

**Review of Sustainability Measures and Other Management  
Controls for the April 2006 - March 2007 Fishing Year**

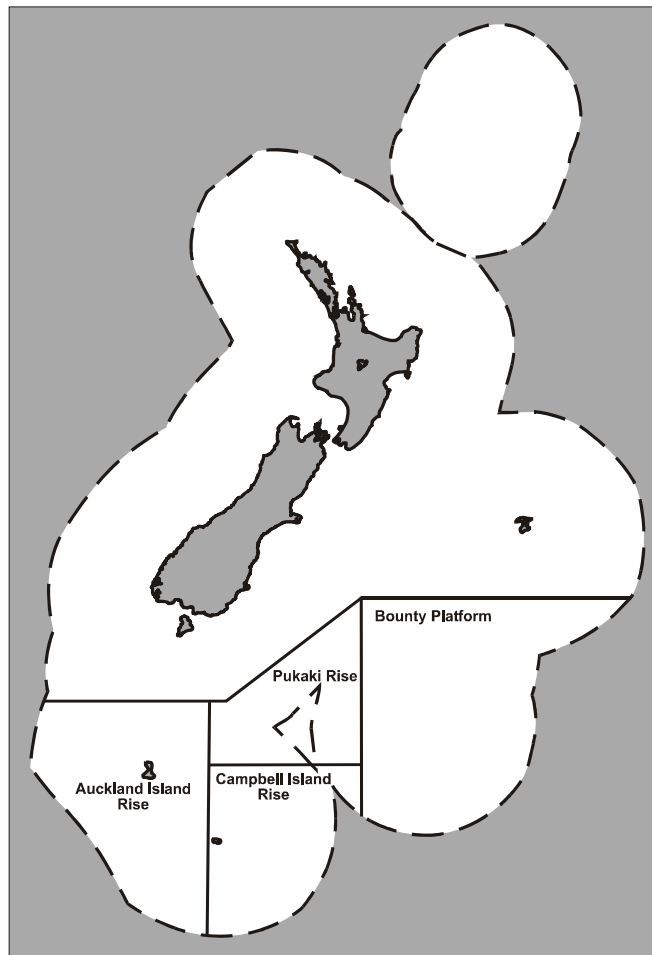
**Initial Position Paper**

**20 February 2006**

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

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

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



## Key issues to be considered

- 1 The key fishery management matters to be considered for the Campbell Island Rise southern blue whiting stock (SBW 6I) include the following:
  - a) The Minister's 2004 decision to retain the 2004-05 total allowable commercial catch (TACC) at 25 000 tonnes. This decision was coupled with the caution that reductions in the 2005-06 SBW 6I TACC might be required unless updated scientific information indicated an improvement in the abundance estimate.
  - b) The Minister's 2005 decision to retain the 2005-06 TACC at 25 000 tonnes. The updated assessment in 2005 suggested continued declines in stock size. The Minister took into account the economic impacts of a TACC reduction

and the relatively small increased risk to the stock of a 25 000 tonne TAC compared with a lower level (as informed by the 2005 assessment).

- c) The latest stock assessment indicates the SBW 6I biomass is below the level that can produce the maximum sustainable yield (the  $B_{MSY}$ ). Section 13 of the Fisheries Act 1996 requires that the Minister sets a TAC that enables the stock level to be altered in a way and rate that will restore it to or above the  $B_{MSY}$  level. In doing so, the Minister shall have regard to the interdependence of stocks, the rebuild period that is appropriate given the biological characteristics of the stock and any environmental conditions affecting it, as well as any social, cultural, and economic factors as the Minister considers relevant. The Minister has discretion in determining the way and rate in which to move a stock towards or above the  $B_{MSY}$  level. This allows for some degree of balancing between utilisation and sustainability considerations while meeting the obligations under s 13 to move a stock towards  $B_{MSY}$ .
- d) The uncertainty in the latest assessment. The 2005 stock assessment has been updated for 2006 by including commercial catch data from the 2005 SBW season. A full stock assessment will not be available until 2007 following completion of the acoustic biomass survey scheduled for 2006. There is therefore a greater degree of uncertainty in the current information than would be the case if new biomass data was available and full revision of the stock assessment had been carried out. Nevertheless, the 2006 assessment represents the best available information for the purposes of decision making under the Fisheries Act 1996.
- e) The approach to managing the SBW 6I fishery, presently based on a current annual yield (CAY) harvest strategy. The CAY strategy is considered appropriate for the fishery's characteristics, and is expected to deliver the best yield over time. Under a CAY strategy, the catch is altered annually according to changes in biomass and should deliver the maximum average yield (MAY) as the long-term average catch - the expected average biomass is termed  $B_{MAY}$ . MFish uses  $B_{MAY}$  as an appropriate representation of  $B_{MSY}$  for this fishery.
- f) The last three stock assessments have suggested declining biomass trends. The updated SBW 6I stock assessment for 2006 is based on the assessment completed in 2006, with 2004 acoustic biomass survey information and updated with information from the fishery in 2004 and 2005 (details in Appendix Two). The 2006 assessment indicates that:
  - SBW 6I biomass has reduced to  $28\%B_0$ , which is less than that required to support the Maximum Sustainable Yield ( $B_{MSY}$ ) - which is estimated by  $B_{MAY} = 34\%B_0$  (and  $B_0$  is the estimate of the biomass if there had been no fishing and average recruitment);
  - The estimated current annual yield (CAY) for 2006-07 is 16 400 tonnes;
  - The estimates of median SBW 6I mid-season biomass continue to decline under constant catch levels of 20 000 tonnes and 25 000 tonnes, reaching  $25\%B_0$  and  $20\%B_0$  respectively in 2008. Under constant catches of 15 000 tonnes and 10 000 tonnes, the biomass stabilises and increases to  $30\%B_0$  and  $35\%B_0$  respectively in 2008.

- g) The use of the estimated 1991 biomass ( $B_{1991}$ ) as a limit reference biomass, and the probability of falling below that biomass to provide a comparison of risk associated with different catch levels. The biomass in 1991 was the lowest ever recorded, yet it gave rise to very strong recruitment and stock recovery. A risk threshold of 10% has been used previously to evaluate risk in SBW 6I, but concerns have arisen that 10% might be too great a probability for a limit biomass. The recruitment strength of the 1991 year class was a rare event, seen only once in the 27 year 'life' of the assessment model, with the 1991 year class 3.5 times stronger than the 'moderately strong' classes in 1992, 1995, 2001, and 2002. The Ministry will continue to investigate the most appropriate risk level to improve the consideration of relative risk of alternative catch levels in SBW 6I. It should be noted that the use of a limit reference does not have a statutory basis and is used as additional guidance only.
- h) The projections indicate that the risk of falling below  $B_{1991}$  is greatest at constant catches of 25 000 tonnes (8% in 2006, 22% in 2007, and 39% in 2008). Lower catch levels are less risky. The three-year constant catch would need to be reduced to approximately 15 000 tonnes to keep the risk of falling below  $B_{1991}$  at less than 10%. These projected levels of risk are greater than those indicated by the previous assessments in 2004 and 2005.
- i) Additional projections show the biomass trend and level of risk if the TACC were to be maintained at 25 000 tonnes in the upcoming 2006-07 fishing year. These projections show that while the TACC could be maintained at 25 000 tonnes in 2006-07, it would subsequently need to be reduced to between 0 tonnes and 5 000 tonnes for 2007-08 if the level of risk is to be less than 10% of depressing the biomass below the  $B_{1991}$  level. If realised, this would be the lowest TACC for the SBW 6I fishery since catch limits were first introduced in 1993, and would have a large economic impact on industry.
- j) An abundance survey of the SBW 6I fishery is planned for September 2006. The updated biomass estimate resulting from this survey will be incorporated in a new stock assessment. Results of this new assessment are anticipated by January 2007, and should be available to inform TACC-setting decisions prior to the 2007-08 fishing season for SBW.
- k) The initial management proposals presented in this IPP should be considered in the context of the Ministry's new direction for fisheries management, which embraces fisheries plans to describe objectives for fisheries as well as the tools and services that will be required to deliver those objectives. The Ministry currently is developing a 'proof of concept' fisheries plan for SBW stocks in collaboration with stakeholders, and is committed to see the Fishery Plan process through to completion.
- l) The fisheries planning framework provides opportunities for MFish and stakeholders to develop collaboratively the set of management measures for SBW 6I that best deliver the desired objectives and address the identifiable risks to the stock over time.

## Initial proposals

- 2 The latest stock assessment explored a range of possible TAC levels from 10 000 to 25 000 tonnes. The Minister might choose to set the TAC at some level across that spectrum. For the purpose of consultation, the Ministry of Fisheries (MFish) proposes three options within that range that reflect different responses to the assessment. The lower the TAC the lower the risk to stock sustainability but the greater the social and economic impacts. It is open to the Minister to choose an option that lies within the range of modelled TAC levels in meeting his sustainability and utilisation obligations set out in the Fisheries Act 1996 (the Act).
- 3 The three options proposed by MFish are as follows:

### Option 1

- i) reduce the total allowable catch (TAC) for SBW 6I for the 2006–07 fishing year to the CAY estimate of 16 400 tonnes;
- ii) set zero allowances within the TAC for customary Māori interests, recreational fishery interests, and other sources of fishing-related mortality;
- iii) set the total allowable commercial catch (TACC) for SBW 6I at 16 400 tonnes;

### Option 2

- i) reduce the TAC for SBW 6I for the 2006-07 fishing year to 20 000 tonnes;
- ii) set zero allowances within the TAC for customary Māori interests, recreational fishery interests, and other sources of fishing-related mortality;
- iii) set the TACC for SBW 6I at 20 000 tonnes;

### Option 3 (the *status quo*)

- i) maintain the TAC for SBW 6I for 2006-07 fishing year at 25 000 tonnes;
- ii) set zero allowances within the TAC for customary Māori interests, recreational fishery interests, and other sources of fishing-related mortality;
- iii) set the TACC for SBW 6I at 25 000 tonnes.

## Rationale for management proposals

### *Updating the stock assessment*

- 4 The proposed management options are based on the updated stock assessment that was reported to the Middle Depths Fisheries Assessment Working Group (the working group) on 31 January 2006. The assessment details are provided in Appendix Two.

- 5 In order to determine whether or not there was any urgent sustainability concern with the Campbell Islands stock, the Working Group agreed to update the 2005 base case assessment and sensitivity tests using the new data from the fishery in 2005. Updated estimates of biomass and yield are provided for the Campbell Island stock based on analyses using proportions of age classes of fish sampled from the commercial fishery, acoustic biomass survey data, and estimates of biological parameters. New information since the 2005 assessment included one year of commercial catch proportions-at-age data.
- 6 For the 2006 updated assessment, the working group again considered two possible hypotheses regarding the observed distribution of fish outside the core acoustic survey area: (1) the northern aggregation had moved further east and were spawning outside the survey area; (2) the fish which previously had spawned in the northern area had been depleted and the fish observed outside of the core area represent a new unsurveyed part of the population. During the 2005 season, most fishing on the northern aggregation occurred within the usual acoustic survey area, and despite some searching few fish were found to the east. The stock assessment was run using both sets of acoustic biomass estimates (Table 1) to examine the stock status under each hypothesis. However, the second hypothesis was considered to be more plausible and was used as the base case.
- 7 The updated assessment represents the best available information on the SBW 6I stock status and projected performance of the stock under a range of constant fishing-year catch levels from 10 000 tonnes up to the current TAC/TACC of 25 000 tonnes. The working group also requested additional projections to illustrate the performance of the stock under a range of constant fishing year catch levels after 2006-07, in the event that the TACC should remain at 25 000 tonnes in the 2006-07 fishing year.

### **Stock assessment results**

- 8 The current assessment (base case) 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 decline thereafter (refer to Figure 2 in Appendix Two to see the biomass trajectory). The 1991 year class was 7 times stronger than the historical mean year class strength, and while it sustained the fishery for the last few years, it now only makes up 5% of the catch. The 1992, 1995, 2001 and 2002 year classes were all much smaller than the 1991 year class (see Appendix Two, Figure 4), being around twice as strong as the mean year class strength, and are referred to as ‘moderately strong’.
- 10 Estimates of the expected unfished biomass  $B_0$  over the time of the model runs (given average recruitment levels), 2005 biomass ( $B_{2005}$ ), and sustainable yields have been calculated for the SBW 6I stock. The estimates of  $B_0$  and  $B_{2005}$  are shown in Table 1.

**Table 1: Bayesian median and 90% confidence intervals of  $B_0$ ,  $B_{2005}$  (in ‘000 t),  $B_{2005}$  as a percentage of  $B_{1991}$  and of  $B_0$ ,  $B_{1991} / B_0$  for the Campbell Island stock.**

Model run	$B_0$	$B_{2005}$	$B_{2005}$ (% $B_{1991}$ )	$B_{2005}$ (% $B_0$ )	$B_{1991} / B_0$
<b>Base case</b>	<b>245</b>	<b>68</b>	<b>164</b>	<b>28</b>	<b>0.17</b>
	(219–285)	(46–105)	(113–240)	(19–41)	(0.13–0.22)
Uninformed $q$	246	76	177	31	0.18
	(221–282)	(47–129)	(119–257)	(19–50)	(0.13–0.24)
Core acoustic	215	35	84	17	0.20
	(199–244)	(27–51)	(65–117)	(12–24)	(0.16–0.24)

- 11 The base case suggests that current biomass is approximately 28%B<sub>0</sub>, a reduction from the estimate of 32% in 2005. The sensitivity runs show how responsive the estimates are to the choice of acoustic biomass series.
- 12 Recruitment in the SBW 6I stock is characterised by periods of moderate recruitment interspersed by relatively rare, extremely strong, recruitment episodes. Only one such event (the 1991 year class) has been observed within the (27 year) timeframe of the model. There is concern that should the biomass be fished down to the 1991 level, that it not certain that a pulse of recruitment of the strength of the 1991 year class will occur to rebuild the stock. Therefore B<sub>1991</sub> should be seen as a limit reference point that the biomass should not be allowed to be reduced below. The limit reference has no statutory basis, but is useful for examining the relative risk between different levels of exploitation.
- 13 The working group discussed the relative relationship of B<sub>1991</sub> and 20%B<sub>0</sub>, which is more commonly used as a limit reference point, but as it is dependent on historical recruitment, it is influenced by the highly variable nature of recruitment in the SBW stock. The working group noted that until a better measure was found, B<sub>1991</sub> should continue to be used as the limit reference point. The updated model runs estimate that B<sub>1991</sub> is about 17% of B<sub>0</sub> (see Table 1), and there is only a slight probability that B<sub>1991</sub> exceeds 20% B<sub>0</sub> (see Figure 1 in Appendix Two). The biomass in 2005 is estimated (from the base case) to be around 164% of B<sub>1991</sub>, down from 194% of B<sub>1991</sub> in 2004.
- 14 The method used to estimate yields is explained in Appendix Two. The plenary noted that the limit biomass assumed in the yield estimation simulations is 20% B<sub>0</sub>, which is different from the use of B<sub>1991</sub> for assessing risk in projections (as described below). No corresponding yield estimates based on the B<sub>1991</sub> limit biomass reference point were available for consideration by the working group. Table 2 shows the estimates of the average biomass that could be expected under a current annual yield strategy (B<sub>MAY</sub>), the maximum average yield under that strategy (MAY), and the current annual yield for the 2006-07 season (CAY<sub>2006-07</sub>).

**Table 2: Yield estimates (MAY, and CAY) and associated parameters**

Stock	B <sub>MAY</sub> (%B <sub>0</sub> )	MAY (tonnes)	U <sub>CAY</sub>	CAY <sub>2006-07</sub> (tonnes)
Campbell Island Rise SBW 6I	34	18 600	0.20	16 400

- 15 Projections of future biomass levels were made assuming fixed catch levels from 10,000 to 25,000 tonnes per year and recruitments drawn randomly from the distribution of year class strengths estimated by the model over the period 1977 to 2002. As an alternative to the CAY estimates, results have been presented in the form of decision tables showing the probability of biomass falling below B<sub>1991</sub> for alternative catch levels from 10 000 to 25 000 tonnes (Table 3) over the next three fishing years.
- 16 The median biomass estimates show that biomass is projected to decline at a catch of 25 000 tonnes (from 27%B<sub>0</sub> to 20%B<sub>0</sub> over the three year period), and at a TACC of 20 000 tonnes the decline will be at a slower rate (from 27%B<sub>0</sub> to 25%B<sub>0</sub> over the same time). If the catch is reduced to 15 000 tonnes in 2006-07 the biomass is projected to stabilise at 28%B<sub>0</sub> and increase slightly to 30%B<sub>0</sub> over the three year

period. Note that under s13 of the Act the Minister is required to manage the fishery towards the biomass level which supports maximum sustainable yield. In this stock  $B_{MAY}$  may be considered as proxy for  $B_{MSY}$  is about 34% $B_0$ .

- 17 At a constant catch level of 25 000 tonnes per year, the probability that the projected biomass will drop below  $B_{1991}$  increases from 8% to 22% to 39% over the next three years. At a constant catch level of 20 000 tonnes per year, the probability that the projected biomass will drop below  $B_{1991}$  is still high, increasing from 6%, to 14% to 23% from 2006 to 2008. Of all the scenarios, only constant catch levels of 15 000 tonnes or less have projected risks of less than 10% of depressing the biomass to below the 1991 level. At a constant catch level of 15 000 tonnes per year, the probability that the projected biomass will drop below  $B_{1991}$  increases from 3% to 6% to 8% over the period 2006 to 2008.

**Table 3: Probability that the projected mid-season vulnerable biomass for 2006, 2007, and 2008 will be less than the mid-season vulnerable biomass in 1991 and the median projected biomass as a percentage of  $B_0$  (with 90% credible intervals) for different constant catch levels for the Campbell Island stock base case run.**

Constant catch (t)	Probability ( $B_{proj} < B_{1991}$ )			Median biomass as percentage $B_0$		
	2006	2007	2008	2006	2007	2008
10 000	0.02	0.02	0.02	29 (18-48)	32 (19-61)	35 (20-81)
15 000	0.03	0.06	0.08	28 (17-48)	29 (16-65)	30 (14-81)
20 000	0.06	0.14	0.23	27 (16-47)	26 (13-59)	25 (9-71)
25 000	0.08	0.22	0.39	27 (15-45)	23 (10-53)	20 (7-63)

- 18 Ministerial decisions for management of the SBW 6I stock for the past two years have weighed economic impacts as well as sustainability risks. MFish considers that economic considerations include the concept of “hard” and “soft” landings as regards downward adjustments in the TACC. A “hard landing” implies a substantial near-term reduction in the TACC, while a “soft landing” might seek to spread reductions out over time. Deferring near term TACC reductions in order to maintain economic returns in the near term might entail a subsequent “hard landing” in the future.
- 19 The working group considered that it was important therefore to look at the implications of maintaining a 25 000 tonne TACC for 2006-07 (in terms of the rate of stock decline and probability that  $B_{2006}$  decreases below  $B_{1991}$ ), as well as the magnitude of the necessary TACC reduction in 2007 to halt this decline and rebuild the stock towards  $B_{MSY}$ . These projections were run for exploitation levels from 0 to 25 000 tonnes, following a catch of 25 000 tonnes in 2006 (table 4). The result of these simulations shows that if the TACC remains at 25 000 tonnes in 2006-07, the TACC in the following year would need to be reduced to somewhere between 0 and 5 000 tonnes to have less than a 10% probability of depressing the stock to below the 1991 biomass.

**Table 4: Probability that the projected mid-season vulnerable biomass for 2006, 2007, and 2008 will be less than the mid-season vulnerable biomass in 1991, and the median projected biomass as a percentage of  $B_0$  (with 90% credible intervals) for a catch of 25,000 t in 2006 followed by constant catch levels from 0–25,000 t for 2007 and 2008 for the base case.**

Constant catch (t)	Probability ( $B_{proj} < B_{1991}$ )			Median biomass as percentage $B_0$		
	2006	2007	2008	2006	2007	2008
0	0.08	0.08	0.03	27 (15-45)	29 (14-65)	36 (19-87)
5 000	0.08	0.12	0.06	27 (15-45)	27 (13-65)	31 (16-84)
10 000	0.08	0.14	0.10	27 (15-45)	25 (13-51)	28 (14-68)
15 000	0.08	0.17	0.18	27 (15-45)	26 (12-54)	26 (11-74)
20 000	0.08	0.21	0.30	27 (15-45)	24 (11-52)	22 (7-64)
25 000	0.08	0.22	0.39	27 (15-45)	23 (10-53)	20 (7-63)

## **TAC and TACC**

### *Section 13 considerations*

- 20 The SBW 6I stock is managed under s 13 of the Act, which prescribes that the Minister shall set the TAC in order to maintain the stock biomass at or above, or move it towards or above, the biomass level that would support the maximum sustainable yield ( $B_{MSY}$ ). In considering the way in which, and rate at which, the biomass of a stock currently below  $B_{MSY}$  is moved towards or above a level that can produce the maximum sustainable yield (MSY), the Act, in s 13(3), requires the Minister to have regard to such social, cultural, and economic factors as he considers to be relevant. MFish interprets this to mean that the Minister has discretion when making decisions about the rate at which to move the stock biomass towards the target level, and allows for some degree of balancing of utilisation and sustainability considerations.
- 21 The MSY can be interpreted as either a static or dynamic concept. The CAY is derived from the dynamic interpretation, and recognises that fish populations fluctuate in size from year-to-year (for environmental and biological, as well as fishery, reasons) so that to get the best sustainable yield from a fishery it is necessary to alter the catch every year. This leads to the idea of maximum average yield (MAY) that is a common way for fisheries scientists to interpret MSY. The MAY represents the long-term average annual catch when the catch each year is the CAY.
- 22 Southern blue whiting display variable recruitment that normally fluctuates on an inter-annual basis. However, the fishery also displays rare peaks in recruitment much stronger than the mean year class, which due to the longevity of the species (as much as 25 years) means that recruits to the fishery contribute to the biomass and fishery for several years. The variability inherent in the stock favours a CAY harvest strategy to enable the maximum yield to be taken over time. Accordingly, the management of the SBW 6I fishery uses a CAY approach.
- 23 Under a CAY strategy the annual yield is estimated as a fixed proportion (harvest rate) of the current biomass. The harvest rate used is designed to maximise the average catch (MAY) over time within an acceptable level of risk. In the case of southern blue whiting, CAY was estimated using the method of Francis (1992) where the acceptable level of risk is taken to be the probability that future biomass would fall below 20%  $B_0$  less than 10% of the time.
- 24 Under a CAY harvest strategy, the average stock size  $B_{MAY}$  is estimated to be 34% $B_0$  (under the assumptions and methods as described above). The updated assessment estimates the current stock size,  $B_{2005}$  as 28% $B_0$  (19-41% confidence interval).
- 25 Under the assumptions noted above and in the working group report, it appears that the Campbell Island Rise SBW stock has declined to less than the  $B_{MSY}$  level required by s 13. In addition, the stock size is projected to continue to decline, at a more rapid rate than that predicted in the 2005 assessment, if catches continue to be taken at the level of the current TACC of 25 000 tonnes for the next three years.
- 26 The base case estimate of CAY is 16 400 tonnes (Table 2). The CAY is the amount estimated from the assessment that can be harvested sustainably from the stock given

current biomass levels, and also rebuild the stock towards  $B_{MAY}$ . Option 1 proposes that the 2006-07 TACC be set at the CAY of 16 400 tonnes.

- 27 MFish acknowledges that there is significant uncertainty in the stock assessment, biomass projections and estimates of yield (as shown by the 90% credible intervals in Table 1). While the working group agreed that the assumptions under the base case provided the most plausible results, it is possible that the base case underestimates the level of decline in the stock and consequently overestimates the available yields. However, the 2006 assessment represents the best available information on the SBW 6I stock at the present time. While proponents of maintaining the status quo could rightly argue that the actual biomass could be at the upper range of each of the projections (and therefore the outlook is not as pessimistic and the management response does not need to be so severe), it is just as likely that the biomass could lie at the lower end of the projections that show the minimum biomass could be less than  $20\%B_0$  under all projected TACCs from one to three years into the future. The Minister is obliged to be cautious in the face of uncertain, unreliable, or inadequate information when deciding on measures to ensure that the SBW 6I stock is managed towards or above the  $B_{MSY}$  level.

### *Evaluation of risk*

- 28 The working group considered that  $B_0$  for the SBW 6I stock may not be well determined because of the highly variable recruitment levels. The working group therefore suggested that the use of  $B_{1991}$  as a limit reference biomass level may be preferable to other reference biomass points based on  $B_0$  (such as  $B_{MSY}$  or  $20\% B_0$ ). The working group has used  $B_{1991}$  as a limit reference point since 2001. As noted above, the use of the  $B_{1991}$  limit reference biomass is not being used instead of the statutory  $B_{MSY}$ , but  $B_{1991}$  provides assistance in examining the relative risk between different catch levels to the longer-term sustainability of the stock.
- 29 As a **limit** reference point, management should aim to maintain the SBW 6I biomass above the  $B_{1991}$  level, rather than managing to that level. The likelihood that the biomass might fall below the reference limit biomass under alternative harvest levels provides the probabilistic information used for risk assessment.
- 30 The January 2006 working group meeting discussed concerns about the increasing probability of SBW 6I stock biomass falling below  $B_{1991}$  for several reasons, including:
- the stock biomass has only been observed at that low level once in the time series;
  - the exceptionally strong recruitment from the 1991 year class has only been observed once in the 27 years covered by the stock assessment.
- 31 MFish has concerns that the acceptable level of risk of depressing the biomass to less than the  $B_{1991}$  level should be less than 10%. As yet, MFish has not developed a formal policy on the use of limit reference points, in particular the suitability of various levels of risk as indicated by the estimated probability of stock biomass falling below the reference limit, despite previous comments to develop an agreed threshold level for management purposes. In previous reports, the working group has used a

10% risk threshold for assessing whether a TACC will let the biomass fall below the  $B_{1991}$  limit reference point.

- 32 The updated base case assessment indicates that at constant catches of 25 000 tonnes per year (the current TAC/TACC), the probability that the projected biomass will drop below  $B_{1991}$  increases from 8% to 39% over the next three years (to 2008) (see Table 3). At a constant catch level of 20 000 tonnes per year, the probability is lower, increasing from 6% to 23% over the same period. At a constant catch of 15 000 tonnes the probability that the biomass will drop below  $B_{1991}$  increases from 3% to 8% over three years. If the risk of depressing the biomass below the limit reference level should be less than 10%, then a constant TACC for the next three years would need to be approximately 15 000 tonnes. If the TAC is retained at 25 000 tonnes or reduced to 20 000 tonnes for 2006-07, then subsequent reductions to lower TAC levels would be required to have less than 10 % risk of falling below  $B_{1991}$ .

### *Discussion of results*

- 33 In the previous two seasons, the Minister decided to retain the TAC at 25 000 tonnes although the assessments indicated that biomass would continue to decline under catches at that level. Those decisions took into account the relatively small increased risk to the stock of the higher TAC in the short term (as informed by respective assessments), balanced against the adverse social and economic implications for industry associated with a reduction of the TAC.
- 34 The 2006 assessment results are more pessimistic, and indicate that the biomass is likely to continue to decline further below the  $B_{MSY}$  estimate at catch levels of 20 000 tonnes or more. The results suggest that reducing the TAC for 2006 will be necessary in order to avoid substantial reductions in the forthcoming few years. The latest assessment suggests that retaining the TAC at the current 25 000 tonne level would necessitate a drastic reduction for 2007 in order to stabilise the biomass and avoid a considerable risk of biomass falling below the  $B_{1991}$  limit level. Based on the latest assessment, the 2006 biomass is below the estimated  $B_{MSY}$  and future TAC reductions will be required in order to move the biomass towards or above the target level over an appropriate period.
- 35 The three year projections suggest that the constant annual catch in 2006, 2007 and 2008 seasons would need to be restricted to 10 000 tonnes or less if the biomass is to rebuild to the estimated  $B_{MSY}$  level by 2008. The Minister has discretion as to the way and rate of the rebuild, and the alternatives modelled in the assessment do not address all of these alternatives.
- 36 Constant catches at 15 000 tonnes in 2006, 2007, and 2008 seasons are projected to result in the median biomass as a percentage of  $B_0$  stabilising and beginning to rebuild towards  $B_{MAY}$  at a faster rate than if the TAC was set at a higher level. In addition, the 15 000 tonne constant catch projection is the only scenario which has less than a 10% risk of depressing the biomass below  $B_{1991}$  within three years.
- 37 A TAC based on the CAY for 2006-07 will rebuild the stock towards  $B_{MAY}$ , although not as quickly as a lower TAC.

- 38 If constant catches at either 25 000 or 20 000 tonnes are taken from 2006 to 2008, the median biomass as a percentage of  $B_0$  will continue to decline below  $B_{MAY}$ . In addition, both the two and three-year projected risks of depressing the biomass to less than the 1991 limit reference point is greater than 10% under both of these catch levels.
- 39 Under a constant catch of 25 000 tonnes for three years, the probability of SBW 6I stock biomass dropping below  $B_{1991}$  is 8% in 2006-07, 22% the following year, and 39% in 2008-09. If the TACC is reduced to 20 000 tonnes the risk decreases to 6% in 2006-07, 14% the following year, and 23% in 2008-09. If the TACC is reduced to 15 000 tonnes the risk decreases to 3% in 2006-07, 6% the following year, and 8% in 2008-09. The above probabilities represent the risk of depressing the biomass below the **limit** reference point (which is to be avoided). There has been some discussion by the working group that a 10% risk of exceeding  $B_{1991}$  is too high, and that a lower value would be a more acceptable risk threshold. This is because recruitment of the magnitude that rebuilt the fishery from its 1991 level has occurred only once in the 27-year observed history of the fishery.
- 40 The available information suggests that the TAC will need to be reduced significantly to ensure long-term sustainability, and rebuild the stock towards  $B_{MSY}$  as is required under s 13 of the Act. There is some question, however, regarding the timing and extent of a TAC reduction. A new acoustic biomass estimate is expected to be available in late 2006, and can therefore be used to inform the TACC setting for the 2007-08 fishing year.

#### *Fishery Plan considerations*

- 41 The Ministry has determined that it intends to employ fisheries plans as provided for under s 11A of the Act as a key tool for fisheries management through which to contribute to the Ministry's overall goal of maximising the value that New Zealanders obtain from the sustainable use of fisheries resources and protection of the aquatic environment.
- 42 Fisheries plans will outline objectives for managing fisheries resources, and describe the management tools and services required to realise those objectives while ensuring that legislative obligations and government-established standards for fisheries are met. Stakeholders should determine their objectives for fisheries, where consensus across stakeholder groupings can be reached.
- 43 Fisheries plans will use a risk assessment approach to confirm an appropriate arrangement, drawing upon a wide range of tools and services to meet objectives, legislative obligations, and relevant standards. Fisheries plans should provide options for rationalising management interventions and services over time to deliver improved cost effectiveness and efficiency in the sustainable utilisation of resources.
- 44 The 'proof of concept' fishery plan for SBW stocks is due to be completed to draft stage by the end of June 2006. The likely timing of any approval of the plan by the Minister and formal implementation of the plan is unknown at this time. The Minister has a choice across the continuum of utilisation opportunities and sustainability risks demonstrated by the assessment results and proposed management options. It is important to note that each of the possible 2006-07 TACC options provided here

impact on the long term planning and TACCs set under any harvest strategy to rebuild the stock to  $B_{MAY}$ . If the 2006-07 TACC is set close to the estimated CAY, it will provide more certainty that future TACCs can be set at a similar level and continue to rebuild the stock as required under s 13. The larger the 2006-07 TACC level is relative to the CAY, the more likely it is that future TACC reductions will be required in order to rebuild the stock to  $B_{MAY}$  within the same time-frame. As noted earlier, a continuation of the *status quo* could result in the 2007-08 TACC needing to be reduced to between 0 and 5 000 tonnes which would severely impact on the economic viability of the fishery, and the long term planning considerations under a Fishery Plan.

### **Justification of the various options**

- 45 The SBW 6I fishery is generally accepted to be managed following a CAY approach, which is considered to maximise yield over time by taking into account the fluctuations in biomass. While setting the TAC at the estimate of CAY would be consistent with s 13 of the Act, constant catches precisely at the CAY level were not included in the modelled projections. Given the inherent uncertainty in the assessment results, MFish considers that the projections at the 15 000 tonne level are a reasonable approximation of constant catches at the CAY level. The relative risk associated with the various options is indicated by the probabilities of biomass falling below the  $B_{1991}$  biomass level or 'limit' biomass.
- 46 It should be noted that the CAY is calculated as a proportion of the available biomass, and will reduce as biomass declines. Should catches be allowed in 2006 that result in the biomass declining further, the subsequent CAY estimate for 2007 will be lower.

### **Option 1 – reduce the TAC to 16 400 tonnes**

- 47 The factors to consider for Option 1 are as follows:
- Section 13 of the Act requires that, in the case where a stock is below the level that can produce the MSY, the TAC be set so that the stock biomass is altered to move it towards or above the level that can produce the MSY, having regard to the interdependence of stocks and within a period appropriate to the biological characteristics of the stock and any environmental conditions affecting it. There is some discretion in the way and rate that the Minister can move a stock towards  $B_{MSY}$ . However, there is an absolute statutory obligation in s 13 to manage stocks towards  $B_{MSY}$ .
    - The base case assessment suggests that the 2006 mid-season vulnerable biomass will be 28%  $B_0$  (within the 90% credible intervals of 19 to 41%), which is below the  $B_{MAY}$ .
    - The biomass projections indicate that if constant catches at the level of 15 000 tonnes are taken in 2006, 2007, and 2008, the biomass will stabilise or increase slightly to 30%  $B_0$  in 2008. The CAY is slightly larger than the 15 000 tonne catch levels modelled in the stock assessment simulations. The scenario under 16 400 tonnes would be marginally different and probably slightly less optimistic.

- Setting the TAC at 16 400 tonnes would be consistent with s 13 in that it would result in stock biomass moving towards or above the  $B_{MSY}$  level within the coming three years based on the best available information.
- The relative risk of biomass falling below the  $B_{1991}$  limit biomass under this option is the lowest of the options proposed. The risk would be similar to that at 15 000 tonnes, which is 3% in 2006, increasing to 8% in 2008. This is the only option where the risk of biomass declining to less than  $B_{1991}$  remains less than 10% over the three years to 2008.
- In regard to the fishery plan for SBW, a TAC of 16 400 tonnes in 2006-07 would provide for a relatively stable stock size and viable yield in the coming three years, which is likely to form a suitable basis for planning the near-future and medium-term management of the fishery.

### Option 2 – reduce the TAC to 20 000 tonnes

48 The factors to consider for Option 2 are summarised below:

- The base case assessment suggests that the 2006 mid-season vulnerable biomass will be 28%  $B_0$  (within the 90% credible intervals of 19 to 41%), which is below the  $B_{MAY}$ .
- The biomass projections indicate that if constant catches at the level of 20 000 tonnes are taken in 2006, 2007, and 2008, the biomass will decrease slowly to 25%  $B_0$  in 2008, which is still further below the 34%  $B_0$  identified under the  $B_{MAY}$  criteria
- Setting the TAC at 20 000 tonnes slows the decline and could be done as the start of a rebuild strategy, bearing in mind uncertainty in information, and imminent development of a fishery plan for this stock Future management would described management actions that would result in biomass moving towards or above the  $B_{MSY}$  level in an appropriate period.
- The relative risk of biomass falling below the  $B_{1991}$  limit biomass under this option is greater than under Option 1. The risk is 6% in 2006, increasing to 14% in 2007 and 23% in 2008. This suggests that a 20 000 tonne TAC in 2006-07 would require a reduction in 2007 to avoid a greater than 10% probability of the biomass falling below the limit level.
- In regard to the impending Fishery Plan, a TAC greater than the CAY creates a situation of increased risk where the initial planning focus will need to be on developing a stock recovery plan, involving several years where the TAC would need to be held at a low level and economic returns would consequently be limited.
- It is possible that the 2006 acoustic survey will reveal a spike in recruitment similar to the 1991 year class (which could rebuild the fishery), however history shows that this has happened only once in twenty-seven years and is therefore unlikely. The results of the acoustic survey are unknown and could improve the future assessment, confirm the current assessment, or be more pessimistic.

### Option 3 – status quo - maintain the TAC at 25 000 tonnes

49 The factors to consider for Option 3 are summarised below:

- The base case assessment suggests that the 2006 mid-season vulnerable biomass will be 28%  $B_0$  (within the 90% credible intervals of 19 to 41%), which is below the  $B_{MAY}$
- The biomass projections indicate that if constant catches at the level of 25 000 tonnes are taken in 2006, 2007, and 2008, the biomass will decrease more rapidly to 20%  $B_0$  in 2008
- Setting the TAC at 25 000 tonnes would not be consistent with s 13 unless an approach to future management was articulated that described management actions that would result in biomass moving towards or above the  $B_{MSY}$  level in an appropriate period.
- The relative risk of biomass falling below the  $B_{1991}$  limit biomass under this option is greater than under Option 2. The risk is 8% in 2006, increasing to 22% in 2007 and 39% in 2008. This suggests that a 25 000 tonne TAC in 2006-07 would require a substantial reduction in 2007 to avoid a greater than 10% probability of the biomass falling below the limit level. The projections suggest that to avoid the risk of biomass declining below  $B_{1991}$  in 2007, the TAC for that year would need to be reduced to less than 5 000 tonnes. Industry has previously commented that SBW fisheries of less than 5 000 tonnes are not economically viable.
- The implications of retaining the 25 000 tonne TAC for 2006 would probably be dire for the management options into the near future, and would present the fishery planning approach with initial requirements to urgently address rebuilding the stock and substantially curtail catches.

### *Economic and social implications*

50 The SBW 6I fishery is characterised by high volumes of catch and relatively low per unit raw product values. Around 80% of all vessels targeting SBW in the Campbell fishery during the 2005-06 season are 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.

51 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.

52 Mfish recognizes that the reduction to the SBW 6I TAC proposed under Options 1 and 2 will have a direct economic effect on industry participants, by reducing the catch tonnage allowed. Fluctuation in port price also poses significant variation in

gross returns to operators. The 2005-06 levy order lists the port price for SBW 6I as \$350 per tonne, which is little change from the 2004-05 port price port price of \$345 per tonne. The stable port price in the last two years contrasts with the previous two years, where prices were \$100 per tonne in 2003-04, and \$590 per tonne in 2002-03.

- 53 The proposed reduction in catch under Option 1 (16 400 tonne TACC) could represent a 34 % decline in gross revenues from the SBW 6I fishstock assuming 2005-06 port prices. In dollar value this equates to about \$3 million at \$350 per tonne. The proposed reduction in catch under Option 2 (20 000 tonne TAC) could represent a 20% decline in TACC, equating to a potential \$1.75 million reduction in gross returns at \$350 per tonne. It should be noted that revenue from landings does not provide a complete picture of economic implications, and variations in currency exchange rates, fuel prices and other operating costs will also have impacts on net returns to operators.
- 54 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 2004 calendar year totalled approximately \$10 million. 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.
- 55 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. The number of vessels targeting southern blue whiting in SBW 6I has ranged in recent years from 18 vessels during 2002-03, to 15 vessels in the 2003-04 and 2004-05 seasons, to 17 vessels in 2005-06. Vessel availability and capacity for the SBW fishery is likely to be influenced further by the 2004-05 season reductions in the hoki TAC, and rationalisation in the fishing industry that has resulted.
- 56 MFish is also aware that catch reductions can have social implications when employment opportunities for catching and processing staff are reduced. However, 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 the TACC under Options 1 or 2.
- 57 Given that this is a relatively high-volume / low-value fishery, retaining the higher catch levels in the near term as represented by Options 2 and 3 is expected to result in the need for significant TACC reductions in 2007, as indicated in Table 4. Lowering the TACC to 5 000 tonnes, (for example) could effectively close the fishery for 2007-08 in the event operators found it uneconomic to fish on such a reduced scale given the logistics employed to locate the SBW stocks and prosecute the fishery. In such case, a “hard landing” could have a much greater impact on economic performance and utilisation than would be achieved by reducing the TAC in 2006-07.
- 58 The Minister’s decisions in the previous two fishing years to maintain a 25 000 tonne TAC has included considerations of potential adverse economic impacts on industry. By maintaining the SBW 6I TAC at 25 000 tonnes over the past two seasons, the industry’s utilisation of the resource has not been constrained by TACC reductions in this time of economic hardship.
- 59 Further discussion of economic implications is provided in Appendix One.

### *Recreational and Māori customary interests*

- 60 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*

- 61 Although scientific observers have reported discards of fish and accidental losses from torn or burst codends, there are no quantitative estimates of this source of mortality and no estimates of discards have been considered in the stock assessments.
- 62 MFish proposes that the known level of other sources of fishing-related mortality is sufficiently low that an allowance within the TAC does not need to be set to account for it at this time. Further information on other sources of fishing-related mortality is provided in Appendix One.

### *Environmental considerations*

#### Marine Mammals

- 63 MFish considers that the proposed options will have no adverse implications for fur seals and other marine mammals. Further information on fur seal capture is provided in Appendix One.

#### Seabirds

- 64 MFish considers that the proposed options have no adverse implications for seabirds to the extent the options proposed either reduce or maintain existing SBW catch limits. Research has noted seabirds dependencies on the availability of SBW as a food source, such that substantial reductions in the abundance of the fishstock in the future could pose adverse impacts on seabirds. Further information on seabird capture issues is provided in Appendix One.

#### Fish bycatch

- 65 The SBW 6I is mostly a middle-depth trawl fishery with very low bycatch of other species. The proposed options have no adverse implications for fish bycatch. Details of fish bycatch are provided in Appendix One.

### ***Statutory considerations***

- 66 MFish considers that the options proposed in this IPP meet the statutory considerations of the Act. However, Options 2 and 3 pose sustainability risks to the SBW 6I fishstock in the medium term, and the justification of Options 2 and 3 requires assumptions about and consideration of future management actions that address sustainability concerns. These issues are discussed further below.

**Section 8** – sets out the purpose of the Act as being “to provide for the utilisation of fisheries resources while ensuring sustainability”. The options proposed achieve this purpose by setting a TAC and TACC for the SBW 6I stock, which enables commercial fishers to continue to utilise the SBW 6I fishery in a sustainable manner,

at least in the short term. Option 1 responds to stock assessment concerns in a precautionary manner based on the best available information and sets the TAC at a level which will allow the stock to rebuild towards  $B_{MAY}$ . Option 2 will continue to reduce the biomass, and will require further TAC reductions in coming years to avoid risks to the stock. However, it has less economic impact than Option 1. Option 3 allows for continued utilisation at the current level during 2006, but would require substantial reductions in the TAC in coming years to address risks to the stock, and those reductions could render the fishery economically unviable.

**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 earlier in this document.

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

The options presented in the IPP are considered to satisfy the requirements of s 13, at least in the short term.

**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.

One characteristic of the SBW 6I stock is that it generally displays variable recruitment, which is very occasionally augmented with spikes in recruitment which are many times higher than normal recruitment. The 1991 year class which rebuilt the stock from its lowest observed biomass ( $B_{1991}$ ) was seven times stronger than the mean year class strength, and recruitment of this strength has only been seen once in the 27 year history of the model.

Previous IPP reports have noted *“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”*.

While the 1991 year class was 3.5 times stronger than any year class since then, this class has almost passed through the fishery and now contributes only 5% of the catch. The biomass has indeed been progressively fished down over the last five years, as a likely result of excessive fishing pressure.

The current biomass is below the estimated  $B_{MSY}$  level, and has been declining for the past few years. Only Option 1 sets a TAC that would see the stock size

stabilise and begin to rebuild within the coming three years. Option 2 would slow the decline in the short term and could be used as part of a medium or longer term rebuild strategy. Option 3 represents a substantial risk to the stock, and would be expected to result in the stock declining further in 2006, Option 3 would require a plan to be articulated to ensure that the requirements of s 13(2)(b)(ii) are met.

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

*Section 13(2)(b)ii* also requires that biological characteristics of the stock should be taken into account in relation to the timeframe over which stock rebuilding will occur. The recruitment characteristics as discussed above, indicate that the stock would be unlikely to rebuild to  $B_{MSY}$  (from a level further depressed under Options 2 or 3), in a comparable timeframe to the historical rebuild from  $B_{1991}$ , as recruitment events of the magnitude of the 1991 year class are very rare occurrences, and cannot be relied upon. Further, this recruitment characteristic adds to concern that to reduce the biomass to less than its historical minimum (which has a probability of 23% under Option 2 and 39% under Option 3 under constant catches within a 3 year timeframe) would be a very risky situation, from where the stock may not recover within a manageable timeframe, with severe economic consequences for the fishery.

***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 options for setting the TAC/TACC for SBW 6I. The expected economic effects have been noted in the relevant part of this advice, but the precise extent of those effects has not been quantified. Economic effects can result in social effects, following on from a reduction in catching and processing capacity that would be likely to accompany a reduction in the TAC/TACC.

The economic and social effects of TAC reductions in the SBW6I fishery, were balanced against other relevant considerations by the previous Ministers in retaining the status quo TAC of 25 000 tonnes for each of the 2004-05 and 2005-06 fishing years. As a result of this two-year lag in reducing the TAC, the stock has declined below  $B_{MSY}$ .

On the basis of the best available information, balancing the utilisation and sustainability considerations now requires a clear distinction be made between a short-term or one-year utilisation outcome followed by likely substantial constraints on utilisation for subsequent years, or a more immediate constraint on utilisation that would be likely to deliver a more stable fishery over the coming three years.

***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 (7 times stronger than the mean year class strength), followed by recruitment levels moderately above average in 1995, 1996, 1998, and 2001 (up to twice the strength of the mean year class). Recruitment of the strength of the 1991 year class has been observed once in 27 years and should not be relied upon to rebuild the stock if it is further reduced. Further information is contained in the stock assessment results presented in Appendix Two.

**Section 9** – requires that decision makers 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. There is some concern that if the stock is allowed to fall below the historical minimum biomass, which has a high risk under Options 2 and 3, that the lack of a key food source may threaten species such as albatross which feed on SBW (Cheryl, Waugh and Hanchet 1999).

*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. However, it is apparent that midwater gear targeting SBW might contact the sea floor more often than previously thought. While no adverse effects specific to the SBW fishery have been documented, MFish will examine the matter further in the near future. 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 which is fully discussed earlier in this document.

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 relevant to SBW arising under international obligations and the provisions of the Treaty of Waitangi

(Fisheries Claims) Settlement Act 1992 are addressed by the provisions of the Fisheries Act 1996. These proposals are consistent with the Act.

**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. A fisheries plan is not in place for SBW at the present time, however, a plan is currently under development for this species.

**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)** – prescribe the matters to be taken into account when setting or varying the TAC, 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 TAC. There are no known Māori customary or recreational fishing interests in the SBW 6I fishery, and no allowances are proposed. The known fishing-related mortality beyond the landed catch is small, and an allowance is not proposed.

No mātaitai 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 21(2)** – requires that, before setting or varying a TACC for any quota management stock, the Minister shall consult such persons and organisations as the Minister considers are representative of those classes of persons having an interest in this section, including Maori, environmental, commercial, and recreational interests.

Although there are no known customary non-commercial or recreational fishing interests in the SBW 6I fishery, key customary and recreational groups are being consulted. Environmental interests were represented at the working group and are included in the consultation process.

**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, and be cautious when information is uncertain, unreliable, or inadequate. 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 latest stock assessment for SBW 6I, as reported at the January 2006 working group meeting. That assessment represents the best available information about the performance of the fishery under the presented range of future catch levels. In addition, NIWA scientists ran projections at the request of the working group showing the stock trajectory and risk of exceeding the minimum historical biomass (which has traditionally been used as a limit reference point for this species) if a constant catch of 25 000 tonnes is taken in the 2006-07 to 2008-09 seasons. These additional projections display that while utilisation would be optimised in 2006-07 under option 3, there is likely to be a ‘hard landing’ the following year with the TAC needing to be reduced to between 0 and 5 000 tonnes to ensure sustainability.

MFish recognises that there is uncertainty in the latest assessment. The 2005 stock assessment has been updated for 2006 by including commercial catch data from the 2005 SBW season. A full stock assessment will not be available until 2007 following completion of the acoustic biomass survey scheduled for 2006. There is therefore a greater degree of uncertainty in the current information than would be case if new biomass data was available and full revision of the stock assessment had been carried out. Nevertheless, the 2006 assessment represents the best available information for the purposes of decision making under the Fisheries Act 1996.

MFish notes that a Fishery Plan is being developed that will allow improved long term planning and management of this stock, and new information in the form of a biomass estimate from an acoustic survey is expected in late 2006 that will be used to update the model. However, *s10* requires that *decisions should be based on the best available information, and the absence of, or uncertainty in, any information should not be used as a reason for postponing or failing to take any measure to achieve the purpose of this Act.*

### *Observer coverage*

- 67 MFish will continue to monitor the catch of fur seals and seabirds in the SBW fisheries through the observer programme. A total of 276 observer days are programmed for the current business year (July 2005 to June 2006) to be applied across all SBW stocks. These observer services provide 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*

- 68 While this assessment raises sustainability concerns given projected stock trends over the next three years, it is based on a model and assumptions stemming from the last acoustic survey in 2004. The next acoustic biomass survey is due to be carried out in August-September 2006, and results will be used in the revised assessment in time for the 2007-08 TAC setting process. This revised assessment is expected to provide greater certainty in the estimates of stock status and yield, and will inform management decisions in 2007-08.

### **Conclusion**

- 69 The most recent SBW 6I stock assessment indicates that the current biomass has been declining under recent catch levels, and has reached 28% of the virgin biomass ( $B_0$ ). That level is below the estimated biomass level that can produce the MSY (which is represented by the  $B_{MAY}$  of 34%  $B_0$ , where  $B_{MAY}$  is taken as a representation of the biomass that would produce the maximum sustainable yield).
- 70 In setting the 2004-05 and 2005-06 TACs for the SBW 6I stock, the previous Minister considered advice provided to him on stock sustainability, uncertainty in the information available, and economic impacts associated with the alternative catch levels. The decision in each case was to retain the TAC at 25 000 tonnes. The current assessment is more pessimistic compared to previous information.
- 71 The SBW 6I stock is managed following a Current Annual Yield (CAY) approach, in order to obtain the Maximum Average Yield over time (where  $B_{MAY}$  is the accepted proxy for  $B_{MSY}$ ). In addition, the stock assessment provides a non-statutory biomass limit reference point based on the abundance in 1991, the lowest estimated level of SBW 6I abundance from which the stock has subsequently recovered. This limit reference point provides further assistance in managing this stock at sustainable levels. The stock assessment indicates an increasing risk of falling below the 1991 reference biomass with continued catches at the level of the 25 000 tonne TAC.
- 72 The latest stock assessment explored a range of possible TAC levels from 10 000 to 25 000 tonnes. The Minister might choose to set the TAC at some level across that spectrum. The lower the TAC the lower the risk to stock sustainability but the greater the social and economic impacts. It is open to the Minister to choose an option that lies within the range of modelled TAC levels in meeting his sustainability and utilisation obligations set out in the Fisheries Act 1996 (the Act).

- 73 This Initial Position Paper proposes three management options for consultation. Option 1 is to set a TAC at 16 400 tonnes (the 2006-07 CAY estimate); Option 2 is to set the TAC at 20 000 tonnes; and Option 3 is to maintain the status quo, retaining the TAC at 25 000 tonnes. An array of catch allowance levels within the range of TACs modelled in the assessment is open for the Minister's choice.
- 74 A TAC reduction to 16 400 tonnes (Option 1) is expected to result in the biomass stabilising and recovering towards  $34\%B_0$  over the coming three years. Option 1 carries the lowest risk to the stock as indicated by it being the only TAC that would not exceed a 10% level of risk of falling below  $B_{1991}$  within three years. Option 1 could provide relative stability in catch levels over the three coming years, although it poses a substantial economic impact given the 8 600 tonne reduction in allowable catch.
- 75 If the TAC is reduced to 20 000 tonnes (Option 2) the stock might continue to decline relative to  $B_{MAY}$ , reaching  $25\%B_0$  by 2008. This option is more risky than Option 1, as evidenced by the level of risk of the stock reaching a level less than  $B_{1991}$  steadily increasing in the near term, reaching 14% in 2007 and 23% in 2008. While this option would have a lesser economic impact in the first year, the projections indicate that substantial reductions in catch levels would be required in subsequent years to avoid further biomass declines and risks of biomass falling to unacceptably low levels.
- 76 The relative sustainability risks are greatest under Option 3 at the current 25 000 tonne TAC, as this level of catch is not sustainable over the longer term based on the best available information. While this option has no additional economic impact in 2006, its consequences in subsequent years could be dire; catches would likely need to be reduced to 5 000 tonnes or less in order to ensure long term sustainability based on the current assessment information.
- 77 MFish considers that, should the Minister choose Options 2 or 3, he will be required to articulate a plan for moving the stock biomass towards or above the  $B_{MSY}$  level in an appropriate way and rate, if those options are to satisfy s 13 requirements.
- 78 MFish is currently developing a fishery plan for the SBW 6I stock. This Plan will provide a framework to provide long term sustainability, improved risk management, and the ability for industry to be better informed in their financial decisions, through the development of a harvest strategy and decision rules.
- 79 The fisheries planning framework provides a possible opportunity for MFish and stakeholders to develop collaboratively the best management arrangements that will deliver the desired utilisation objectives and satisfy the sustainability obligations for the fishery over the medium to longer term.

## Initial Proposed Options

80 MFish proposes that:

EITHER

- a) OPTION 1 - for the fishing year commencing on 1 April 2006, the southern blue whiting TAC for the Campbell Island Rise stock (SBW 6I) be reduced to 16 400 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 16 400 tonnes.

OR

- b) OPTION 2 - for the fishing year commencing on 1 April 2006, the southern blue whiting TAC for the Campbell Island Rise stock (SBW 6I) 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.

OR

- c) OPTION 3 (*status quo*) - for the fishing year commencing on 1 April 2006, the southern blue whiting TAC for the Campbell Island Rise stock (SBW 6I) be retained at its current level of 25 000 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 retained at 25 000 tonnes.

# APPENDIX ONE – FISHERY SUMMARY

## Catch information

81 The following table illustrates the catches from the southern blue whiting fisheries by area for 1978 to 2005-06 (preliminary) from vessel logbooks and fishing returns.

Table A: Estimated catches (t) of southern blue whiting by area for the period 1978 to 2004-05 from vessel logbooks and QMRs. – no catch limit in place. \*, before 1997-98 there was no separate catch limit for Auckland Is. Estimates for 2004-05 are preliminary.

	<u>Bounty Platform</u>		<u>Campbell Island Rise</u>		<u>Pukaki Rise</u>		<u>Auckland Is.</u>		<u>Total</u>	
	(a) Fishing year	Catch	Limit	Catch	Limit*	Catch	Limit	Catch	Limit*	Catch
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	24 938	35 140 ‡
2001–02‡	2 261	8 000	29 999	30 000	230	5 500	10	1 640	32 501	45 140 ‡
2002–03‡	7 564	8 000	33 433	30 000	508	5 500	254	1 640	41 775	45 140 ‡
2003–04‡	3 812	3 500	23 718	25 000	163	5 500	116	1 640	27 812	35 640 ‡
2004–05‡	1 477	3 500	19 776	25 000	239	5 500	70	1 640	21 567	35 640 ‡
2005–06‡	3 962	3 500	26 190	25 000	58	5 500	50	1 640	30 260	35 640 ‡

<sup>f</sup> 1 April-30 September. + 1 October-30 September.

† 1 October 1998-31 March 2000 # 1 April -31 March.

‡ SBW 1 (all EEZ areas outside QMA6) had a TACC of 8 t, and reported catches of 9 t in 2000–01, 1 t in 2001–02, 16 t in 2002–03, 2.6 t in 2003–04, and 5 t in 2004–05.

## SBW stock structure

82 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

83 Since 1997, management of the SBW 6I fishery has been based on a CAY strategy. A CAY strategy takes into account the biological characteristics of the stock and the current status of the stock based on a current assessment. 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**

- 84 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).
- 85 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.
- 86 The catch limits for the Campbell fishery were under-caught in three of the last six years (since introduction into the QMS). 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. The TACC for the Campbell fishery was exceeded in 2002-03 and 2005-06.
- 87 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***

- 88 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.
- 89 An estimation of the primary product value of the SBW 6I fishery can be undertaken by an examination of port prices and TACC level. The 2005-06 levy order lists the port price for SBW 6I as \$350 per tonne, which is little change from the 2004-05 port price of \$345 per tonne. The stable port price in the last two years contrasts with the previous two years, where the 2003-04 port price for SBW was \$100 per tonne, and the 2002-03 port price was as high as \$590 per tonne. The landed catches for the SBW 6I fishery in 2003-04, 2004-05 and 2005-06 were about 24 000 tonnes, 20 000 tonnes, and 26 000 tonnes, resulting in gross raw product values of \$2.4, \$6.9, and \$9.1 million respectively, (based on the relevant-year port prices).

- 90 The reported New Zealand FOB export value of SBW products for the 2004 calendar year totalled approximately \$10 million including surimi, frozen fillet, and frozen head and gutted product. 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.
- 91 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***

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

### ***Māori customary fishery***

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

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

- 94 Scientific observers have reported discards of undersize fish and accidental loss from torn or burst codends.
- 95 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.

### ***Illegal catches***

- 96 The level of illegal and unreported catch is thought to be low, however, the operators of one vessel have recently been convicted for area misreporting. In 2002–03, the vessel caught about 204 tonnes on the Campbell Island Rise (SBW 6I) that were reported against quota for the Pukaki Rise (SBW 6R), and another 480 tonnes caught on the Campbell Island Rise were reported against quota for the Auckland Islands Shelf (SBW 6A). Table 1 shows corrected totals by area for 2002–03.

### ***Observer coverage***

- 97 In the 2004-05 and 2005-06 fishing years, observer coverage was planned to cover about 330 days. This compares to the 2001-02 fishing year there where there were 408 observer days in the SBW fisheries. In 2004-05, the number of observed days achieved was 294, and in 2005-06 it was 261 days. 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.
- 98 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%).

- 99 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***

- 100 Research reports estimate the number of New Zealand fur seals captured in the SBW fishery (from extrapolation of data from observed tows – the vast majority of fishing effort is in SBW 6I) as:
- 1999-00 - 14 fur seals (c.v. = 43%) (based on four confirmed deaths reported in the 27% observer coverage of the 789 tows conducted)
  - 2000-01 - 88 seals (c.v. = 15%) (based on the seasonal mean catch rate – 62% of tows in SBW 6I were observed and 25 seals observed caught in that part of the fishery)
  - 2001-02 – 18 seals estimated caught in SBW 6I (c.v. = 39%) (based on mean catch rate of 0.022 fur seals caught per observed tow (s.e. = 0.011)
  - 2002-03 – 17 seals (c.v. = 24%) Based on mean catch rate in September 0.030 (s.e. = 0.010).
- 101 The reports reveal that fur seal bycatch rates were significantly lower in the Campbell Plateau compared to the Bounty Platform. However, the Campbell fishery generally accounts for more than 90 % of SBW target fishing effort.
- 102 Application of a marine mammal exclusion device has been trialled 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***

- 103 Research reports estimate the following incidental captures of seabirds in the SBW fishery:
- 1999-00 - two seabirds were landed dead from tows off the north-eastern 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” (Seabird National Plan of Action (NPOA))
  - 2000-01 – one Salvin’s albatross observed caught off Bounty Platform; one grey petrel and one southern cape pigeon caught north of Campbell Rise
- 104 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 area.

## **Fish bycatch**

- 105 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.
- 106 However, the latest research results confirm that the southern blue whiting fishery is characterised by relatively clean catches of the target species. Based on data collected between 1990 and 2002, 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 be among the least wasteful of those New Zealand trawl fisheries examined.

## **Research**

- 107 An acoustic survey of the Campbell fishery was completed in winter 2004. This survey was incorporated into an updated stock assessment, reported to a special working group plenary in February 2005 (see Appendix Two). A further update of the assessment was undertaken in January 2006, which included new data from the 2005-06 fishery. That updated assessment was reported to the Middle Depths Fishery Assessment Working Group at the end of January 2006. A revised assessment is planned for later this year, and will include a new acoustic biomass estimate from a survey planned for August-September 2006.

## **Compliance information**

- 108 There are unlikely to be significant compliance concerns in the SBW 6I fishery. However, large bags taken are likely to contain damaged and undersized fish, potentially resulting in dumping and high grading of fish. Past misreporting of catches between areas has also been confirmed, and incentives exist given the large differences in the catch limits between adjacent fishery areas or stocks.
- 109 The operators of one vessel were recently convicted for misreporting of catch (i.e. trucking of fish). They admitted that in 2002–03 about 204 tonnes caught on the Campbell Island Rise (SBW 6I) was reported against quota for the Pukaki Rise (SBW 6R) and that another 480 tonnes from the Campbell Island Rise was reported against quota for the Auckland Islands Shelf (SBW 6A).

## APPENDIX TWO – STOCK ASSESSMENT

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- 110 For the updated 2006 assessment, estimates of biomass and yield are provided for the Campbell Island Rise SBW 6I stock based on analyses using catch-at-age from the commercial fishery, acoustic survey data, and estimates of biological parameters. New information since the 2005 assessment included one year of commercial catch proportions-at-age data. In order to determine whether there was any urgent sustainability concern with the Campbell Islands stock, the Middle Depths Working Group (WG) agreed to update the 2005 base case assessment and sensitivity tests using the new proportion-at-age data.

### Estimates of fishery parameters and abundance indices

- 111 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 2003). However, the WG was unable to resolve the inconsistencies between the various data sources (swim bladder 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 WG 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.
- 112 A further acoustic survey of the Campbell Island stock was completed in August/September 2004 (O’Driscoll *et al.* in prep.) Two snapshots were carried out on pre-spawning and spawning aggregations on the Campbell Island Rise. The distribution of fish on the ‘northern’ ground during the 2004 survey was quite different to previous years. Most of the fish caught by the commercial vessels, and about 50% of the biomass from the acoustic survey, came from several aggregations to the east of the core survey area.
- 113 For the 2005 assessment, the Plenary considered two possible hypotheses regarding the observed distribution of fish outside the core area: (1) the northern aggregation had moved further east and were spawning outside the survey area; (2) the fish which previously had spawned in the northern area had been depleted and the fish observed outside of the core area represent a new unsurveyed part of the population. During the 2005 season, most fishing on the northern aggregation occurred within the usual acoustic survey area, and despite some searching few fish were found to the east. The stock assessment was run using both sets of acoustic biomass estimates (Table 4) to examine the stock status under each hypothesis. However, the second hypothesis was considered to be more plausible and was used as the base case.

**Table 4: Estimates of biomass (000 t) for age 1, 2, 3 and 4+ fish from acoustic surveys of Campbell Island Rise, and CPUE indices. – no data. \*Estimates include fish from outside the standard survey area.**

Year	Campbell Island Rise				CPUE
	1	2	3	4+	
1986	–	–	–	–	1.00
1987	–	–	–	–	0.91
1988	–	–	–	–	0.88
1989	–	–	–	–	1.38
1990	–	–	–	–	1.06
1991	–	–	–	–	1.30
1992	–	–	–	–	0.60
1993	1.82	71.90	14.78	24.03	1.03
1994	0.33	12.26	139.55	28.84	1.19
1995	0.00	11.18	23.23	130.54	1.23
1996	–	–	–	–	2.28
1997	–	–	–	–	2.28
1998	2.28	13.14	28.02	167.67	1.74
1999	–	–	–	–	2.55
2000	0.96	10.46	8.42	135.61	1.85
2001	–	–	–	–	1.83
2002	3.06	3.73	11.55	148.19	1.94
2002*	3.06	3.83	11.84	152.18	–
2004	1.51	14.42	18.87	17.28	–
2004*	1.51	17.33	34.53	56.20	–

114 A standardised CPUE analysis of the Campbell Island stock was completed up until the 2002 fishing season, and the indices are shown in Table 4. In the past there has been 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. The indices have therefore not been used in the stock assessment since 1998.

## Biomass estimates for the Campbell Island stock

### *The stock assessment model*

115 The stock assessment model partitions the Campbell Island 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

116 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.

- 117 The model was fitted to the two series of 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 2005. 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.
- 118 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. \*Estimates include fish from outside the standard survey area.**

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
*2002	3 829	76	11 842	72	152 184	68
2004	14 412	16	18 873	24	17 283	32
*2004	17 327	16	34 527	27	56 197	38

### **Estimation**

- 119 Model parameters were estimated using Bayesian methods implemented using the NIWA stock assessment program CASAL v2.07 (Bull et al. 2004). 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.
- 120 MCMC chains were estimated using a burn-in length of 1 million iterations, with every 10 000<sup>th</sup> sample taken from the next 10 million iterations (i.e., a final sample of length 1000 was taken from the Bayesian posterior).

121 Equilibrium “virgin” biomass is equal to the population that there would have been if all the YCS were equal to one and there was no fishing. However, there was a period of unknown (and possibly large) catches from the Campbell Island 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 2003, under the assumption that the estimates from the model should average one.

### **Prior distributions and penalty functions**

122 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 for the acoustic survey 4+  $q$ .

**Table 7:** The distributions, priors, and bounds assumed for the various parameters being estimated in the Campbell Island Rise stock assessment. The parameters are mean and c.v. for lognormal; and mean and s.d. for normal. \*The prior for the adult (4+) acoustic  $q$  used for a sensitivity run. The process errors were fixed at their MPD values when carrying out the MCMCs.

Parameter	N	Distribution	Values		Bounds	
			Mean	c.v. / s.d.	Lower	Upper
$B_0$	1	Uniform-log	–	–	30 000	800 000
Acoustic $qs$ age 2, 3	2	Uniform-log	–	–	0.1	2.8
YCS	27	Lognormal	1.00	1.30	0.001	100
Initial population	18	Uniform-log	–	–	2e5	2e12
Selectivity ages 2-4 (by sex)	6	Uniform	–	–	0.0001	1
M (average)	1	Lognormal	0.20	0.20	0.075	0.325
M (difference)	1	Normal	0.00	0.05	-0.05	0.05
Process errors	4	Uniform-log	–	–	0.0001	1
Acoustic age 4+ $q$	1	Lognormal	1.40	0.20	0.1	2.8
*Acoustic age 4+ $q$	1	Uniform-log	–	–	0.1	2.8

123 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 WG agreed to extend the lower bound to 0.1. The informed prior for the adult acoustic  $q$  will need to be revised in future to take account of the new estimates of the absorption coefficient, tow body motion (pitch and roll), and the target strength–fish length relationship.

124 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 zero 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.

## **Base case and sensitivity runs**

125 The WG considered three runs, which were essentially updates of the 2005 assessment. The WG agreed that the model run using an informed prior on  $q$ , and which included the acoustic biomass indices incorporating all surveyed strata, provided the most plausible results and this was chosen as the base case. However, the WG noted that if fish had been outside the core survey area in the earlier years (Hypothesis 2) then the assessment would underestimate the level of decline in the Campbell Island stock and would consequently overestimate the available yields. The Plenary agreed that Hypothesis 1 would be reported as the base case and to report two sensitivity runs bracketing the base case assessment, one exploring the effect of an uninformed prior on the acoustic  $q$  and the other representing Hypothesis 2 (Table 8). The WG noted that the run which used the low acoustic biomass series based only on the core survey strata indicated that the exploitation rate had been very high in 2005 which was considered unlikely.

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

<b>Model label</b>	<b>Description</b>
<b>Base case</b>	<b>Lognormal prior on adult acoustic <math>q</math>, and high acoustic biomass series</b>
Uninformed $q$	Uniform-log prior on adult acoustic $q$ , and high acoustic biomass series
Low acoustic	Lognormal prior on adult acoustic $q$ , and low acoustic biomass series

126 Since 2001, the Plenary has used  $B_{1991}$  as a limit reference biomass level for the Campbell Island Rise stock. Recruitment in the Campbell Island Rise stock is characterised by periods of moderate recruitment interspersed by relatively rare, extremely strong, recruitment events. Only one such event (1991 year class) has been observed within the timeframe of the model, although historical data suggests that this may have happened in the past. Given the high variability in recruitment levels,  $B_0$  is probably not well determined. Therefore, the Plenary considered that  $B_{1991}$  may be a better limit reference point than the more commonly used 20%  $B_0$ . Based on the assumptions of the model and the available data,  $B_{1991}$  is estimated to be about 17% of  $B_0$  and there is only a slight probability that  $B_{1991}$  exceeds 20%  $B_0$  (Figure 1).

127 The Plenary agreed that the probability of falling below  $B_{1991}$  should be kept low for several reasons, including:

- the stock biomass has only been observed at that low level once in the time series;
- the exceptionally strong recruitment from the 1991 year class has only been observed once in the 27 years covered by the stock assessment; and
- although no stock recruitment relationship is assumed in the model, the risks of poor recruitment may be higher at  $B_{1991}$  levels than at 20% $B_0$ .

128 The Plenary does not have an agreed target reference biomass level or associated risk level for the Campbell Island Rise stock. The development of an appropriate target reference biomass level will be the focus of future discussions, and will require some direction from fisheries managers on the acceptable levels of risk and the harvest strategy to be applied.

129 For each model run, MPD fits were obtained and qualitatively evaluated. MCMC estimates of the median of the posterior and 90% credible intervals are reported for virgin biomass,  $B_{2005}$ ,  $B_{2005}$  (as % $B_0$ ), and  $B_{2005}$  (as % $B_{1991}$ ).

## Results

130 The estimated MCMC marginal posterior distributions for spawning stock biomass by year are shown for the base case in Figure 2, and the results summarised in Table 9. The run suggests that the stock biomass showed a steady decline from the early 1980s until 1993 followed by a large increase to 1996, and a decline thereafter. Exploitation rates are shown in Figure 3. The catch is dominated numerically by the 2001 and 2002 year classes, and the strong 1991, 1995, 1996, and 1998 year classes now contribute to only a small proportion of the commercial catch (Figure 4). The 2003 year class is estimated to be below average by the model, but since it appears only once in the catch-at-age data it is not well estimated, (and is not used in projections). Estimates of the adult acoustic  $q$ , the 2005 exploitation rate and  $M$  are given in Table 9.

131 The sensitivity runs show that the estimates of  $B_{2005}$  and stock status are very sensitive to the choice of acoustic biomass series but only slightly sensitive to the prior used for the acoustic  $q$  (Table 9).

Table 9: Bayesian median and 90% credible intervals of  $B_0$ ,  $B_{2005}$  (in '000 t),  $B_{2005}$  as a percentage of  $B_{1991}$  and of  $B_0$ ,  $B_{1991} / B_0$ , adult 4+ acoustic  $q$ , the 2005 exploitation rate, and  $M$  for each of the three runs for the Campbell Island stock.

Model run	$B_0$	$B_{2005}$	$B_{2005}$ (% $B_{1991}$ )	$B_{2005}$ (% $B_0$ )	$B_{1991} / B_0$
Base case	245 (219–285)	68 (46–105)	164 (113–240)	28 (19–41)	0.17 (0.13–0.22)
Uninformed $q$	246 (221–282)	76 (47–129)	177 (119–257)	31 (19–50)	0.18 (0.13–0.24)
Core acoustic	215 (199–244)	35 (27–51)	84 (65–117)	17 (12–24)	0.20 (0.16–0.24)

Model run	$q$	$U_{2005}$	$M$
Base case	1.18 (0.99–1.35)	0.33 (0.23–0.45)	0.17 (0.13–0.21)
Uninformed $q$	1.08 (0.78–1.33)	0.30 (0.19–0.45)	0.18 (0.14–0.23)
Core acoustic	1.16 (1.03–1.28)	0.56 (0.42–0.68)	0.18 (0.15–0.21)

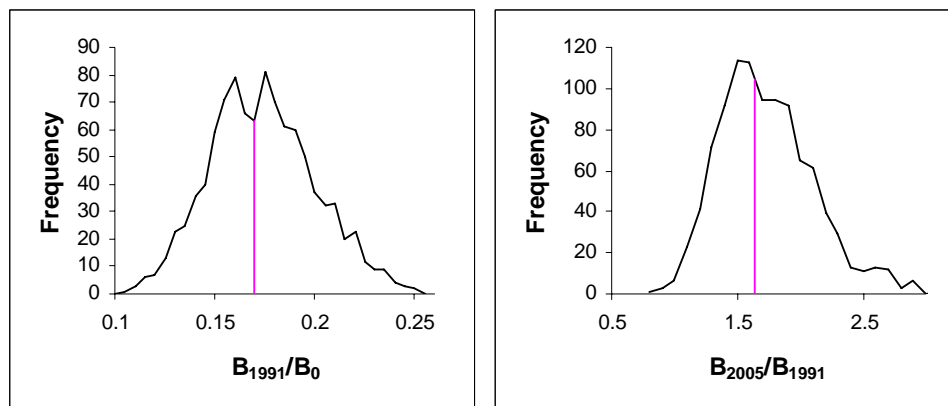


Figure 1: Posterior distributions for  $B_{1991}/B_0$  (median 0.17) and  $B_{2005}/B_{1991}$  (median 1.64) for the Campbell Island stock for the base case.

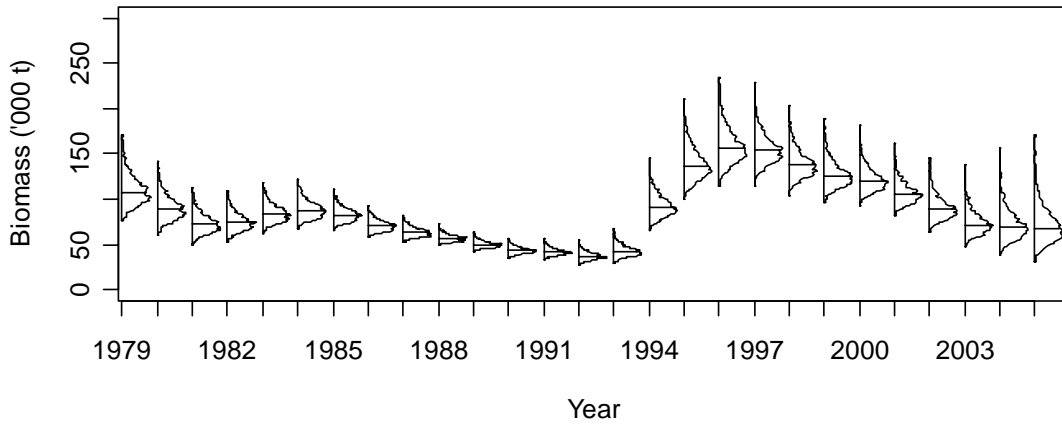


Figure 2: Estimated posterior distributions of biomass trajectories for the Campbell Island stock for the base case.

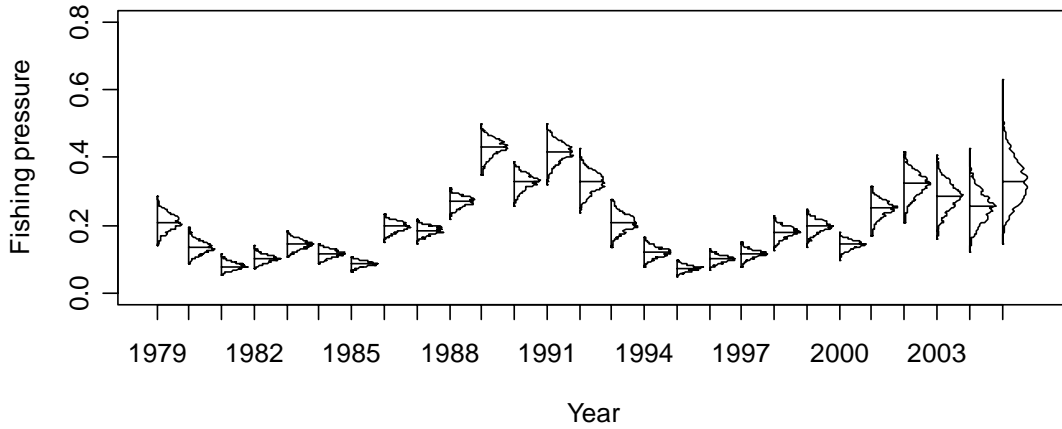


Figure 3: Estimated posterior distributions of exploitation rates for the Campbell Island stock for the base case.

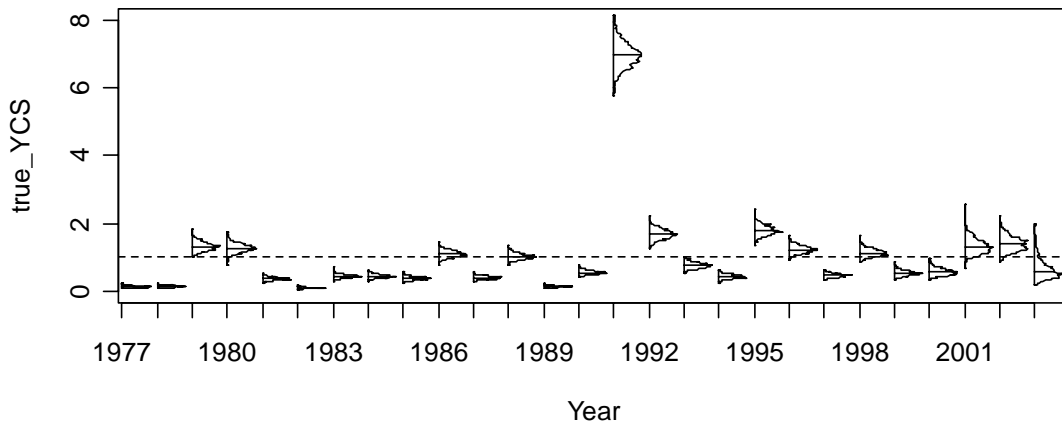


Figure 4: Estimated posterior distributions of year class strengths for the Campbell Island stock for the base case.

132 Projections were made assuming fixed catch levels from 10,000 to 25,000 t per year using the MCMC samples. Recruitments were drawn randomly from the distribution of year class strengths estimated by the model over the period 1977 to 2002. The probability that the mid-season biomass for the specified year will be less than the limit reference biomass is reported in Table 10.

**Table 10: Probability that the projected mid-season vulnerable biomass for 2006, 2007, and 2008 will be less than the mid-season vulnerable biomass in 1991 and the median projected biomass as a percentage of  $B_0$  (with 90% credible intervals) for different constant catch levels for the Campbell Island stock base case run.**

Constant catch (t)	Probability ( $B_{\text{proj}} < B_{1991}$ )			Median biomass as proportion $B_0$		
	2006	2007	2008	2006	2007	2008
10 000	0.02	0.02	0.02	29 (18–48)	32 (19–61)	35 (20–81)
15 000	0.03	0.06	0.08	28 (17–48)	29 (16–65)	30 (14–81)
20 000	0.06	0.14	0.23	27 (16–47)	26 (13–59)	25 (9–71)
25 000	0.08	0.22	0.39	27 (15–45)	23 (10–53)	20 (7–63)

133 At the request of the WG, a further set of projections was made to examine the effect of taking a catch of 25 000 tonnes in 2006-07. The results are shown in Table 10A below.

**Table 10A: Probability that the projected mid-season vulnerable biomass for 2006, 2007, and 2008 will be less than the mid-season vulnerable biomass in 1991, and the median projected biomass as a percentage of  $B_0$  (with 90% credible intervals) for a catch of 25,000 t in 2006 followed by constant catch levels from 0–25,000 t for 2007 and 2008 for the base case.**

Constant catch (t)	Probability ( $B_{\text{proj}} < B_{1991}$ )			Median biomass as percentage $B_0$		
	2006	2007	2008	2006	2007	2008
0	0.08	0.08	0.03	27 (15–45)	29 (14–65)	36 (19–87)
5 000	0.08	0.12	0.06	27 (15–45)	27 (13–65)	31 (16–84)
10 000	0.08	0.14	0.10	27 (15–45)	25 (13–51)	28 (14–68)
15 000	0.08	0.17	0.18	27 (15–45)	26 (12–54)	26 (11–74)
20 000	0.08	0.21	0.30	27 (15–45)	24 (11–52)	22 (7–64)
25 000	0.08	0.22	0.39	27 (15–45)	23 (10–53)	20 (7–63)

### Yield estimates

134 Estimates of sustainable yields have been calculated for the Campbell Island Rise for each of the runs. Yield estimates were based on the 1000 samples from the Bayesian posterior, with yield estimates based on stochastic simulations run over 100 years (Bull et al. 2003). The simulation method of Francis (1992) was used to estimate MAY and CAY subject to the constraint that spawning stock biomass should not fall below 20% of  $B_0$  more than 10% of the time. The estimates of  $B_{\text{MAY}}$ , MAY, and  $\text{CAY}_{2006-07}$  are given for the Campbell Island stock in Table 18.  $\text{MCY}$  and  $B_{\text{MCY}}$  estimates have not been presented for the current assessment update due to the fact that the methods for calculating these reference points are currently under revision.

**Table 18: Yield estimates (MAY and CAY) and associated parameters.**

Model run	$B_{\text{MAY}}$ (% $B_0$ )	MAY (t)	$U_{\text{CAY}}$	$\text{CAY}_{2005-06}$ (t)
Campbell Island Rise	34	18 600	0.20	16 400

135 For the Campbell Island Rise stock, the Plenary noted that the limit biomass assumed in the yield estimation simulations is 20% $B_0$ , which is different from the use of  $B_{1991}$  for assessing risk in projections. No corresponding yield estimates based on the  $B_{1991}$  limit biomass reference point were available for consideration by the Plenary.

## STATUS OF THE CAMPBELL ISLAND STOCK

136 The 2005 Campbell Island stock assessment was updated by including catches an additional year of proportion-at-age data. For the base case,  $B_{2005}$  was estimated to be

68 000 t (90% credible interval 46 000–105 000 t), corresponding to 28%B<sub>0</sub> (90% credible interval 19–41%). Estimates of B<sub>2005</sub> were very sensitive to the choice of series of acoustic survey estimates but only slightly sensitive to the prior used for the adult acoustic  $q$ .

- 137 The catch is dominated numerically by the 2001 and 2002 year classes, and the strong 1991, 1995, 1996, and 1998 year classes now contribute to only a small proportion of the commercial catch. The TACC was reduced to 25 000 t in 1 April 2003, and at this level of catch, the biomass is projected to decline further. At the current TACC level, the probability that the biomass will drop below B<sub>1991</sub> is projected to increase from 8% to 39% over the next three years (Table 10).

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