report 114. 23 p. NIWA. (Unpublished report).
- Bull, B.; Francis, R.I.C.C., Dunn, A.; Gilbert, D.J. (2002). CASAL (C++ algorithmic stock assessment laboratory): CASAL User Manual v1.02.2002/10/21. *NIWA Technical Report 117*. 199 p.
- Cordue, P.L. (1996). A model-based method for bounding virgin biomass using a catch history, relative biomass indices, and ancillary information. New Zealand Fisheries Assessment Research Document 96/8. 48 p. (Draft report held in NIWA library, Wellington.)
- Dunford, A. (2001a). Estimates of target strength of southern blue whiting (*Micromesistius australis*). Final Research Report for Ministry of Fisheries Research Project SBW9801 Objective 4. 12 p. (Unpublished report held by the Ministry of Fisheries, Wellington.)
- Dunford, A. (2001b). Estimates of target strength of southern blue whiting (*Micromesistius australis*) from the Campbell Rise and Pukaki Rise, September 2000. Final Research Report for Ministry of Fisheries Research Project SBW1999/01 Objective 3. 18 p. (Unpublished report held by the Ministry of Fisheries, Wellington.)
- Dunn, A.; Hanchet, S.M. (1998). Two-phase acoustic survey designs for southern blue whiting on the Bounty Platform and the Pukaki Rise. *NIWA Technical Report 28*. 29 p.
- Dunn, A.; Francis, R.I.C.C.; Doonan, I.J. (1999). The sensitivity of some catch curve estimators of mortality to stochastic noise, error, and selectivity. New Zealand Fisheries Assessment Research Document 99/5. 23 p. (Draft report held in NIWA library, Wellington.)
- Dunn, A.; Grimes, P.J.; Hanchet, S.M. (2001). Comparative evaluation of two-phase and adaptive cluster sampling designs for acoustic surveys of southern blue whiting (*M. australis*) on the Campbell Rise. Final Research Report for MFish Research Project SBW1999/01. Objective 1. 15 p. (Unpublished report held by the Ministry of Fisheries, Wellington.)
- Francis, R.I.C.C. (1992). Recommendations concerning the calculation of maximum constant yield (MCY) and current annual yield (CAY). New Zealand Fisheries Assessment Research Document 92/8. 27 p. (Draft report held in NIWA library, Wellington.)
- Gilbert, D.G.; McKenzie, J.R.; Davies, N.M.; Field, K.D. (2000). Assessment of the SNA 1 stocks for the 1999–2000 fishing year. *New Zealand Fisheries Assessment Report 2000/38*. 52 p.
- Hanchet, S.M. (1991). Southern blue whiting fishery assessment for the 1991–92 fishing year. New Zealand Fisheries Assessment Research Document 91/7. 48 p. (Draft report held in NIWA library, Wellington.)
- Hanchet, S.M. (1999). Stock structure of southern blue whiting (*Micromesistius australis*) in New Zealand waters. *New Zealand Journal of Marine and Freshwater Research* 33(4): 599–610.
- Hanchet, S.M. (2002a). Southern blue whiting (*Micromesistius australis*) stock assessment for the Campbell Island Rise and Pukaki Rise for 2001 and 2002. *New Zealand Fisheries Assessment Report 2002/31*. 38 p.

- Hanchet, S.M. (2002b). Southern blue whiting (*Micromesistius australis*) stock assessment for the Bounty Platform for 2002 and 2003. *New Zealand Fisheries Assessment Report 2002/53*. 23 p.
- Hanchet, S.M.; Bull, B.; Bryan, C. (2000a). Diel variation in fish density estimates during acoustic surveys of southern blue whiting. *New Zealand Fisheries Assessment Report 2000/16*. 22 p.
- Hanchet, S.M.; Grimes, P.J. (2000). Acoustic biomass estimates of southern blue whiting (*Micromesistius australis*) from the Bounty Platform, August 1999. *New Zealand Fisheries Assessment Report 2000/30*. 25 p.
- Hanchet, S.M.; Grimes, P.J. (2001). Acoustic biomass estimates of southern blue whiting (*Micromesistius australis*) from the Campbell Island Rise and Pukaki Rise, September 2000. *New Zealand Fisheries Assessment Report 2001/58*. 37 p.
- Hanchet, S.M.; Grimes, P.J.; Coombs, R.F. (2002). Acoustic biomass estimates of southern blue whiting (*Micromesistius australis*) from the Bounty Platform, August 2001. *New Zealand Fisheries Assessment Report 2002/58*. 35 p.
- Hanchet, S.M., Grimes, P.J.; Dunford, A.; Ricnik, A. (2002). Classification of fish marks from southern blue whiting acoustic surveys. Final Research Report for MFish Research Project SBW2000/02 Objective 2. 55 p.
- Hanchet, S.M.; Haist, V.; Fournier, D. (1998). An integrated assessment of southern blue whiting (*Micromesistius australis*) from New Zealand waters using separable Sequential Population Analysis. In Funk, F. et al. (eds). *Alaska Sea Grant College Program Report No. AK-SG-98-01*. University of Alaska, Fairbanks, 1998.
- Hanchet, S.M.; Renwick, J.A. (1999). Prediction of southern blue whiting (*Micromesistius australis*) year class strength in New Zealand waters. *New Zealand Fisheries Assessment Research Document 99/51*. 24 p. (Draft report held in NIWA library, Wellington.)
- Hanchet, S.M.; Richards, L.; Bradford, E. (2000b). Decomposition of acoustic biomass estimates of southern blue whiting (*Micromesistius australis*) using length and age frequency data. *New Zealand Fisheries Assessment Report 2000/43*. 37 p.
- Hilborn, R. M.; Maunder, A.; Parma, B.; Ernst, J.; Payne, J.; Starr, P. (2001). COLERAINE: a generalised age-structured stock assessment model user's manual V.2.0. FRI-UW Report Series 0116. School of Aquatic and Fishery Sciences, University of Washington, Seattle, 58 p.
- McClatchie, S.; Macaulay, G.; Hanchet, S.; Coombs, R.F. (1998). Target strength of southern blue whiting (*Micromesistius australis*) using swimbladder modelling, split beam and deconvolution. *ICES Journal of Marine Science* 55: 482–493.
- McClatchie, S.; Thorne, R.; Grimes, P.J.; Hanchet, S. (2000). Ground truth and target identification for fisheries acoustics. *Fisheries Research* 47: 173–191.
- Monstad, T.; Borkin, I.; Ermolchev, V. (1992). Report of the joint Norwegian-Russian acoustic survey on blue whiting, spring 1992. *ICES C.M. 1992/H:6, Pelagic Fish Committee*. 26 p.

