Stock assessment of SNA 2 for 2010

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EXECUTIVE SUMMARY

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A stock assessment of SNA 2 was conducted using a statistical, age-structured population model implemented in Stock Synthesis. The model encompasses the 1933–2009 period and incorporates seven years of catch-at-age data sampled from the commercial fishery (between 1991–92 and 2007–08) and a standardised CPUE index for the bottom trawl fishery for the recent period (1989–90 to 2007–08). Two alternative values of natural mortality were considered (0.075 and 0.06).

Preliminary model runs revealed that the model was highly sensitive to the assumptions regarding fishery selectivity. It was considered that there was insufficient information content in the age frequency data to estimate the selectivity of the older age classes due to confounding with fishing mortality. On that basis, it was decided to adopt an externally derived selectivity function.

The model fit to both the age composition data and the CPUE indices is poor. There is a clear conflict between the two data sources as evidenced by the fit to the most recent years' data; the model fits the recent decline in the CPUE indices only by estimating lower year class strengths than is evident in the commercial age frequency observations. Conversely, the model is unable to fit to the strong decline in the CPUE indices in the early 1990s given the observed age compositions. The biomass trajectory derived from the model displays a strong decline in biomass during the 1960s and 1970s concomitant with the higher levels of catch during the period. The estimated biomass trajectory is highly constrained throughout this period and during the preceding years due to structural assumptions of the model, principally the fixed selectivity, deterministic recruitment, and fixed biological parameters.

The model estimates of recent fishing mortality rates are influenced by the recent catch-at-age data mediated by the assumed selectivity function. Consequently, the assumed selectivity function has considerable influence on the estimates of current stock status. Further, given the conflict between the data sources, the relative weighting of the CPUE and age frequency data is also highly influential. On that basis, estimates of current stock status are not considered reliable and it is not possible to make conclusions regarding current stock status from the assessment models. Nonetheless, for the range of model options investigated, the estimates of *MSY* are comparable. This is attributable to the similar estimates of R_0 (and therefore B_0) among the various model options. The estimates of virgin biomass are consistent with the minimum biomass levels necessary to support the catch history during the period before the mid 1980s.

The two models yielded median values of *MSY* of 496 t and 443 t for the higher ($M = 0.075$) and lower ($M = 0.06$) natural mortality scenarios, respectively. The *MSY* estimates are highly constrained by the structural assumptions of the model and the associated confidence intervals do not represent the true uncertainty associated with the yield estimates. These yield estimates are likely to be conservative as they are based on estimates of R_0 that approach the minimum level of (deterministic) recruitment necessary to support the historical catches from the stock. Conversely, the models may over-estimate yields to the extent that the historical catches have been over-estimated (i.e. the allowance for 20% over-catch of the reported catch).

1. INTRODUCTION

Snapper (*Pagrus auratus*) is an important component of the bycatch of the inshore fishery off the east coast of the North Island. Reported landings from the fishery peaked in the late 1960s and early 1970s at 800–900 t. Catches reduced considerably in the early 1980s and recovered somewhat during the late 1980s. Since the mid 1990s, annual reported catches have fluctuated about 300–350 t. The TACC for SNA 2 was increased to about this level (315 t) in 2002–03 (Ministry of Fisheries Science Group 2009).

The first stock assessment of SNA 2 was conducted in 2002 (Gilbert & Phillips 2003). The assessment incorporated four years of catch-at-age data in an age-structured population model. The current (2002) biomass was estimated to be near to or somewhat below B_{MSY} but was projected to increase towards B_{MSY} by 2006. However, no biomass indices were available for inclusion in the model and, consequently, estimates of stock status were considered highly uncertain.

Since 2002, an additional three years of age composition data have been collected from the fishery. In addition, a time series of recent CPUE indices has been derived for the stock (Kendrick & Bentley in press). The availability of these additional data meant that it was an appropriate time to update and revise the previous stock assessment.

This report documents the results of the assessment undertaken as a component of the Ministry of Fisheries research project SNA2009-01. The principal objective of the project is “to conduct a stock assessment for snapper (*Pagurus auratus*) in SNA 2, including estimating biomass and sustainable yields”.

2. MODEL DATA SETS

The model incorporates three sources of observational data from the SNA 2 fishery: annual catches, a time series of standardised CPUE indices and age frequency distributions from market sampling of the commercial catch during the 1990s and 2000s.

2.1 Catch

Catch data are available from 1933 to the 2008–09 fishing year. The catch history was configured in a similar manner to the previous assessment (Gilbert & Phillips 2003), including the reported catch, a non-reported catch, and a small recreational and customary harvest (Figure 1, Appendix 1). The annual non-reported catch was assumed equal to 20% of the reported catch for the years before 1986–87, reduced to 10% of the reported catch in 1986–87 and assumed to decrease by 1% of the reported catch each year until 1995–96, after which the unreported catch was assumed to be 1% of the reported catch.

The reported commercial catch is principally taken by the inshore trawl fishery. For almost all years since 1989–90, the bottom trawl fishery has accounted for at least 90% of the total annual SNA 2 catch (Kendrick & Bentley in press).

Following previous assessments, the combined recreational and customary catches were assumed for the 1933–2009 period using a step function that increased the annual catch by 5 t each decade from an initial catch level of 10 t. The assumed catches in 1993 and 1996 were similar to the catch estimates from the telephone/diary surveys in those years (36 and 40 t, respectively). However, the assumed catches are much lower than the SNA 2 recreational catch estimates for 2000 and 2001 (322 and 173 t, respectively) (Ministry of Fisheries Science Group 2009).

2.2 CPUE indices

Annual CPUE indices were available for 1989–90 to 2008–09 (1990–2009 model years). The indices were derived from catch and effort data from single bottom trawls targeting a range of inshore species within SNA 2 (Kendrick & Bentley in press). Catch and effort data from the earlier years of the fishery are not available in a comparable format and, hence, no CPUE indices are available for the earlier period.

The indices decline sharply from 1990 to 1994, increase steadily from 1995 to 2006 and then decline markedly over the two following years. Members of the NIN WG considered that the trends in the CPUE indices may be strongly influenced by changes in the management regime throughout the period, particularly the changes in the provisions relating to the over-catch of the TACC. For example, the decline in the indices in 2007 and 2008 may be attributable to a concomitant increase in the deemed values for SNA 2 resulting in a stronger disincentive to over-catch the TACC. There is concern regarding the reliability of the CPUE indices as an index of stock abundance, particularly in the most recent years.

2.3 Age compositions

Age frequency data from the commercial fishery were available from seven years of market sampling: 1991–92, 1997–98, 1998–99, 1999–2000, 2002–03, 2004–05, and 2007–08. Most of the age sampling was conducted from snapper catches taken as a bycatch from the inshore trawl fisheries. Details of the individual sampling programmes are documented in the relevant reports (Ryan 1993, Blackwell et al 1999, Blackwell et al 2000, Blackwell & Gilbert 2001, Blackwell & Gilbert 2005, Blackwell & Gilbert 2006).

A review of snapper ageing techniques (Davies & Walsh 1995) revealed some inconsistencies with the ageing of the otoliths collected from SNA 2. As a result, a standardised approach was adopted for the ageing of the 1999–2000, 2002–03, 2004–05, and 2007–08 otolith collections. However, the first three years of sampling data (1991–92, 1997–98, and 1998–99) have not been reanalysed and these data are considered less reliable than the later samples.

The age frequency distributions principally comprise 3–10 year old fish and few older fish sampled (Figure 2). There is considerable variability in the age compositions among years and between consecutive years. However, the somewhat intermittent sampling and the relatively narrow age range sampled means that it is difficult to identify strong and weak year classes persisting through the successive age samples (Figure 3). It is also likely that differences in the operation of the principal target fisheries and the distribution of sampled component of the catch may introduce considerable variation into the age frequency distributions, thereby obscuring the underlying age structure of the snapper population.

3. MODEL STRUCTURE AND ASSUMPTIONS

A statistical, age-structured population model was implemented using the Stock Synthesis (SS) software (version 3.02C) (Methot 2005, 2009). For simplicity and compatibility with previous assessments, the stock assessment model adopts an annual structure with a single (12 month) fishing season. Catches and other observational data are assigned to the calendar year of the end of the fishing year (for example, the 2002–03 fishing year is denoted 2003).

The model encompasses the 1933–2009 period. The model structure includes two sexes, 1–19 year age classes, and an accumulating age class for older fish (20+ years). Recruitment is defined as fish entering the model population (age 0 year). The age structure of the population at the start of the model is assumed to be in an unexploited, equilibrium state. The catch is removed throughout the fishing season using a hybrid method to calculate fishing mortality that combines Pope's approximation and continuous *F* (see Methot 2009).

Biological parameters are equivalent to those used in the previous assessment and are equivalent for the two sexes (Table 1). Two alternative values of natural mortality were considered: a higher value of 0.075 and a lower value of 0.06. Both of these values are routinely applied in the SNA 1 and SNA 8 stock assessments. Natural mortality was assumed to be invariant with age.

As for other snapper assessments, it was assumed that there is no relationship between spawning stock biomass and recruitment (i.e. steepness, *h,* of 1.0). Recruitment deviates were estimated for 1985–2002 as these years correspond to the year classes for which there are at least two observations in the age frequency data (for the fully selected age classes). The standard deviation of the natural logarithm of recruitment (σ_R) was fixed at 0.6.

The CPUE index was assumed to have a selectivity equivalent to the commercial fishery and catchability was temporally invariant. A coefficient of variation (c.v.) of 20% was assumed for the CPUE indices.

The sample size assigned to each of the age frequency samples was determined using an iterative reweighting approach (following McAllister & Ianelli 1997). Preliminary model runs suggested that the age frequency data should be down-weighted and, consequently, an effective sample size of 50 was adopted for each of the age frequency samples.

The ageing error associated with the otolith readings has not been quantified; however, ageing error is considered to be low (about 10–15%) for the 4–9 age classes and slightly higher for younger and older age classes. Age specific ageing error, parameterised as the standard deviation of age, was incorporated in the model to approximate the following assumed levels: age classes 1–9 years, s.d. = 0.35; age classes 10–19 years, s.d. = 0.4; 20+ years, s.d. = 0.35. The same age specific ageing error was assumed for all age frequency observations.

The CPUE indices are assumed to have a lognormal error structure, while the age frequency distributions are assumed to have a multinomial error structure. The contribution of each component of the objective function was described by Methot (2005).

The model provided estimates of reference (B_0 and B_{MSY}) and current biomass (B_x) and fishing mortality. These management quantities are defined in Table 2. Model uncertainty was estimated using a Markov chain Monte Carlo (MCMC) approach.

4. PRELIMINARY MODEL RUNS

A range of preliminary models was investigated based on the model structure described above. The initial runs estimated the selectivity of the commercial fishery using a double normal functional form (see Methot 2009). The resulting selectivity function estimated that full selectivity occurred at age 5 years and that selectivity declined for fish older than 8 years. Selectivity for the age classes older than 12 years was very low (Figure 4).

The estimated selectivity pattern is consistent with the observed age frequency distributions. Nonetheless, given the high catches that occurred during the 1970s, it is probable that the observed age structure in the subsequent years, in particular the proportion of fish in the accumulated age class (20+ years), could also be indicative of the historical pattern of exploitation. However, the very low selectivity estimated for the older age classes meant that the model was effectively ignoring any information content in this component of the sampled age structure.

The biomass trajectory derived from the model was characterised by a strong decline in spawning biomass from 1960 to the early 1980s, followed by a steady increase in the spawning biomass. However, the model predicts that a large component of the adult population is invulnerable to the fishery ("cryptic biomass") due to the very low selectivity of the older age classes. Therefore, any conclusions regarding the current stock status from such a model are extremely uncertain as they are largely dependent on an unobserved component of the stock.

The model was unable to fit the CPUE indices, particularly the initial sharp decline in the indices and the decline in the CPUE indices in the two most recent years. These indices are clearly inconsistent with the observed age frequency distributions and the biological parameters for the stock.

The uncertainty associated with key model parameters was investigated using an MCMC approach. The lower bound of the biomass trajectory was effectively constrained by the level of the historical catch; however, the upper bound on the biomass trajectory was not constrained within a reasonable upper limit, indicating that there is no information in the model data sets to reliably estimate the magnitude of the stock.

An alternative model was investigated that parameterised the fishery selectivity using a logistic function (i.e., non-declining selectivity for the older age classes). The resulting biomass trajectory differed considerably from the previous model. The biomass was estimated to remain at a low level from 1980 onwards and the current stock status was much less optimistic. Nonetheless, the fit to the age frequency data was substantially worse than for the model with the double normal selectivity. The model was also unable to fit the variation in the CPUE indices, particularly the declines in the indices early and late in the series.

The second model is also highly constrained by the assumption of full selection for the oldest age classes and the assumption of deterministic recruitment for most of the model period. Consequently, the model estimate of B_0 (and therefore R_0) was largely dependent on the catch history included in the model and the results of the model are relatively insensitive to both the age frequency data and the CPUE indices.

The two alternative parameterisations of fishery selectivity (double normal and logistic) are considered to represent the extreme bounds of the range of plausible selectivity for the older age classes in the population, at least for the fishery in the period with observations of the age composition of the catch. The estimation of a double normal selectivity function is likely to result in overly optimistic conclusions regarding current stock status, while the converse is likely for a model that assumes logistic selectivity.

5. FINAL MODEL

Based on the results of the preliminary modelling (described in Section 4), the NIN WG agreed that the data were inadequate to derive a reliable estimate of the recent fishery selectivity. In an attempt to progress the assessment, it was decided to adopt an externally derived selectivity function. The selectivity of the Bay of Plenty SNA 1 single bottom trawl fishery (Gilbert et al. 2000), modified to account for the more rapid growth of younger snapper in SNA 2, was applied to define the selectivity of the older age classes. The selectivity of the younger (1–5 year) age classes was based on the age-specific estimates of selectivity obtained from the double normal selectivity model. The resulting composite age-specific selectivity is characterised by low selectivity for the youngest age classes, a sharp increase in selectivity at age 4 years, full selectivity for the 5–10 year classes, and a steady decline in the selectivity of older age classes to a selectivity of 0.30 for the terminal age class (Figure 4).

The NIN WG agreed to apply the selectivity function as a proxy for the fishery selectivity. The model results are strongly influenced by this assumption, particularly in regard to the estimates of biomass during the more recent period (1990–2009) and the estimates of current stock status.

Two principal model scenarios were considered using the different values of natural mortality (0.075 and 0.060). The model is highly constrained as the only parameters being estimated are R_0 and the recent recruitment deviates (1985–2002). Recruitment for 1933–1984 and 2003–2009 is deterministic (i.e., equal to R_0).

To investigate the relative influence of the age frequency and CPUE data sets in the model, two additional model runs were conducted that either up-weighted the age data (effective sample size = 500, CPUE c.v. = 0.4) or up-weighted the CPUE data (effective sample size = 5, CPUE c.v. = 0.1). The relative weightings are considered to be extreme and are not considered to represent a plausible range of relative weightings for the two data sets. Instead, the model runs were conducted simply to indicate the differences in the information content of the two sets of data, given the other model assumptions. These two model scenarios used the higher value of natural mortality (0.075).

5.1 Fits to observational data

The model likelihood comprises two main components: the fit to the CPUE indices and the age frequency observations (Table 3). The lower value of M results in a better fit to the combined data sets than the higher M scenario; however, the model results are strongly influenced by the key assumptions and, therefore, these results do not enable inference as to which value of M is more appropriate.

The CPUE indices decline sharply between 1990 and 1994, generally increase during 1993–2006, and then decline steeply from 2006 to 2009. The overall fit to the CPUE indices is very poor for both of the base models. Neither model fits the initial decline in the CPUE indices or the decline in the CPUE indices at the end of the series (Figure 5). Instead, both models estimate that recent biomass levels remained stable (lower M) or increased (higher M) under the assumption of deterministic recruitment for the 2003–09 year classes.

For the two models, there is a reasonably good fit to the more recent age frequency observations. However, the fit to the first three years of data (1992, 1998, and 1999) is very poor (Figures 6 and 7). This may reflect a higher degree of sampling error in the earlier data and/or indicate that the data are not consistent with the assumption of deterministic recruitment for the year classes before 1985.

5.2 Model parameterisation

The only model parameters being estimated are R_0 and the 1985–2002 recruitment deviates. The higher M model yields a correspondingly higher estimate of R_0 than the lower M model, although the time-series of recruitment deviates is comparable for the two models (Figure 8). Both models estimate a very weak 1994 year class and a strong 1999 year class.

Both models yield very precise estimates of R_0 (c.v. < 1%) from the MCMCs. This level of precision is unrealistic and is an artefact of the assumption of deterministic recruitment before 1984. The model estimates a value of R_0 that is sufficiently large to sustain the catches during this early period and, consequently, the lower bound of the R_0 is constrained by the catch history. The upper bound of the R_0 is constrained by the fixed selectivity function, specifically the selectivity of the oldest age classes.

5.3 Biomass trajectory

The two models estimate a large decline in spawning stock biomass from the early 1950s to the early 1980s that is consistent with the catch history of the fishery (**Error! Reference source not found.**). The biomass was estimated to have been depleted to about 5% of the unexploited level by the early 1980s and fishing mortality rates on the vulnerable age classes are estimated to be very high (exceeding 1.0) during the early 1980s.

Both models estimate that spawning biomass has increased since 1980, although the magnitude of the increase in biomass is sensitive to the assumed value of natural mortality. The model that adopts the higher value of M yields a considerably higher level of biomass in 2009 (B_{2009}/B_0 = 26.3%) than the lower M model (B_{2009}/B_0 = 11.6%) (Table 4).

The confidence intervals associated with the biomass trajectories imply a high level of precision (Table 4 and Figure 9). However, as discussed in the previous section, this is largely due to the structural assumptions of the model, principally the deterministic recruitment through the earlier period (1933–1984) of the model and the assumptions that key biological parameters and fishery selectivity are known without error and are temporally invariant. Virgin biomass (B_0) is highly constrained by the precision of the estimate of R_0 which is essentially determined by the catch history.

As previously discussed, the biomass trajectories and, particularly, the estimates of current biomass are strongly dependent on the assumed selectivity function. The true selectivity of the fishery is unknown and may differ considerably from the assumed selectivity function. Consequently, current stock status, both in absolute and relative terms, must be considered highly uncertain and the estimates of current stock status should not be applied in a management context.

The estimates of current biomass are also sensitive to the relative influence of the two sets of observational data: the CPUE indices and the age frequency samples. There is a clear conflict between these two data sets that is evident from the divergent biomass trajectories that result from different relative weightings of the two data sets. A high weighting of the age frequency data results in a considerably more optimistic level of current biomass from 2000 onwards, while a higher weighting of the CPUE indices results in a considerably lower level of biomass from 1990 onwards (Figure 10).

5.4 Yield estimates

The various model scenarios yield very similar estimates of MSY (443–496 t) despite the differences in the model assumptions (Table 4). Further, the range of models investigated during the preliminary modelling also yielded very similar estimates of MSY.

The robustness of the MSY estimates reflects the dependence of the model estimates of R_0 on the catch history for the early period of the model. For comparison, the average annual catch for 1933–84 was 479 t, essentially equivalent to the MSY estimates from the range of models.

6. CONCLUSIONS

The ability to undertake a comprehensive assessment of SNA 2 is constrained by the lack of informative data from the fishery. Firstly, the CPUE indices are available for a limited period only and do not encompass the period when the stock is likely to have undergone the largest decline in abundance (1950–80). There is also considerable concern that the CPUE indices do not reliably index stock abundance, particularly during the most recent period.

Secondly, the age frequency samples have been derived from a bycatch trawl fishery and, hence, are unlikely to be representative of the underlying age composition of the population. The model mediates the observed age composition via the selectivity function for the fishery; however, the estimation of selectivity is confounded by the recent fishing mortality rates and, in the absence of historical age frequency data, selectivity cannot be reliably estimated directly from the available age frequency data.

This necessitated the adoption of a selectivity function derived externally of the model. This selectivity function may approximate the selectivity of the fishery although the true selectivity is unknown. The model results, principally the level of current biomass, are highly sensitive to the assumed selectivity function and, consequently, the estimates of current stock status are not considered reliable.

There is also a clear conflict between the information content of the CPUE indices and the age frequency samples. The models cannot provide a reasonable fit to both of the two data sets and differential weighting of the two data sets yield considerably different estimates of current stock status; models that achieve a good fit to the age frequency data provide a considerably more optimistic estimate of current biomass compared to models that attempt to fit the CPUE indices.

One consistent aspect of the range of model options investigated was the estimates of *MSY*. The estimates were insensitive to assumptions regarding natural mortality, selectivity, and the relative weighting of the two sets of observational data. The estimates of *MSY* from this study are also comparable to the *MSY* estimates from the previous assessment (Gilbert & Phillips 2003).

The robustness of the *MSY* estimates is attributable to the structural assumptions of the models, specifically the assumption of deterministic recruitment during the early model period and the fixed biological parameters. The model estimates of R_0 (and hence *MSY*) are dependent on the catch history for the early model period; i.e., the model estimates a value of R_0 that is sufficient to support the catches through the earlier model period. Hence, the estimates of *MSY* are comparable to the average annual catch from the fishery during the early period (before 1985).

The catch history informs the model regarding the minimum level of biomass (and hence R_0 and *MSY*) required to sustain the catches; however, there is no information included in the model to provide a reasonable upper bound on the size of the stock. Hence, the structural assumptions of the model may result in conservative estimates of B_0, R_0, and *MSY*. However, other assumptions in the model may lead to less conservative estimates of *MSY*, particularly the assumed level of over-catch during the pre QMS period (20% of the reported catch), the lack of a stock-recruit relationship and the assumption of deterministic recruitment during the early period.

Since the mid 1980s, the level of catch from the fishery has been considerably below the estimates of *MSY* (average annual catch 1985–2008 was 364 t). Therefore, if recruitment has approximated long-term average levels, the biomass would be expected to have increased, albeit slowly, over the last two decades and would continue to increase at the current level of catch (376 t). However, this conclusion is dependent on the reliability of the catch history included in the early period of the model, particularly the assumed level of over-catch. Given the uncertainty regarding the catch history, the NIN WG was not prepared to conclude that the stock was likely to have increased or will continue to increase. Instead, the Working Group concluded that it was unlikely that the biomass would decline under the current level of catch.

The current assessment is limited by the quality of the available data and the lack of any contrasting data (other than catch) from the historical period of the model. There are a number of refinements to the current assessment that should be addressed in future assessments. Firstly, there is potential to refine the catch-at-age samples through the re-ageing of the first three years of data, thereby ensuring consistency with the more recent samples. It may also be worth excluding the early period from the model and initiating the model at the start of the period for which more data are available (from the mid 1980s).

Nonetheless, there remains the issue of deriving a reliable estimate of the current fishery selectivity. No historical age frequency data are available from the commercial fishery, although length frequency samples are available from the commercial snapper catch from East Cape, Hawke Bay, and Castlepoint from 1966 to 1973 (Paul & Tarring 1980). There is also an age frequency distribution of the snapper catch from a trawl survey conducted within SNA 2 during 1972. These data were not available for inclusion in the current assessment. While these data are unlikely to inform the model regarding the selectivity of the recent bycatch trawl fishery, the data may enable the estimation of historical trends in recruitment and should be incorporated in any future assessment of the stock.

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Table 1: Model parameters and priors for the base model.

Parameter			Parameter values, assumptions	Number of parameters
Length-wt relationship	fixed	a	$4.467 * 10^{-5}$	-
$W(kg) = aL(cm)^b$		b	2.793	-
Growth parameters	fixed	k	0.061	-
(Von Bertalanffy)		L_∞	68.9	-
		L_{age1}	22.33	-
Natural mortality	fixed	M	0.075 or 0.06	-
Maturity	fixed		Ages 1–2 0; age 3 0.5; ages ≥4 1	-
BH steepness	fixed	h	1.0	-
Virgin recruitment	estimated	R_0	lognormal prior (mean 2, sd 10)	1
Std.dev. of log recruitment	fixed	σ_R	0.6	-
Recruitment deviations	Estimated (1985–2002)		Lognormal	18
Initial F	fixed		0	-
Catchability - CPUE				1
Selectivity				
Commercial	fixed		See Section 5.0	
			Total	20

Table 2: Definition of symbols for the various management quantities.

Symbol	**Definition**
B_0	The equilibrium, unexploited mid season female mature biomass.
B_x	The mid season female mature biomass in year *x*.
MSY	The maximum sustainable yield, expressed in tonnes based on the recent fishing mortality at age.
B_{MSY}	The equilibrium, mid season female mature biomass that produces the *MSY*.

Table 3: The relative weighting of each of the components of the observational data and the contribution of each component to the total model likelihood.

Model	Data source	c.v.	Effective sample size	Likelihood component
$M = 0.075$	CPUE index	0.20		-13.81
	Age frequency		50	65.33
$M = 0.060$	CPUE index	0.20		-20.04
	Age frequency		50	55.01

Table 4: Key reference points and current (2009) biomass (mature, female only) relative to the biomass based reference points (median of MCMC runs and the 95% confidence interval) for the final model scenarios.

Scenario	B_0	B_{2009}	B_{MSY}	MSY	B_{MSY} $/B_0$	B_{2009}/B_0 B_{MSY}/B_0	B_{2009}/B_{MSY} B_{MSY}/B_0	$Pr(B_{2009} > 0.2\,B_0)$	$Pr(B_{2009} > 0.1\,B_0)$
M 0.075	8,669 (8,583–8,816)	2,285 (1,869–2,830)	1,650 (1,634–1,678)	496 (491–505)	0.190 (0.190–0.190)	0.263 (0.216–0.321)	1.384 (1.137–1.685)	0.996	1.000
M 0.06	9,228 (9,166–9,314)	1,073 (780–1,458)	1,798 (1,786–1,815)	443 (440–447)	0.195 (0.195–0.195)	0.116 (0.085–0.157)	0.597 (0.435–0.806)	0.000	0.838
Up wt. CPUE	8,713 (8,669–8,749)	335 (179–566)	1,868 (1,858–1,876)	473 (471–475)	0.214 (0.214–0.214)	0.038 (0.021–0.065)	0.179 (0.096–0.302)	0.000	0.000
Up wt Age	8,632 (8,605–8,659)	3,044 (2,769–3,355)	1,643 (1,638–1,648)	494 (492–496)	0.190 (0.190–0.190)	0.353 (0.321–0.388)	1.853 (1.687–2.038)	1.000	1.000

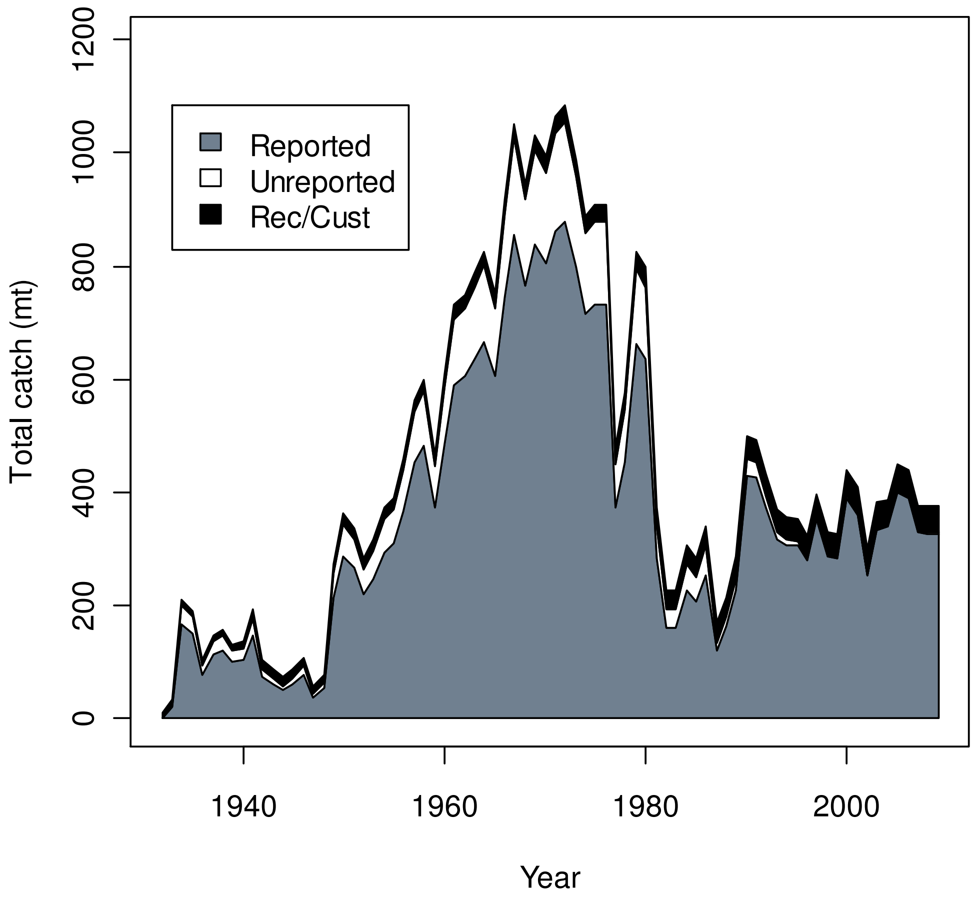

Figure 1: Catch history of SNA 2 incorporated in the stock assessment (Rec/Cust denotes the assumed combined recreational and customary catch).

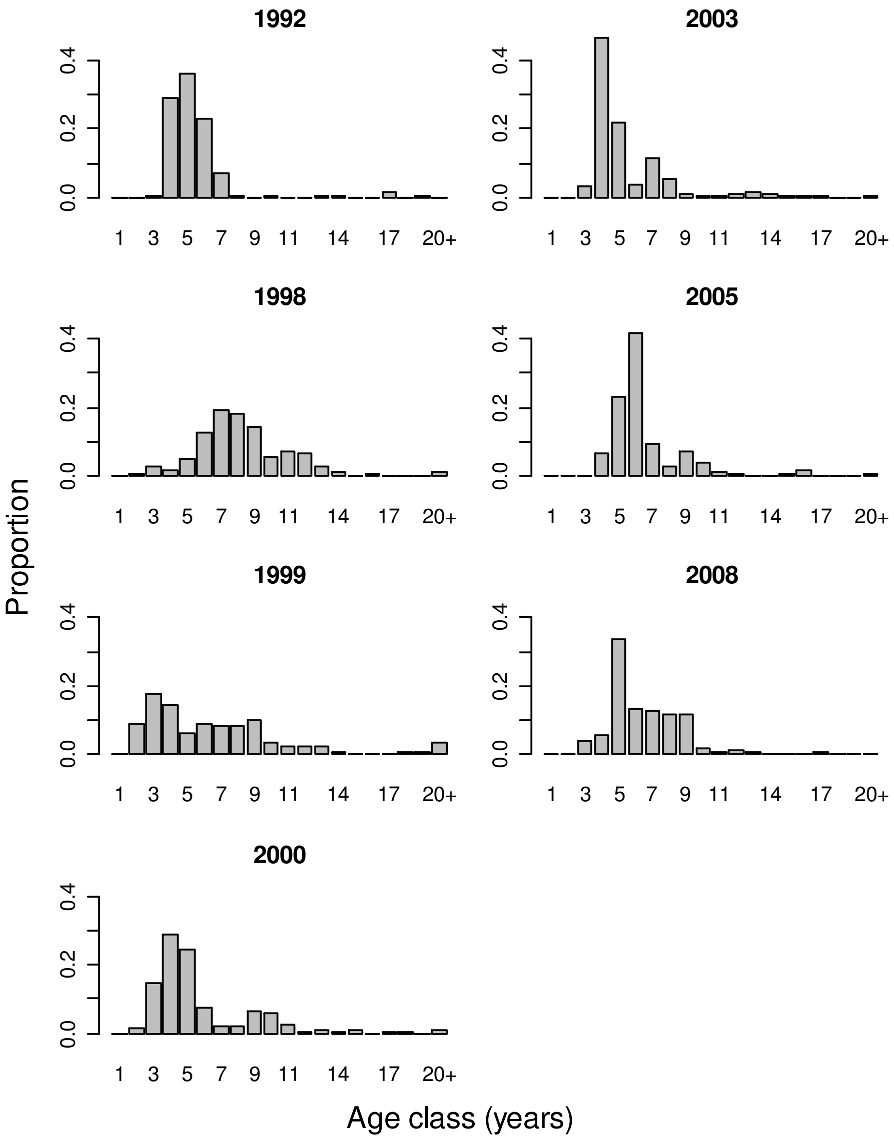

Figure 2: The age compositions from the SNA 2 market sampling programmes.

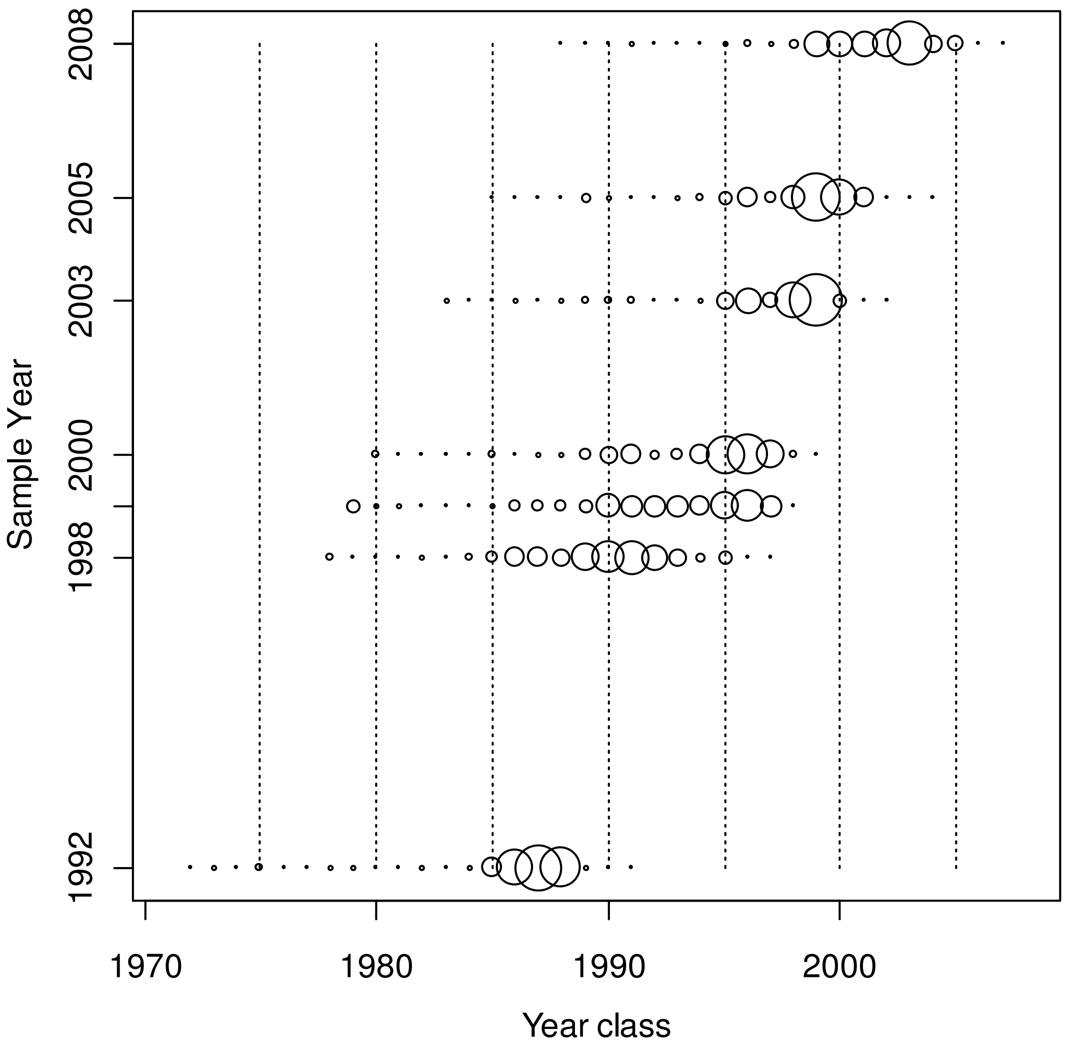

Figure 3: The proportional age compositions from the SNA 2 market sampling programmes plotted relative to the year class (age 0) (x-axis) and the year of sampling (y-axis). The area of the circle is proportional to the size of the age class.

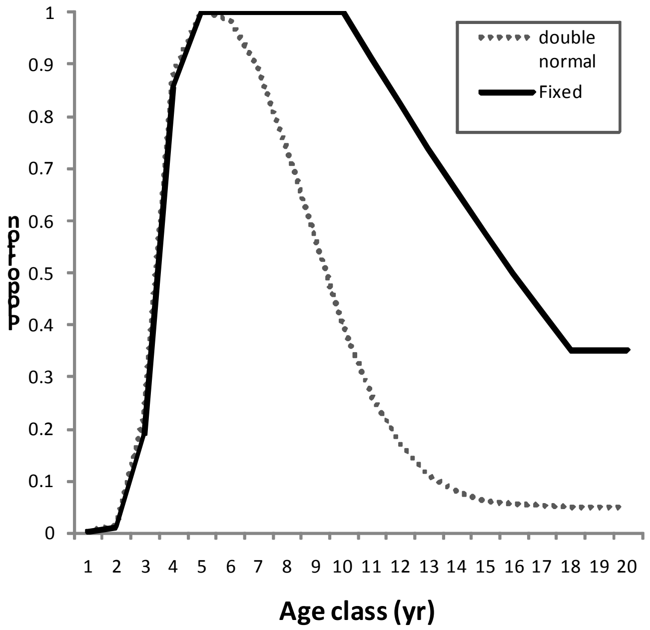

Figure 4. The estimated double normal selectivity function derived from the preliminary model runs and the fixed selectivity function applied in the final model runs.

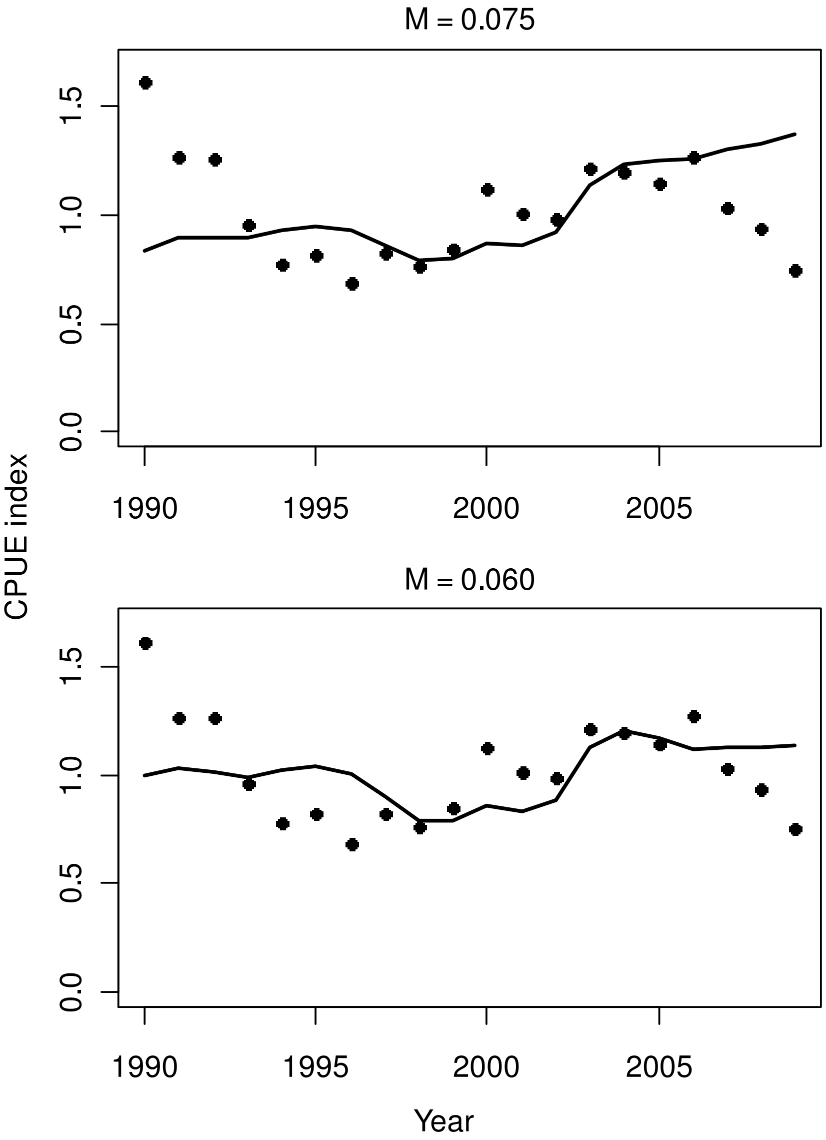

Figure 5: Fit (black line) to the CPUE indices (points) from the higher *M* model (top) and lower *M* model (bottom).

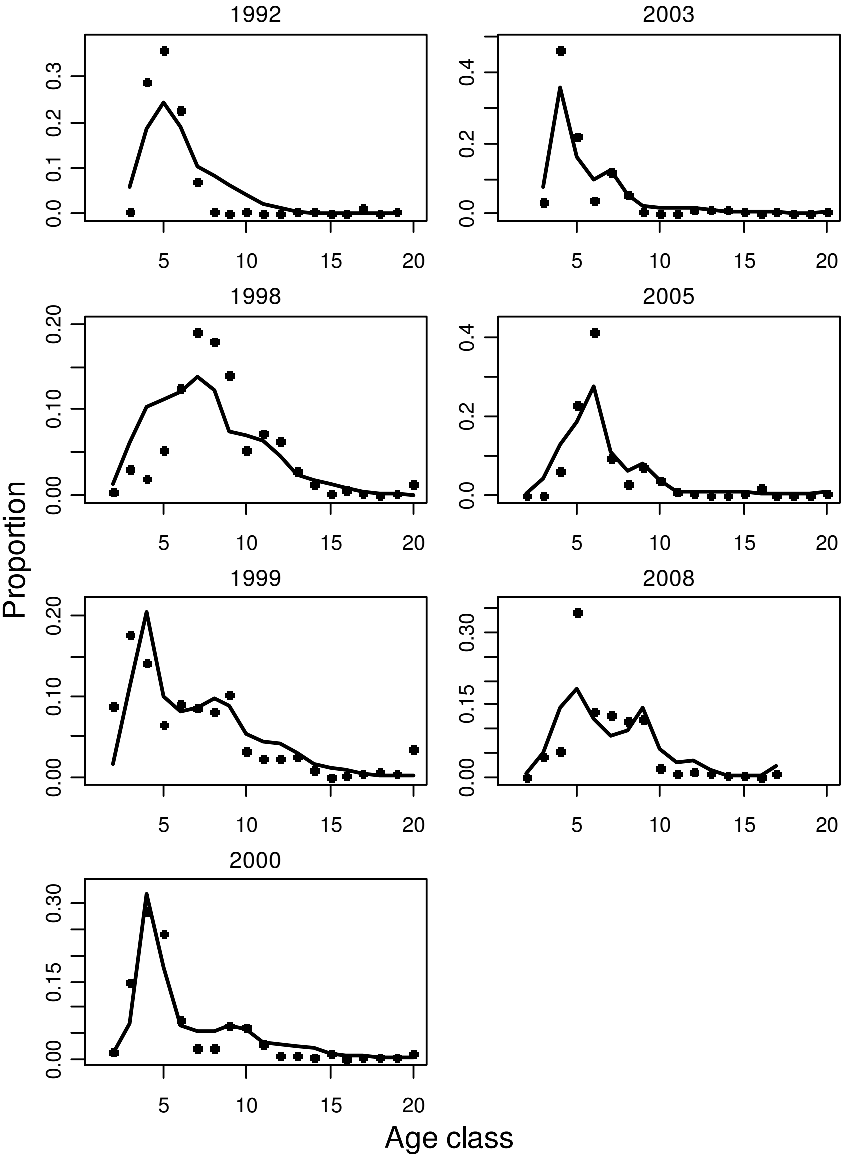

Figure 6: The predicted (lines) and observed (points) annual age frequency distributions from the catch sampling data for the higher *M* model (*M* = 0.075). The oldest age class represents an accumulated age class of older fish (20+ age classes).

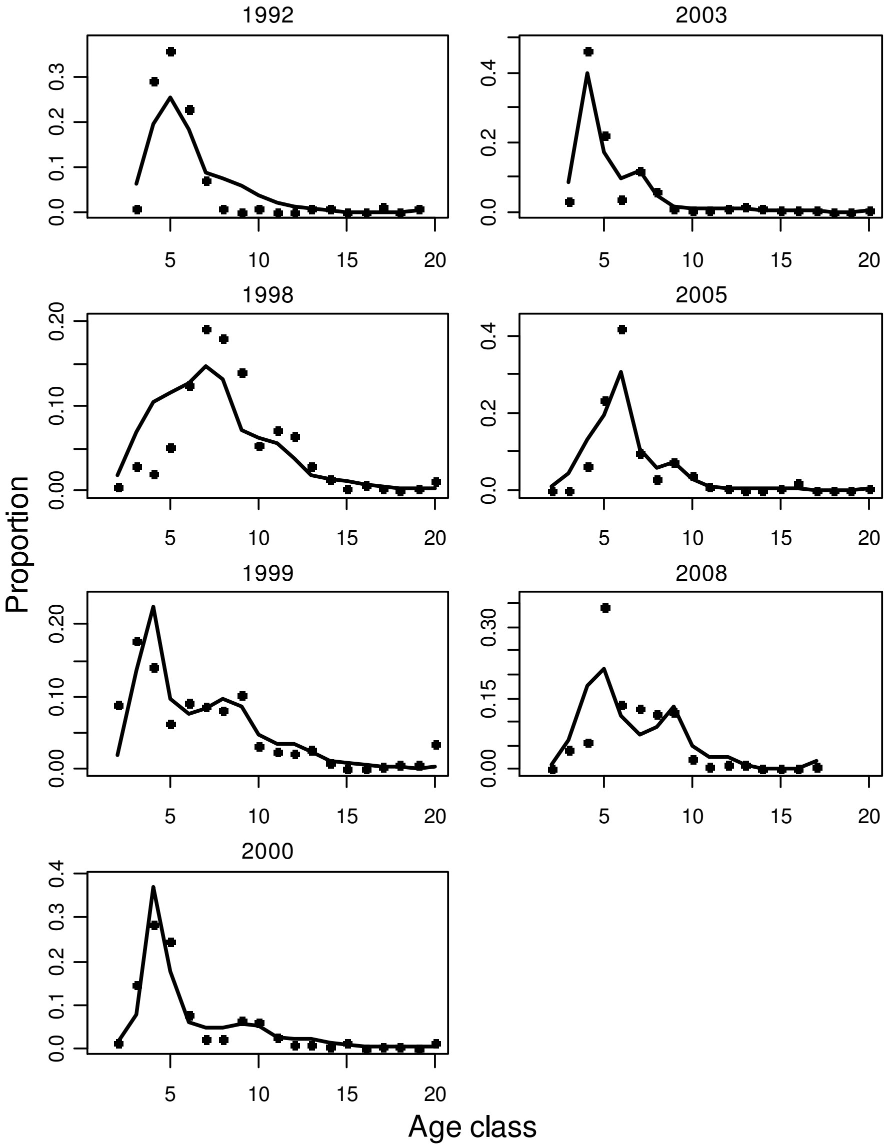

Figure 7: The predicted (lines) and observed (points) annual age frequency distributions from the catch sampling data for the lower *M* model (*M* = 0.060). The oldest age class represents an accumulated age class of older fish (20+ age classes).

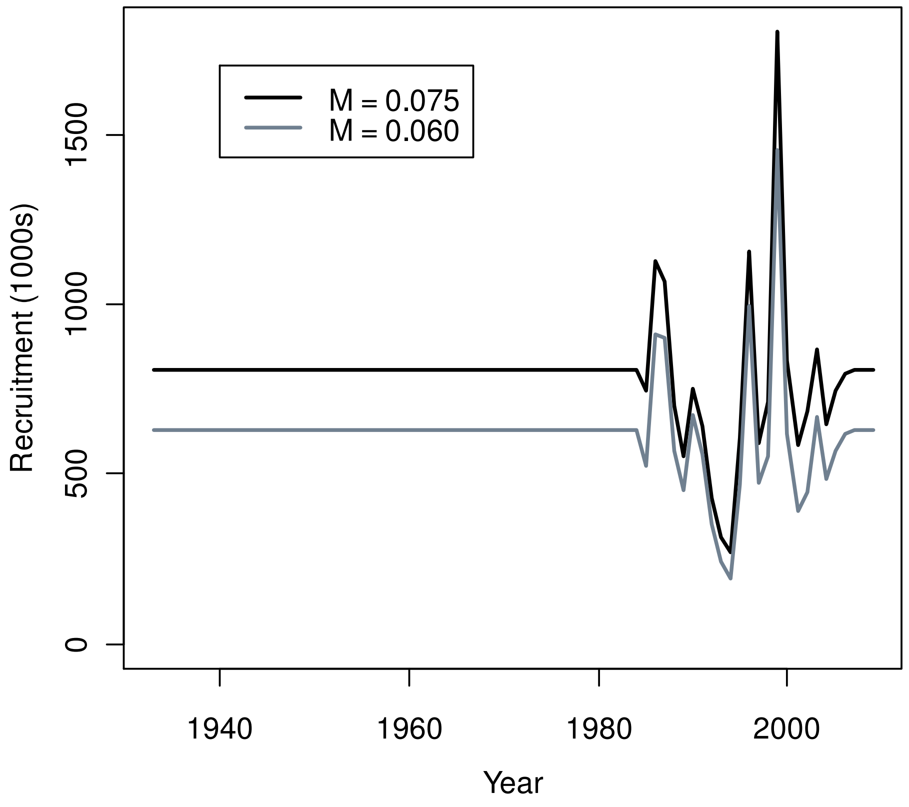

Figure 8: Maximum likelihood estimates of annual recruitment (number of fish, thousands) for the higher *M* and lower *M* models.

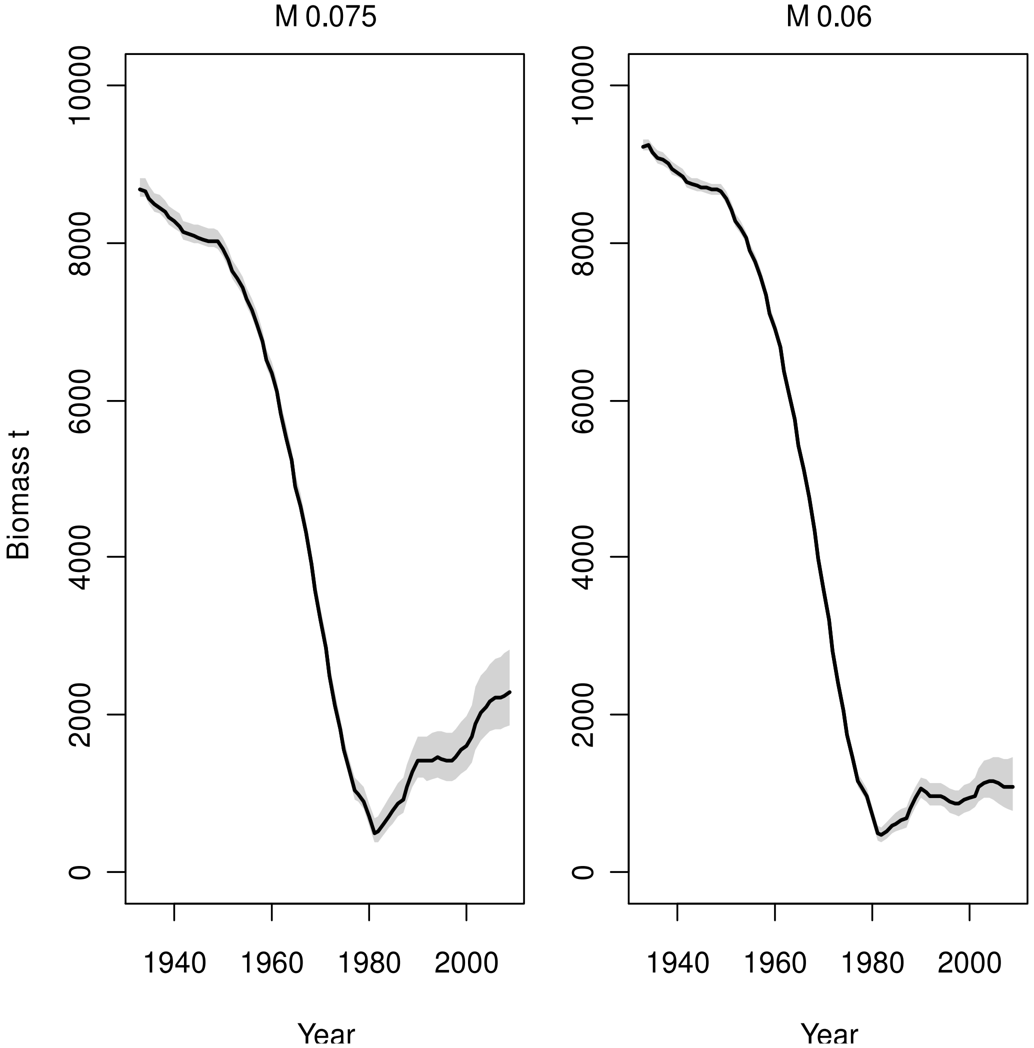

Figure 9: Spawning biomass (female only) trajectories (median of MCMCs) for the higher *M* (left) and lower *M* model (right) runs. The 95% confidence intervals (shaded) were derived from MCMC.

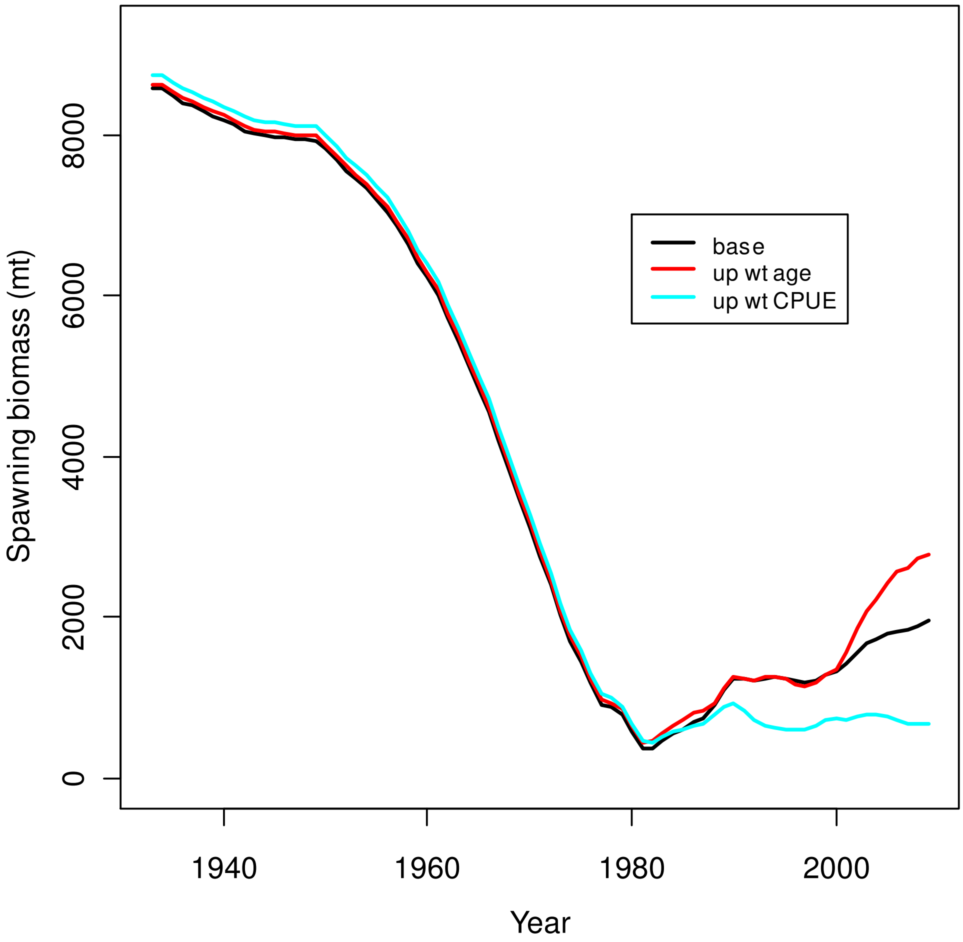

Figure 10: A comparison of the spawning biomass (female only) trajectories (MLEs) for different weights of the CPUE indices and the age frequency samples for model runs with natural mortality at 0.075.

Appendix 1. Catch history included in the SNA 2 stock assessment model

Year	Reported landings	Unreported	Recreational/ Customary	Total
1933	21	4	10	35
1934	168	34	10	212
1935	149	30	10	189
1936	78	16	10	104
1937	114	23	10	147
1938	122	24	10	156
1939	100	20	10	130
1940	103	21	15	139
1941	148	30	15	193
1942	74	15	15	104
1943	60	12	15	87
1944	49	10	15	74
1945	59	12	15	86
1946	77	15	15	107
1947	36	7	15	58
1948	53	11	15	79
1949	215	43	15	273
1950	285	57	20	362
1951	265	53	20	338
1952	220	44	20	284
1953	247	49	20	316
1954	293	59	20	372
1955	309	62	20	391
1956	365	73	20	458
1957	452	90	20	562
1958	483	97	20	600
1959	372	74	20	466
1960	487	97	25	609
1961	589	118	25	732
1962	604	121	25	750
1963	636	127	25	788
1964	667	133	25	825
1965	605	121	25	751
1966	744	149	25	918
1967	856	171	25	1052
1968	765	153	25	943
1969	837	167	25	1029
1970	804	161	30	995
1971	861	172	30	1063
1972	878	176	30	1084
1973	798	160	30	988
1974	716	143	30	889
1975	732	146	30	908
1976	732	146	30	908
1977	374	75	30	479
1978	454	91	30	575
1979	662	132	30	824
1980	636	127	35	798
1981	283	57	35	375
1982	160	32	35	227
1983	160	32	35	227
1984	227	45	35	307
1985	208	42	35	285
1986	255	51	35	341
1987	122	12	35	169
1988	165	15	35	215
1989	227	18	40	285
1990	429	30	40	499
1991	427	26	40	493
1992	373	19	40	432
1993	316	13	40	369
1994	307	9	40	356
1995	307	6	40	353
1996	279	3	40	322
1997	352	4	40	396
1998	286	3	40	329
1999	283	3	40	326
2000	391	4	45	440
2001	360	4	45	409
2002	252	3	45	300
2003	334	3	45	382
2004	339	3	45	387
2005	399	4	45	448
2006	389	4	45	438
2007	329	3	45	377
2008	328	3	45	376
2009	328	3	45	376

Appendix 2. Stock Synthesis input files

SNA2.ctl file

```
#C fishing mortality uses the hybrid method
#_data_and_control_files: simple.dat // simple.ctl
#_SS-V3.01-g-opt;_09/01/08;_Stock_Synthesis_by_Richard_Methot_(NOAA);_using_Otter_Research_ADMB_7.0.1

1  #_N_Growth_Patterns
1 #_N_Morphs_Within_GrowthPattern
#Cond 1 #_Morph_between/within_stdev_ratio (no read if N_morphs=1)
#Cond  1 #vector_Morphdist_(-1_in_first_val_gives_normal_approx)

#Cond 0  #  N recruitment designs goes here if N_GP*nseas*pop>1
#Cond 0  #  placeholder for recruitment interaction request
#Cond 1 1 1  # example recruitment design element for GP=1, seas=1, pop=1

#Cond 0 # N_movement_definitions goes here if pop > 1
#Cond 1.0 # first age that moves (real age at begin of season, not integer)
#Cond 1 1 1 2 4 10 # example move definition for seas=1, morph=1, source=1 dest=2, age1=4, age2=10

0 #_Nblock_Designs

0.5 #_fracfemale
3 #_natM_type:_0=1Parm; 1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=agespec_withseasinterpolate
0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075
0.075
0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075
0.075
1 # GrowthModel: 1=vonBert with L1&L2; 2=Richards with L1&L2; 3=not implemented; 4=not implemented
1 #_Growth_Age_for_L1
999 #_Growth_Age_for_L2 (999 to use as Linf)
0 #_SD_add_to_LAA (set to 0.1 for SS2 V1.x compatibility)
0 #_CV_Growth_Pattern:  0 CV=f(LAA); 1 CV=F(A); 2 SD=F(LAA); 3 SD=F(A)
3 #_maturity_option:  1=length logistic; 2=age logistic; 3=read age-maturity matrix by growth_pattern; 4=read age-fecundity
# Plenary report has maturity at 3-4 YEARS age.
0 0 0.5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
#_placeholder for empirical age-maturity by growth pattern
1 #_First_Mature_Age
1 #_fecundity option:(1)eggs=Wt*(a+b*Wt);(2)eggs=a*L^b;(3)eggs=a*Wt^b
1 #_parameter_offset_approach (1=none, 2= M, G, CV_G as offset from female-GP1, 3=like SS2 V1.x)
2 #_env/block/dev_adjust_method (1=standard; 2=with logistic trans to keep within base parm bounds)

#_growth_parms
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
# 0.05 0.15 0.1 0.1 0 0.8 -3 0 0 0 0 0.5 0 0 # NatM_p_1_Fem_GP:1_
 1 45 22.33 36 0 10 -2 0 0 0 0 0.5 0 0 # L_at_Amin_Fem_GP_1_   # THIS SEEMS HIGH BUT AS DO IN PLENARY
 40 90 68.9 70 0 10 -4 0 0 0 0 0.5 0 0 # L_at_Amax_Fem_GP_1_
 0.05 0.061 0.061 0.15 0 0.8 -4 0 0 0 0 0.5 0 0 # VonBert_K_Fem_GP_1_
 0.05 0.25 0.1 0.1 0 0.8 -3 0 0 0 0 0.5 0 0 # CV_young_Fem_GP_1_
 0.05 0.25 0.1 0.1 0 0.8 -3 0 0 0 0 0.5 0 0 # CV_young_Fem_GP_1_
# 0.05 0.15 0.1 0.1 0 0.8 -3 0 0 0 0 0.5 0 0 # NatM_p_1_Fem_GP:1_
 1 45 22.33 36 0 10 -2 0 0 0 0 0.5 0 0 # L_at_Amin_Fem_GP_1_
 40 90 68.9 70 0 10 -4 0 0 0 0 0.5 0 0 # L_at_Amax_Fem_GP_1_
 0.05 0.061 0.061 0.15 0 0.8 -4 0 0 0 0 0.5 0 0 # VonBert_K_Fem_GP_1_
 0.05 0.25 0.1 0.1 0 0.8 -3 0 0 0 0 0.5 0 0 # CV_young_Fem_GP_1_
 0.05 0.25 0.1 0.1 0 0.8 -3 0 0 0 0 0.5 0 0 # CV_young_Fem_GP_1_
# -3 3 0.04467 0.04467 0 0.8 -3 0 0 0 0 0.5 0 0 # Wtlen1_Fem
 -3 3 0.00004467 0.00004467 0 0.8 -3 0 0 0 0 0.5 0 0 # Wtlen1_Fem
 -3 4 2.793 2.793 0 0.8 -3 0 0 0 0 0.5 0 0 # Wtlen2_Fem
 -3 3 -9999 55 -1 0.8 -3 0 0 0 0 0 0 0 # Mat50-Fem
 -3 3 -0.25 -0.25 0 0.8 -3 0 0 0 0 0 0 0 # Matslp-Fem
 -3 3 1 1 0 0.8 -3 0 0 0 0 0.5 0 0 # Eggs1_Fem
 -3 3 0 0 0 0.8 -3 0 0 0 0 0.5 0 0 # Eggs2_Fem
```

```
 -3 3 0.00004467 0.00004467 0 0.8 -3 0 0 0 0 0.5 0 0 # Wtlen1_Mal
 -3 4 2.793 2.793 0 0.8 -3 0 0 0 0 0.5 0 0 # Wtlen2_Mal
 0 0 0 0 -1 0 -4 0 0 0 0 0 0 0 # RecrDist_GP_1_
 0 0 0 0 -1 0 -4 0 0 0 0 0 0 0 # RecrDist_Area_1_
 0 0 0 0 -1 0 -4 0 0 0 0 0 0 0 # RecrDist_Seas_1_
 0 0 0 0 -1 0 -4 0 0 0 0 0 0 0 # CohortGrowDev

#Cond 0  #custom_MG-env_setup (0/1)
#Cond -2 2 0 0 -1 99 -2 #_placeholder when no MG-environ parameters

#Cond 0  #custom_MG-block_setup (0/1)
#Cond -2 2 0 0 -1 99 -2 #_placeholder when no MG-block parameters

#_seasonal_effects_on_biology_parms
 0 0 0 0 0 0 0 0 0 0 #_femwtlen1,femwtlen2,mat1,mat2,fec1,fec2,Malewtlen1,malewtlen2,L1,K
#Cond -2 2 0 0 -1 99 -2 #_placeholder when no seasonal MG parameters

#Cond -4 #_MGparm_Dev_Phase

#_Spawner-Recruitment
3 #_SR_function
#_LO HI INIT PRIOR PR_type SD PHASE
# 0 5 2 10.3 0 10 1 # SR_R0
 -2 20 2 2 0 10 1 # SR_R0
 0.2 1 1 0.7 2 0.2 -1 # SR_steep
 0 2 0.6 0.6 0 0.8 -4 # SR_sigmaR
-5 5 0 0 0 1 -3 # SR_envlink
 -5 5 0 0 0 1 -4 # SR_R1_offset
 0 0 0 0 -1 0 -99 # SR_autocorr
1 #_SR_env_link
0 #_SR_env_target_0=none;1=devs;_2=R0;_3=steepness

1 #do_recdev:  0=none; 1=devvector; 2=simple deviations
1985 # first year of main recr_devs; early devs can preceed this era
2002 # last year of main recr_devs; forecast devs start in following year
3 #_recdev phase
1 # (0/1) to read 11 advanced options
0 #_recdev_early_start (0=none; neg value makes relative to recdev_start)
-4 #_recdev_early_phase
0 #_forecast_recruitment phase (incl. late recr) (0 value resets to maxphase+1)
10 #_lambda for prior_fore_recr occurring before endyr+1; 5 is a moderate constraint on the devs
1980 #_last_early_yr_nobias_adj_in_MPD
1988 #_first_yr_fullbias_adj_in_MPD
2002 #_last_yr_fullbias_adj_in_MPD
2003 #_first_recent_yr_nobias_adj_in_MPD
-5 #min rec_dev
5 #max rec_dev
0 #_read_recdevs
##_end of advanced SR options


#Fishing Mortality info
0.3 # F ballpark for tuning early phases - results insensitive to value
2006 # F ballpark year
3 # F_Method:  1=Pope; 2=instan. F; 3=hybrid (hybrid is recommended)
2.9 # max F or harvest rate, depends on F_Method  - results insensitive to value (alternative 1.2)
4 # N iterations for tuning F in hybrid method (recommend 3 to 7)
# no additional F input needed for Fmethod 1
# read overall start F value; overall phase; N detailed inputs to read for Fmethod 2
# read N iterations for tuning for Fmethod 3 (recommend 3 to 7)
#Fleet Year Seas F_value se phase (for detailed setup of F_Method=2)

#_initial_F_parms
#_LO HI INIT PRIOR PR_type SD PHASE
0 1 0 0.01 0 99 -2 # InitF_1_FISHERY1_
# no additional F input needed for Fmethod 1 and 3
# F_method 2 requires:
```

```
#Cond 0.05 1 0 #overall start F value; overall phase; N detailed inputs to read
#Fleet Year Seas F_value se phase

#_Q_setup
 # A=do power, B=env-var, C=extra SD, D=devtype(<0=mirror, 0/1=none, 2=cons, 3=rand, 4=randwalk); E=0=num/1=bio,
F=err_type
 #_A  B  C  D  E  F
 0 0 0 0 1 0
 0 0 0 0 1 0

#Cond 0 #_If q has random component, then 0=read one parm for each fleet with random q; 1=read a parm for each year of
index
#_Q_parms(if_any)
# LO HI INIT PRIOR PR_type SD PHASE
# -7 5 0.138624 0 -1 1 1 # Q_base_2__SURVEY1_

#_size_selex_types
#_Pattern Discard Male Special
 0 0 0 0 # 1
 0 0 0 0 # 2 # CPUE index

#_age_selex_types
#_Pattern Discard Male Special
14 0 0 0 # age specific
15 0 0 1 # equivalent

#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
## age specific based on SNA 1 BT age based selectivity shifted to two years earlier to account for
## higher growth rate of SNA 2 relative to SNA 1
# modified with selectivity of younger age classes from double normal - base case.
-10     10      -5.999964792    1       0       1000    -1      0       0       0       0       0
        0       0       #       AgeSel_1_P_1_
-10     10      -5.942983634    1       0       1000    -1      0       0       0       0       0
        0       0       #       AgeSel_1_P_2_
-10     10      -4.220968801    1       0       1000    -1      0       0       0       0       0
        0       0       #       AgeSel_1_P_3_
-10     10      -1.259918049    1       0       1000    -1      0       0       0       0       0
        0       0       #       AgeSel_1_P_4_
-10     10      1.971880929     1       0       1000    -1      0       0       0       0       0
        0       0       #       AgeSel_1_P_5_
-10     10      9.21    1       0       1000    -1      0       0       0       0       0       0
        0       #       AgeSel_1_P_6_
-10     10      9.21    1       0       1000    -1      0       0       0       0       0       0
        0       #       AgeSel_1_P_7_
-10     10      9.21    1       0       1000    -1      0       0       0       0       0       0
        0       #       AgeSel_1_P_8_
-10     10      9.21    1       0       1000    -1      0       0       0       0       0       0
        0       #       AgeSel_1_P_9_
-10     10      9.21    1       0       1000    -1      0       0       0       0       0       0
        0       #       AgeSel_1_P_10_
-10     10      9.21    1       0       1000    -1      0       0       0       0       0       0
        0       #       AgeSel_1_P_11_
-10     10      2.512305624     1       0       1000    -1      0       0       0       0       0
        0       0       #       AgeSel_1_P_12_
-10     10      1.734601055     1       0       1000    -1      0       0       0       0       0
        0       0       #       AgeSel_1_P_13_
-10     10      1.236762627     1       0       1000    -1      0       0       0       0       0
        0       0       #       AgeSel_1_P_14_
-10     10      0.84729786      1       0       1000    -1      0       0       0       0       0
        0       0       #       AgeSel_1_P_15_
-10     10      0.510825624     1       0       1000    -1      0       0       0       0       0
        0       0       #       AgeSel_1_P_16_
-10     10      0.200670695     1       0       1000    -1      0       0       0       0       0
        0       0       #       AgeSel_1_P_17_
-10     10      -0.100083459    1       0       1000    -1      0       0       0       0       0
        0       0       #       AgeSel_1_P_18_
```

```
-10     10      -0.405465108    1       0       1000    -1      0       0       0       0       0
        0       0       #       AgeSel_1_P_19_
-10     10      -0.405465108    1       0       1000    -1      0       0       0       0       0
        0       0       #       AgeSel_1_P_20_
-10     10      -0.405465108    1       0       1000    -1      0       0       0       0       0
        0       0       #       AgeSel_1_P_21_

#Cond 0 #_custom_sel-env_setup (0/1)
#Cond -2 2 0 0 -1 99 -2 #_placeholder when no enviro fxns

# 0 #_custom_sel-blk_setup (0/1)
# -2 2 0 0 -1 99 -2 #_placeholder when no block usage
# -2 2 0 0 -1 99 -2 #_placeholder when no selex devs
# -4 # placeholder for selparm_Dev_Phase
# 1 #_env/block/dev_adjust_method (1=standard; 2=logistic trans to keep in base parm bounds)

# Tag loss and Tag reporting parameters go next
0  # TG_custom:  0=no read; 1=read if tags exist
#Cond -6 6 1 1 2 0.01 -4 0 0 0 0 0 0 0  #_placeholder if no parameters

1 #_Variance_adjustments_to_input_values
#_1 2 3 - one column per fishery/survey
 0 0 #_add_to_survey_CV
 0 0 #_add_to_discard_stddev
 0 0 #_add_to_bodywt_CV
 1 1 #_mult_by_lencomp_N
 1 1 #_mult_by_agecomp_N
 1 1 #_mult_by_size-at-age_N
30 #_DF_for_discard_like
30 #_DF_for_meanbodywt_like


1 #_maxlambdaphase
1 #_sd_offset

0 #3 # number of changes to make to default Lambdas (default value is 1.0)
# Like_comp codes:  1=surv; 2=disc; 3=mnwt; 4=length; 5=age; 6=WtFreq; 7=sizeage; 8=catch;
# 9=init_equ_catch; 10=recrdev; 11=parm_prior; 12=parm_dev; 13=CrashPen; 14=Morphcomp; 15=Tag-comp; 16=Tag-
negbin
#like_comp fleet/survey  phase  value  wtfreq_method
# 1 2 2 1 1
# 4 2 2 1 1
# 4 2 3 1 1
0
#1 # (0/1) read specs for more stddev reporting
# 1 1 -1 5 1 5 1 -1 5 # selex type, len/age, year, N selex bins, Growth pattern, N growth ages, area For N-at-age, Year, N bins
# -5 16 27 38 46 # vector with selex std bin picks (-1 in first bin to self-generate)
# -1 2 14 26 40 # vector with growth std bin picks (-1 in first bin to self-generate)
# -1 2 14 26 40 # vector with N-at-age std bin picks (-1 in first bin to self-generate)
999
```

SNA2.dat file

```
 #C data generated using SS bootstrap feature
1933 #_styr
2009 #_endyr
1 #_nseas
 12 #_months/season
1 #_spawn_seas
1 #_Nfleet
1 #_Nsurveys
1 #_N_areas
FISHERY1%SURVEY1
 0.5 0.5 #_surveytiming_in_season
```

```
 1 1 #_area_assignments_for_each_fishery_and_survey
 1 #_units of catch:  1=bio; 2=num
 0.01 #_se of log(catch) only used for init_eq_catch and for Fmethod 2 and 3
2 #_Ngenders
20 #_Nages
 0 #_init_equil_catch_for_each_fishery
77 #_N_lines_of_catch_to_read
#_catch_biomass(mtons):_columns_are_fisheries,year,season
35      1933    1
212     1934    1
189     1935    1
104     1936    1
147     1937    1
156     1938    1
130     1939    1
139     1940    1
193     1941    1
104     1942    1
87      1943    1
74      1944    1
86      1945    1
107     1946    1
58      1947    1
79      1948    1
273     1949    1
362     1950    1
338     1951    1
284     1952    1
316     1953    1
372     1954    1
391     1955    1
458     1956    1
562     1957    1
600     1958    1
466     1959    1
609     1960    1
732     1961    1
750     1962    1
788     1963    1
825     1964    1
751     1965    1
918     1966    1
1052    1967    1
943     1968    1
1029    1969    1
995     1970    1
1063    1971    1
1084    1972    1
988     1973    1
889     1974    1
908     1975    1
908     1976    1
479     1977    1
575     1978    1
824     1979    1
798     1980    1
375     1981    1
227     1982    1
227     1983    1
307     1984    1
285     1985    1
341     1986    1
169     1987    1
215     1988    1
285     1989    1
499     1990    1
493     1991    1
```

```
432       1992    1
369       1993    1
356       1994    1
353       1995    1
322       1996    1
396       1997    1
329       1998    1
326       1999    1
440       2000    1
409       2001    1
300       2002    1
382       2003    1
387       2004    1
448       2005    1
438       2006    1
377       2007    1
376       2008    1  # 2008 = 2007/08 fishing year
376       2009    1  # 2009 assunes equivalent to 2008

20 #_N_cpue_and_surveyabundance_observations
# 1990 = 1989/90 fishing year
# CV = 0.2 start, before iterative reweight
#_year seas index obs se(log)
1990      1       2       1.616   0.2
1991      1       2       1.265   0.2
1992      1       2       1.262   0.2
1993      1       2       0.96    0.2
1994      1       2       0.777   0.2
1995      1       2       0.821   0.2
1996      1       2       0.688   0.2
1997      1       2       0.824   0.2
1998      1       2       0.762   0.2
1999      1       2       0.847   0.2
2000      1       2       1.123   0.2
2001      1       2       1.012   0.2
2002      1       2       0.984   0.2
2003      1       2       1.218   0.2
2004      1       2       1.196   0.2
2005      1       2       1.147   0.2
2006      1       2       1.271   0.2
2007      1       2       1.035   0.2
2008      1       2       0.937   0.2
2009      1       2       0.751   0.2

2 #_discard_type (1=bio or num; 2=fraction)
0 #_N_discard_obs

0 #_N_meanbodywt_obs

2 # length bin method: 1=use databins; 2=generate from binwidth,min,max below; 3=read vector
2 # binwidth for population size comp
10 # minimum size in the population (lower edge of first bin and size at age 0.00)
100 # maximum size in the population (lower edge of last bin)

1e-005 #_comp_tail_compression
# use this to deal with different age of plus group in age structure
1e-007 #_add_to_comp

0 #_combine males into females at or below this bin number
25 #_N_LengthBins
26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 68 72 76 80 90
0  #_N_Length_obs
#Yr Seas Flt/Svy Gender Part Nsamp datavector(female-male)

20 #_N_age_bins
 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
1 #_N_ageerror_definitions
```

```
0.5     1.5     2.5     3.5     4.5     5.5     6.5     7.5     8.5     9.5     10.5    11.5    12.5
        13.5    14.5    15.5    16.5    17.5    18.5    19.5    20.5
0.35    0.35    0.35    0.35    0.35    0.35    0.35    0.35    0.35    0.35    0.35    0.4     0.4
        0.4     0.4     0.4     0.4     0.4     0.4     0.4     0.35

7 #_N_Agecomp_obs using full size range
#0 #_N_Agecomp_obs conditioned on Lbin_method
1 #_Lbin_method: 1=poplenbins; 2=datalenbins; 3=lengths
1 #_combine males into females at or below this bin number
#Yr Seas Flt/Svy Gender Part Ageerr Lbin_lo Lbin_hi Nsamp datavector(female-male)
# SAMPLE SIZE determined by SDNR
# SEASON - single season
1992    1       1       0       0       1       1       -1      50      0       0       0.0069
        0.2897  0.3586  0.2276  0.069   0.0069  0       0.0069  0       0       0.0069  0.0069  0
        0       0.0138  0       0.0069  0       0       0       0.0069  0.2897  0.3586  0.2276
        0.069   0.0069  0       0.0069  0       0       0.0069  0.0069  0       0       0.0138  0
        0.0069  0
1998    1       1       0       0       1       1       -1      50      0       0.004   0.0302
        0.0194  0.0517  0.1249  0.1911  0.1801  0.1409  0.0532  0.0724  0.0637  0.0288  0.0135
        0.0027  0.0063  0.0023  0.0003  0.0017  0.0124  0       0.004   0.0302  0.0194  0.0517
        0.1249  0.1911  0.1801  0.1409  0.0532  0.0724  0.0637  0.0288  0.0135  0.0027  0.0063
        0.0023  0.0003  0.0017  0.0124
1999    1       1       0       0       1       1       -1      50      0       0.0894  0.1769
        0.1421  0.0644  0.0915  0.0863  0.0817  0.1022  0.0328  0.0234  0.0228  0.0264  0.0081  0
        0.002   0.0033  0.0066  0.0054  0.0346  0       0.0894  0.1769  0.1421  0.0644  0.0915
        0.0863  0.0817  0.1022  0.0328  0.0234  0.0228  0.0264  0.0081  0       0.002   0.0033
        0.0066  0.0054  0.0346
2000    1       1       0       0       1       1       -1      50      0       0.0133  0.1468
        0.2859  0.2442  0.0758  0.0216  0.02    0.0639  0.0598  0.0262  0.0055  0.0075  0.0037
        0.0101  0.0001  0.0011  0.0024  0.0008  0.0115  0       0.0133  0.1468  0.2859  0.2442
        0.0758  0.0216  0.02    0.0639  0.0598  0.0262  0.0055  0.0075  0.0037  0.0101  0.0001
        0.0011  0.0024  0.0008  0.0115
2003    1       1       0       0       1       1       -1      50      0       0       0.0338
        0.4653  0.2204  0.0395  0.1163  0.0563  0.0076  0.003   0.0032  0.0097  0.0127  0.0124
        0.0059  0.002   0.005   0.0002  0.0006  0.006   0       0       0.0338  0.4653  0.2204
        0.0395  0.1163  0.0563  0.0076  0.003   0.0032  0.0097  0.0127  0.0124  0.0059  0.002
        0.005   0.0002  0.0006  0.006
2005    1       1       0       0       1       1       -1      50      0       0.0025  0.0007
        0.0641  0.2306  0.4159  0.0955  0.0282  0.0721  0.037   0.0122  0.0052  0.002   0.0011
        0.0062  0.0182  0       0.0008  0.0024  0.0032  0       0.0025  0.0007  0.0641  0.2306
        0.4159  0.0955  0.0282  0.0721  0.037   0.0122  0.0052  0.002   0.0011  0.0062  0.0182  0
        0.0008  0.0024  0.0032
2008    1       1       0       0       1       1       -1      50      0       0.0008  0.0401
        0.0554  0.3374  0.1345  0.1273  0.1161  0.1188  0.0201  0.0075  0.0115  0.0078  0.0031
        0.0022  0.0004  0.0076  0       0       0       0       0.0008  0.0401  0.0554  0.3374
        0.1345  0.1273  0.1161  0.1188  0.0201  0.0075  0.0115  0.0078  0.0031  0.0022  0.0004
        0.0076  0       0       0

0 #_N_MeanSize-at-Age_obs
#Yr Seas Flt/Svy Gender Part Ageerr Ignore datavector(female-male)
#                          samplesize(female-male)

1 #_N_environ_variables
0 #_N_environ_obs

0 # no wtfreq data

0 # no tag data

0 # no morphcomp data

999

ENDDATA
```