Alternative Analyses of the NRC Simulated Stock Assessment Data

Report to the NRC Stock assessment Panel

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Introduction

The following represents independent analyses of a statistical age-structured model extended from Fournier and Archibald (1982). We apply Bayesian methods (Berger 1985) for a comprehensive treatment of errors in variables and underlying processes. The model described below is designed to deal with realistic fishery data problems. To address possible violations in error structure assumptions (e.g., the age composition data follows a multinomial distribution), we use robust likelihood distributions similar to Fournier and Hampton (1996).

The purpose of this presentation is primarily to demonstrate how typical fishery data problems can be addressed in a comprehensive and formal manner. We recognize, however, that the simulated data provided below is probably devoid of many "problem areas" commonly associated with fishery data. Consequently, these analyses probably represent a more comprehensive treatment of errors than might be warranted given the manner in which the data were simulated.

Methods

Model structure

The model used standard population dynamics forms. We used an explicit age-structured model with the standard catch equation as the operational population dynamics model (e.g., Deriso et al. 1985, Hilborn and Walters 1992). Catch in numbers at age in year t ($C_{a,t}$) and total catch biomass (Y_t) were

$$C_{t,a} = \frac{F_{t,a}}{Z_{t,a}}\left(1 - e^{-Z_{a,t}}\right)N_{t,a}, \qquad 1 \le t \le T \quad 1 \le a \le A$$

$$N_{t+1,a+1} = N_{t,a}e^{-Z_{t,a}} \qquad 1 \le t \le T \quad 1 \le a < A$$

$$N_{t+1,A} = N_{t,A-1}e^{-Z_{t,A-1}} + N_{t,A}e^{-Z_{t,A}} \qquad 1 \le t \le T$$

$$Z_{t,a} = F_{t,a} + M_t$$

$$C_{t\cdot} = \sum_{a=1}^{A} C_{t,a}$$

$$p_{t,a} = C_{t,a}/C_{t\cdot}$$

$$Y_t = \sum_{a=1}^{A} w_a C_{t,a} \text{ , and}$$

where

T	is the number of years of fishing,
A	is the number of age classes in the population,
$N_{t,a}$	is the number of fish age a in year t,
$C_{t,a}$	is the catch of age class a in year t,
$p_{t,a}$	is the proportion of the total catch in year t, that is in age class a,
$C_{t\cdot}$	is the total catch in year t,
w_a	is the mean body weight (kg) of fish in age class a,
$Y_{t\cdot}$	is the total yield biomass in year t,
$F_{t,a}$	is the instantantaneous fishing mortality for age class a, in year t,
M_t	is the instantantaneous natural mortality in year t, and
$Z_{t,a}$	is the instantantaneous total mortality for age class a, in year t.

We reduced the freedom of the parameters listed above by restricting the variation in the fishing mortality rates ($F_{t,a}$) by assuming that

$$
\begin{aligned}
F_{t,a} &= s_{t,a} q_t E_t \exp(\varepsilon_t) & \varepsilon_t &\sim N(0, \sigma_E^2) \\
s_{t+1,a} &= s_{t,a} \exp(\gamma_{t,a}), & \gamma_{t,a} &\sim N(0, \sigma_s^2) \\
q_{t+1} &= q_t \exp(\delta_t), & \delta_t &\sim N(0, \sigma_q^2) \\
M_{t+1} &= M_t \exp(\omega_t), & \omega_t &\sim N(0, \sigma_M^2)
\end{aligned}
$$

where

$s_{t,a}$ is the selectivity for age class a in year t,
q_t is the catchability in year t, and
E_t is the effort in year t.

If the selectivities ($s_{t,a}$) are constant over time then variable catchabilities (q_t) result in a decomposition of the fishing mortality rate into an age component and a year component. This assumption creates what is known as separable model. If selectivity in fact changes over time, then the separable model can mask important changes in fish abundance. In our analyses, we constrain the variance term (σ_s^2) to allow selectivity to change slowly over time–thus improving our ability to estimate the $\gamma_{t,a}$. Also, to provide regularity in the age component, we placed a curvature penalty on the selectivity coefficients using the squared second-differences. We selected a simple random walk as our time-series effect on these quantities. Time series structure in catchability and selectivity was introduced by Gudmundsson (1994) for analyses of catch-at-age data. Prior assumptions about the relative variance quantities were made. For example, we assume that the variance of transient effects (e.g., σ_E^2) is large relative to permanent changes in catchability (σ_q^2). Similarly, small variance values were selected for changes in natural mortality.

Recruitment (R_t) represents numbers of age-1 individuals and was modeled as a stochastic process about a mean value (R_0):

$$N_{t,1} = R_t = R_0 e^{\tau_t}, \qquad \tau_t \sim \mathrm{N}(0, \sigma_R^2) \ .$$

We chose not to model an underlying stock-recruitment relationship since the main goal of this exercise was to assess the current status of the stocks. If an analyses of projections been required, the Bayesian framework presented here would have been well suited to several types of appropriate stock recruitment analyses (Thompson 1992, Ianelli and Heifetz, 1995).

Mature spawning biomass during year*t* was defined as:

$$B_t = \sum_{a=1}^{15} w_a \phi_a N_{at}$$

where ϕ_a, the proportion of mature females at age, was calculated as a logistic function with the parameters provided by the Panel:

$$\phi_a = \frac{1}{1 + e^{-(\rho a - \beta)}} \quad .$$

The computation for predicting survey proportions at age assumed that the survey was completed at the beginning of the year (prior to the fishery), and that removals by the survey were insignificant. Consequently, a set of analogous catchability and selectivity terms were estimated for fitting the survey observations as:

$$N^s_{t,a} = N_{t,a} q^s_t s^s_{t,a}$$

where the superscript *s* denotes quantities pertaining to the survey processes.

Parameter estimation

The objective function was simply the product of the likelihood function and prior distributions. To fit large numbers of parameters in nonlinear models it is useful to be able to estimate certain parameters in different stages. The ability to estimate stages is also important in using robust likelihood functions since it is often undesirable to use robust objective functions when models are far from a solution. Consequently, in the early stages of estimation we use the following negative log-likelihood function for the survey and fishery catch at age data (in numbers):

$$f = 0.5 \cdot A \cdot T \cdot \ln\left(\sum_{a,t} \frac{\left(O_{at} - \hat{C}_{at}\right)^2}{\hat{C}_{at}} \right) ,$$

$$\hat{C} = C \cdot E_{ageing}$$

$$E_{ageing} = \begin{pmatrix} b_{1,1} & b_{1,2} & b_{1,3} & \cdots & b_{1,15} \\ b_{2,1} & b_{2,2} & & & \\ b_{3,1} & & \ddots & & \\ \vdots & & & \ddots & \\ b_{15,2} & & & & b_{15,15} \end{pmatrix} ,$$

where *A*, and *T*, represent the number of age classes and years, respectively, and O_{at}, $\hat{C}_{at}$ represent the observed and predicted catches The elements $b_{i,j}$ represent ageing mis-classification proportions which were provided by the Panel.

As the model fit approached a solution, we invoke a robust likelihood function which fit proportions at age as:

$$\prod_{a=1}^{A}\prod_{t=1}^{T}\left[\frac{1}{\sqrt{2\pi\left(\eta_{t,a}+0.1/T\right)\tau}}\left(\exp\left\{-\frac{\left(p_{t,a}-\hat{p}_{t,a}\right)^2}{2\left(\eta_{t,a}+0.1/T\right)\tau^2}\right\}+0.01\right)\right]$$

Taking the logarithm we obtain the log-likelihood function for the age composition data:

$$-1/2\sum_{a=1}^{A}\sum_{t=1}^{T}\log_e\left(2\pi\left(\eta_{t,a}+0.1/T\right)\right)-\sum_{a=1}^{A}T\log_e(\tau)$$
$$+\sum_{a=1}^{A}\sum_{t=1}^{T}\log_e\left[\exp\left\{-\frac{\left(p_{t,a}-\hat{p}_{t,a}\right)^2}{2\left(\eta_{t,a}+0.1/T\right)\tau^2}\right\}+0.01\right]$$

where $\eta_{t,a}=\hat{p}_{t,a}\left(1-\hat{p}_{t,a}\right)$

and $\tau^2=1/(\text{sample size})$

gives the variance for $p_{t,a}$

$$\left(\eta_{t,a}+0.1/T\right)\tau^2.$$

Completing the estimation in this fashion reduces the model sensitivity to outlier data points.

The contribution to the log-likelihood function for the observed total catches is given by

$$\lambda_c\sum_t\left(\log\left(O_{t\cdot}/\hat{C}_{t\cdot}\right)^2\right)$$

where λ_c represents prior assumptions about the accuracy of the observed catch data. Similarly, the contribution of prior distributions (in negative log-density) to the log-likelihood function include

$$\lambda_\varepsilon\sum_t\varepsilon_t^2+\lambda_\gamma\sum_{ta}\gamma_{t,a}^2+\lambda_\delta\sum_t\delta_t^2+\lambda_\omega\sum_t\omega_t^2+\ g(M)$$

where the size of the λ's represent prior assumptions about the variances of these random variables and *g(M)* represents the negative log-likelihood of a log-normal density with a mean 0.225 and standard deviation of 0.15. We used uninformative priorpdf's for all other model parameters.

For the model presented below, over 400 parameters were estimated (Appendix I). To easily estimate such a large number of parameters in such a non-linear model, automatic differentiation software extended from Greiwank and Corliss (1991) and developed into C++ class libraries was used. This software provided the derivative calculations needed for finding the posterior mode via a quasi-Newton function minimization routine (e.g., Press et al. 1992). The model implementation language (ADModel Builder) gave simple and rapid access to these routines and provided the ability estimate the variance-covariance matrix for all dependent and independent parameters of interest. For key quantities of interest, e.g., current stock size, the software also produces likelihood profiles which avoids the assumption that the likelihood shape is quadratic (implied when the inverse Hessian estimates are used).

Levels of analyses

For the purposes of this report, we performed stock assessment using fishery data only and compared these results to using that found using both fishery and survey data. In addition, we provide a retrospective analyses as requested by the Panel.

Computation of quotas

The Panel requested that for benchmark purposes, the $F_{40\%}$ harvest rate be applied to make recommendations for harvests in the next year. The $F_{40\%}$ rate corresponds to the fishing mortality that will reduce the spawning biomass *per recruit* to 40% of its unfished level. Therefore, the key quantities involved include age-specific fishery selectivity, maturation, growth in weight, and natural mortality. As mentioned above, had time permitted, a more detailed analyses of the stock recruitment data would have been appropriate to arrive at a comprehensive analyses of harvest levels.

Results and discussion

Results are summarized in Tables 1-10 and Figures 1-10. In most cases the differences between the results using survey and fishery data together and fishery data alone were small.

For data set 3 we were informed that there was a potential change in the way the survey was carried out after year 15. While we could have altered the model to specifically acknowledge this documented change (i.e., treat the survey as from two different periods with corresponding sets of relevant model parameters). Instead, we chose to ignore this information and see if the model detects any change in catchability (which is somewhat restricted in the amount of inter-annual variability that is allowed). Interestingly, results for data set 3 show a significant change in the latter part of the time series (Fig. 6, top left panel). The pattern of survey catchability for all other data sets suggested little or no change over the 30 year periods.

Estimates of marginal posterior probability densities on the level of depletion (or stock increase) since the beginning of the time series were broader for the fishery data alone

(Figs. 11-15). This reflects the level of information provided by the survey data. We suggest that, in lieu of knowing the "true" natural mortality rate (which would scale the population to the correct absolute stock size), a reasonable method of presentation for current stock status is in terms of relative changes, as presented here.

In evaluating our results it is clear that further attention is needed regarding model specification. For example, the estimated level of variability in inter-annual changes in natural mortality should be evaluated more closely. Also, sensitivity to our prior assumptions about the relative levels of variability for changes in catchability and selectivity should be examined. Finally, we treated each data set identically. Specific potential problem areas for the model were not assessed based on the outcomes of any single data analysis.

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Tables

Table 1. Results from analyses of data set 1 using ONLY fishery data.

Year	Exploitable Biomass	Mature	Total	Avg F age 7-15+	Exploitation Fraction	Recruits (age 1)	Year 31 Exploitable Biomass	Year 31 Yield @ $F_{40\%}$
1	2,446	1,851	4,641	0.159	0.085	211	**130**	**32**
2	2,328	1,968	4,239	0.247	0.136	602		
3	2,025	1,853	3,704	0.223	0.123	666	Full Selection $F_{40\%}$:	
4	1,690	1,667	3,416	0.420	0.180	584	0.2978	
5	1,351	1,196	2,959	0.129	0.060	314		
6	1,397	1,118	2,999	0.176	0.088	389		
7	1,393	1,031	2,935	0.267	0.120	459		
8	1,328	944	2,786	0.165	0.083	965		
9	1,316	1,005	2,908	0.238	0.112	542		
10	1,304	994	2,965	0.345	0.140	252		
11	1,234	859	2,800	0.212	0.091	86		
12	1,278	830	2,668	0.255	0.121	169		
13	1,340	837	2,355	0.369	0.196	89		
14	1,096	827	1,854	0.322	0.177	213		
15	872	805	1,519	0.477	0.229	341		
16	586	607	1,268	0.455	0.204	765		
17	498	428	1,298	0.424	0.141	211		
18	477	302	1,403	0.304	0.104	316		
19	557	257	1,534	0.678	0.219	217		
20	534	203	1,387	0.886	0.271	96		
21	455	193	1,093	0.301	0.120	105		
22	466	286	1,046	0.476	0.197	177		
23	411	308	900	0.888	0.323	52		
24	288	220	654	1.215	0.379	329		
25	183	115	497	0.838	0.280	207		
26	170	72	548	1.437	0.290	455		
27	149	35	579	1.110	0.235	156		
28	188	28	631	1.621	0.345	53		
29	168	22	500	0.822	0.244	196		
30	172	35	469	1.222	0.344	0		

Table 2. Results from analyses of data set 1 using both survey and fishery data.

Year	Exploitable Biomass	Mature	Total	Avg F age 7-15+	Exploitation Fraction	Recruits (age 1)	Year 31 Exploitable Biomass	Year 31 Yield @ $F_{40\%}$
1	2,296	1,773	4,514	0.172	0.088	270	**94**	**25**
2	2,166	1,868	4,089	0.269	0.141	550		
3	1,850	1,727	3,527	0.242	0.129	639	Full Selection $F_{40\%}$:	
4	1,494	1,545	3,247	0.471	0.189	556	0.3100	
5	1,162	1,089	2,768	0.148	0.065	275		
6	1,203	1,020	2,801	0.204	0.094	459		
7	1,149	932	2,737	0.313	0.129	431		
8	1,087	843	2,608	0.192	0.089	919		
9	1,081	898	2,739	0.274	0.119	503		
10	1,033	895	2,823	0.410	0.147	287		
11	982	773	2,687	0.250	0.094	86		
12	1,021	767	2,575	0.301	0.126	153		
13	1,042	785	2,275	0.438	0.202	93		
14	856	776	1,793	0.380	0.183	203		
15	691	760	1,475	0.559	0.236	363		
16	458	574	1,234	0.549	0.210	758		
17	385	399	1,266	0.518	0.144	271		
18	370	274	1,381	0.364	0.106	299		
19	432	232	1,527	0.809	0.220	226		
20	410	185	1,391	1.053	0.270	92		
21	355	185	1,106	0.352	0.119	95		
22	368	287	1,055	0.553	0.195	119		
23	325	320	897	1.057	0.325	92		
24	225	232	636	1.470	0.390	304		
25	148	120	474	1.007	0.293	233		
26	132	70	522	1.758	0.304	408		
27	114	29	546	1.341	0.249	147		
28	144	23	587	2.033	0.371	50		
29	122	19	445	1.086	0.275	133		
30	120	30	401	1.726	0.403	107		

Table 3. Results from analyses of data set 2 using ONLY fishery data.

Year	Exploitable Biomass	Mature	Total	Avg F age 7-15+	Exploitation Fraction	Recruits (age 1)	Year 31 Exploitable Biomass	Year 31 Yield @ F40%
1	1,920	953	3,518	0.055	0.030	293	**344**	**66**
2	2,028	1,062	3,604	0.126	0.066	138		
3	2,007	1,082	3,413	0.124	0.072	246	Full Selection F40%:	
4	2,016	1,126	3,235	0.163	0.096	1135	0.2270	
5	1,870	1,078	3,141	0.107	0.061	503		
6	1,815	1,065	3,295	0.144	0.077	851		
7	1,913	1,041	3,466	0.188	0.081	477		
8	1,901	934	3,483	0.096	0.049	0		
9	2,108	861	3,459	0.112	0.063	112		
10	2,246	845	3,214	0.232	0.143	100		
11	1,978	864	2,615	0.128	0.087	75		
12	1,771	976	2,238	0.120	0.085	347		
13	1,574	1,043	1,959	0.210	0.141	140		
14	1,255	933	1,659	0.234	0.153	357		
15	1,005	716	1,474	0.310	0.164	208		
16	763	476	1,334	0.311	0.162	329		
17	687	324	1,276	0.235	0.109	147		
18	670	259	1,297	0.261	0.127	535		
19	661	236	1,346	0.238	0.111	148		
20	682	240	1,388	0.437	0.177	109		
21	631	216	1,260	0.299	0.137	225		
22	710	222	1,196	0.660	0.327	76		
23	516	164	871	0.644	0.302	52		
24	371	127	633	0.901	0.371	86		
25	241	84	426	0.661	0.321	329		
26	180	60	411	0.819	0.257	151		
27	164	36	472	0.388	0.125	587		
28	232	35	667	0.656	0.171	74		
29	286	27	758	0.405	0.145	235		
30	370	28	825	0.422	0.160	0		

Table 4. Results from analyses of data set 2 using both survey and fishery data.

Year	Exploitable Biomass	Mature	Total	Avg F age 7-15+	Exploitation Fraction	Recruits (age 1)	Year 31 Exploitable Biomass	Year 31 Yield @ F40%
1	1,482	810	3,175	0.068	0.034	300	**130**	**29**
2	1,573	914	3,274	0.154	0.073	94		
3	1,547	934	3,102	0.151	0.079	297	Full Selection $F_{40\%}$:	
4	1,638	982	2,964	0.198	0.105	979	0.2646	
5	1,510	926	2,866	0.130	0.067	700		
6	1,480	913	3,051	0.172	0.083	750		
7	1,489	893	3,255	0.223	0.087	476		
8	1,497	796	3,289	0.112	0.052	23		
9	1,682	738	3,290	0.129	0.067	97		
10	1,798	741	3,092	0.266	0.149	104		
11	1,599	775	2,531	0.147	0.089	74		
12	1,437	906	2,162	0.135	0.088	351		
13	1,256	990	1,904	0.239	0.145	178		
14	1,007	882	1,622	0.265	0.157	333		
15	826	674	1,454	0.346	0.166	250		
16	627	438	1,327	0.347	0.163	353		
17	567	291	1,291	0.260	0.107	177		
18	553	231	1,329	0.287	0.124	585		
19	525	216	1,401	0.270	0.107	180		
20	551	228	1,473	0.484	0.166	118		
21	522	212	1,367	0.322	0.126	158		
22	630	230	1,300	0.693	0.301	36		
23	464	182	932	0.716	0.282	77		
24	320	143	645	1.068	0.364	81		
25	193	91	405	0.813	0.337	283		
26	133	62	375	1.086	0.282	120		
27	111	30	393	0.551	0.150	335		
28	153	24	506	1.073	0.226	64		
29	163	13	490	0.741	0.225	55		
30	177	14	459	0.950	0.287	55		

Table 5. Results from analyses of data set 3 using ONLY fishery data.

Year	Exploitable Biomass	Mature	Total	Avg F age 7-15+	Exploitation Fraction	Recruits (age 1)	Year 31 Exploitable Biomass	Year 31 Yield @ F40%
1	4,459	2,678	7,001	0.059	0.037	65	**3,987**	**708**
2	4,239	2,851	6,345	0.127	0.084	114		
3	3,661	2,533	5,377	0.109	0.073	332	Full Selection F40%:	
4	3,494	2,318	4,676	0.127	0.086	1,077	0.2098	
5	2,914	2,002	4,503	0.161	0.097	3,808		
6	2,602	1,590	5,163	0.148	0.071	1,045		
7	2,842	1,293	6,128	0.198	0.073	495		
8	3,053	1,038	6,675	0.136	0.058	1,293		
9	3,911	875	7,276	0.172	0.087	3,038		
10	4,266	705	8,137	0.202	0.092	4,575		
11	4,572	662	9,378	0.151	0.064	421		
12	5,326	891	10,356	0.093	0.043	112		
13	6,236	1,366	10,664	0.170	0.090	381		
14	6,660	1,539	9,734	0.099	0.061	533		
15	6,349	1,589	8,832	0.186	0.118	575		
16	5,144	1,627	7,467	0.090	0.061	1,391		
17	4,846	2,123	7,058	0.138	0.090	1,863		
18	4,520	2,547	6,936	0.152	0.101	1,923		
19	4,019	2,405	7,140	0.173	0.102	968		
20	3,856	1,863	7,314	0.257	0.127	722		
21	3,836	1,310	7,041	0.141	0.077	1,485		
22	4,245	1,104	7,067	0.154	0.089	154		
23	4,183	1,018	6,751	0.159	0.087	725		
24	4,025	1,092	6,296	0.171	0.097	1,050		
25	3,820	1,256	5,868	0.159	0.098	944		
26	3,663	1,400	5,782	0.167	0.091	2,588		
27	3,458	1,381	6,051	0.110	0.056	654		
28	3,608	1,356	6,557	0.186	0.084	1,094		
29	3,703	1,238	7,053	0.101	0.052	5,867		
30	4,014	1,176	8,538	0.108	0.045	0		

Table 6. Results from analyses of data set 3 using both survey and fishery data.

Year	Exploitable Biomass	Mature	Total	Avg F age 7-15+	Exploitation Fraction	Recruits (age 1)	Year 31 Exploitable Biomass	Year 31 Yield @ F40%
1	3,323	2,268	6,156	0.073	0.042	147	**962**	**201**
2	3,171	2,386	5,572	0.158	0.095	83		
3	2,827	2,098	4,706	0.131	0.084	306	Full Selection $F_{40\%}$:	
4	2,730	1,924	4,088	0.150	0.098	1,028	0.2479	
5	2,278	1,667	3,968	0.191	0.110	3,393		
6	2,001	1,301	4,553	0.177	0.080	923		
7	2,186	1,048	5,442	0.242	0.083	469		
8	2,326	821	5,951	0.166	0.065	1,255		
9	2,943	683	6,425	0.214	0.099	2,090		
10	3,236	540	7,009	0.254	0.106	4,551		
11	3,372	513	8,057	0.190	0.074	315		
12	3,894	724	9,018	0.121	0.050	149		
13	4,681	1,135	9,369	0.216	0.102	301		
14	5,202	1,263	8,563	0.122	0.069	492		
15	4,968	1,295	7,724	0.226	0.135	452		
16	4,315	1,310	6,516	0.110	0.069	1,384		
17	4,013	1,726	6,220	0.170	0.102	1,496		
18	3,944	2,114	6,079	0.181	0.115	1,628		
19	3,396	2,007	6,172	0.205	0.118	775		
20	3,187	1,514	6,223	0.319	0.149	676		
21	2,974	993	5,768	0.182	0.094	980		
22	3,282	814	5,620	0.201	0.112	118		
23	3,085	734	5,138	0.222	0.115	420		
24	2,794	769	4,478	0.254	0.137	536		
25	2,478	843	3,838	0.250	0.150	469		
26	2,167	870	3,375	0.293	0.156	987		
27	1,830	770	3,058	0.215	0.110	294		
28	1,762	690	2,954	0.411	0.187	284		
29	1,481	508	2,573	0.259	0.143	1,316		
30	1,393	416	2,747	0.322	0.140	1,453		

Table 7. Results from analyses of data set 4 using ONLY fishery data.

Year	Exploitable Biomass	Mature	Total	Avg F age 7-15+	Exploitation Fraction	Recruits (age 1)	Year 31 Exploitable Biomass	Year 31 Yield @ F40%
1	4,794	2,606	7,238	0.088	0.054	1,162	**101**	**17**
2	4,466	2,666	7,214	0.163	0.091	291		
3	4,343	2,391	6,751	0.223	0.128	294	Full Selection F40%:	
4	4,001	1,950	5,881	0.127	0.073	257	0.1997	
5	3,908	1,845	5,282	0.172	0.113	294		
6	3,457	1,773	4,528	0.164	0.111	824		
7	2,959	1,763	4,042	0.255	0.150	864		
8	2,375	1,538	3,627	0.166	0.095	649		
9	2,158	1,343	3,644	0.325	0.172	712		
10	1,980	942	3,498	0.422	0.184	871		
11	1,788	617	3,264	0.226	0.101	118		
12	1,904	547	3,236	0.254	0.132	256		
13	1,661	560	2,993	0.282	0.137	372		
14	1,564	603	2,680	0.432	0.230	337		
15	1,318	548	2,215	0.498	0.241	507		
16	1,007	461	1,848	0.336	0.159	357		
17	895	433	1,780	0.460	0.198	237		
18	800	325	1,631	0.440	0.196	284		
19	760	244	1,494	0.844	0.316	137		
20	575	143	1,152	1.216	0.388	465		
21	364	72	903	0.730	0.248	737		
22	379	64	1,066	0.764	0.210	478		
23	417	54	1,259	2.022	0.424	380		
24	321	15	1,030	1.318	0.307	261		
25	352	12	945	0.628	0.186	165		
26	425	22	944	0.938	0.300	74		
27	381	31	750	0.785	0.297	62		
28	348	40	597	1.851	0.529	237		
29	148	16	341	0.837	0.262	212		
30	138	16	377	1.448	0.329	0		

Table 8. Results from analyses of data set 4 using both survey and fishery data.

Year	Exploitable Biomass	Mature	Total	Avg F age 7-15+	Exploitation Fraction	Recruits (age 1)	Year 31 Exploitable Biomass	Year 31 Yield @ $F_{40\%}$
1	4,105	2,380	6,983	0.100	0.056	1,166	**76**	**15**
2	3,826	2,454	6,957	0.184	0.095	293		
3	3,717	2,183	6,545	0.251	0.132	293	Full Selection $F_{40\%}$:	
4	3,524	1,764	5,707	0.144	0.075	252	0.2271	
5	3,441	1,656	5,067	0.195	0.118	294		
6	3,032	1,602	4,308	0.185	0.117	801		
7	2,411	1,615	3,841	0.290	0.157	912		
8	1,930	1,407	3,464	0.189	0.099	647		
9	1,766	1,232	3,532	0.368	0.177	724		
10	1,602	849	3,422	0.483	0.188	869		
11	1,442	537	3,203	0.258	0.103	118		
12	1,532	478	3,169	0.292	0.135	227		
13	1,301	500	2,908	0.327	0.141	350		
14	1,230	561	2,607	0.506	0.237	345		
15	1,029	517	2,143	0.590	0.249	513		
16	786	435	1,785	0.395	0.164	323		
17	701	410	1,729	0.538	0.204	272		
18	629	302	1,597	0.505	0.200	281		
19	609	224	1,491	0.954	0.317	147		
20	465	131	1,169	1.365	0.383	439		
21	300	70	925	0.827	0.242	748		
22	315	64	1,076	0.878	0.208	468		
23	341	55	1,249	2.275	0.428	373		
24	260	16	1,025	1.496	0.308	268		
25	282	13	944	0.729	0.186	163		
26	340	22	941	1.089	0.301	78		
27	305	30	750	0.919	0.297	61		
28	281	40	594	2.203	0.532	222		
29	116	15	325	0.995	0.275	167		
30	107	14	350	1.846	0.355	60		

Table 9. Results from analyses of data set 5 using ONLY fishery data.

Year	Exploitable Biomass	Mature	Total	Avg F age 7-15+	Exploitation Fraction	Recruits (age 1)	Year 31 Exploitable Biomass	Year 31 Yield @ F40%
1	1,162	686	1,874	1.301	0.495	324	**3,569**	**690**
2	528	276	1,053	0.325	0.143	855		
3	523	269	1,328	0.198	0.074	1,393	Full Selection F40%:	
4	668	290	2,055	0.381	0.104	1,944	0.2366	
5	890	266	2,980	0.146	0.036	909		
6	1,400	307	3,962	0.179	0.060	243		
7	1,943	433	4,493	0.149	0.054	567		
8	2,446	758	4,652	0.095	0.046	257		
9	2,884	1,317	4,592	0.093	0.053	148		
10	3,067	1,941	4,307	0.152	0.093	237		
11	2,765	2,171	4,029	0.106	0.066	3,524		
12	2,621	2,111	4,707	0.092	0.047	2,334		
13	2,799	1,936	6,108	0.137	0.058	2,445		
14	3,122	1,661	7,568	0.089	0.031	438		
15	3,998	1,536	8,806	0.167	0.061	1,811		
16	4,796	1,658	9,281	0.120	0.055	509		
17	5,644	2,499	9,335	0.073	0.039	571		
18	6,229	3,637	9,289	0.114	0.072	2,461		
19	5,771	4,215	9,057	0.111	0.067	570		
20	5,611	4,248	8,928	0.161	0.087	1,946		
21	5,099	3,876	8,742	0.087	0.047	1,691		
22	5,247	3,682	9,071	0.080	0.041	1,102		
23	5,422	3,527	9,361	0.115	0.059	1,219		
24	5,497	3,571	9,253	0.104	0.052	0		
25	4,579	3,695	8,785	0.083	0.045	190		
26	4,664	3,922	8,138	0.091	0.053	683		
27	4,487	4,161	7,367	0.074	0.047	725		
28	4,525	4,259	6,802	0.128	0.081	1,120		
29	4,053	3,907	6,263	0.089	0.058	1,038		
30	3,613	3,424	6,074	0.132	0.077	0		

Table 10. Results from analyses of data set 5 using both survey and fishery data.

Year	Exploitable Biomass	Mature	Total	Avg F age 7-15+	Exploitation Fraction	Recruits (age 1)	Year 31 Exploitable Biomass	Year 31 Yield @ F40%
1	996	640	1,800	1.524	0.515	322	**2,346**	**504**
2	442	241	1,006	0.390	0.150	719		
3	433	234	1,219	0.245	0.080	1,121	Full Selection F40%:	
4	517	257	1,811	0.516	0.118	1,862	0.2658	
5	632	224	2,566	0.202	0.042	762		
6	970	260	3,423	0.257	0.069	208		
7	1,353	361	3,880	0.202	0.062	522		
8	1,717	620	4,017	0.128	0.053	190		
9	2,059	1,075	3,951	0.125	0.061	148		
10	2,222	1,617	3,697	0.201	0.109	209		
11	2,006	1,804	3,412	0.139	0.078	3,000		
12	1,912	1,726	3,954	0.119	0.056	2,063		
13	2,057	1,572	5,141	0.178	0.069	1,875		
14	2,275	1,320	6,393	0.115	0.036	1,159		
15	2,874	1,218	7,606	0.218	0.071	1,141		
16	3,381	1,309	8,063	0.154	0.063	680		
17	4,021	2,033	8,208	0.095	0.044	484		
18	4,546	3,005	8,207	0.146	0.082	2,044		
19	4,208	3,497	7,958	0.142	0.077	724		
20	4,105	3,601	7,792	0.207	0.100	1,573		
21	3,676	3,241	7,483	0.112	0.055	1,509		
22	3,760	3,033	7,685	0.102	0.048	872		
23	3,922	2,890	7,872	0.147	0.070	1,075		
24	3,900	2,885	7,719	0.137	0.062	65		
25	3,291	2,961	7,251	0.107	0.055	132		
26	3,307	3,145	6,684	0.119	0.065	494		
27	3,132	3,306	5,963	0.099	0.058	441		
28	3,160	3,353	5,360	0.172	0.102	636		
29	2,798	3,025	4,692	0.122	0.077	577		
30	2,427	2,611	4,295	0.190	0.109	76		

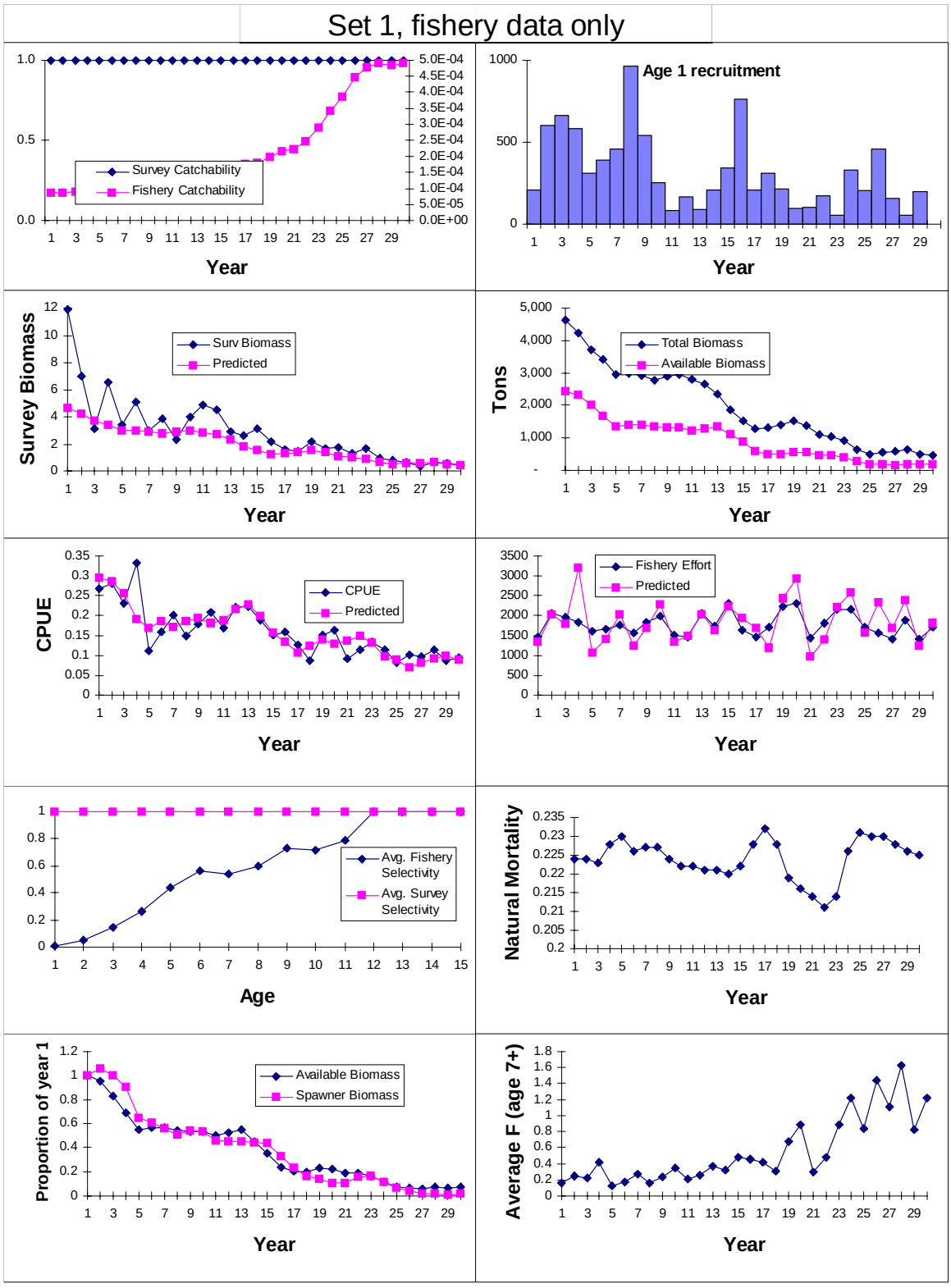

Figure 1. Analyses of data set 1 using ONLY fishery data (plots pertaining to surveys are not relevant).

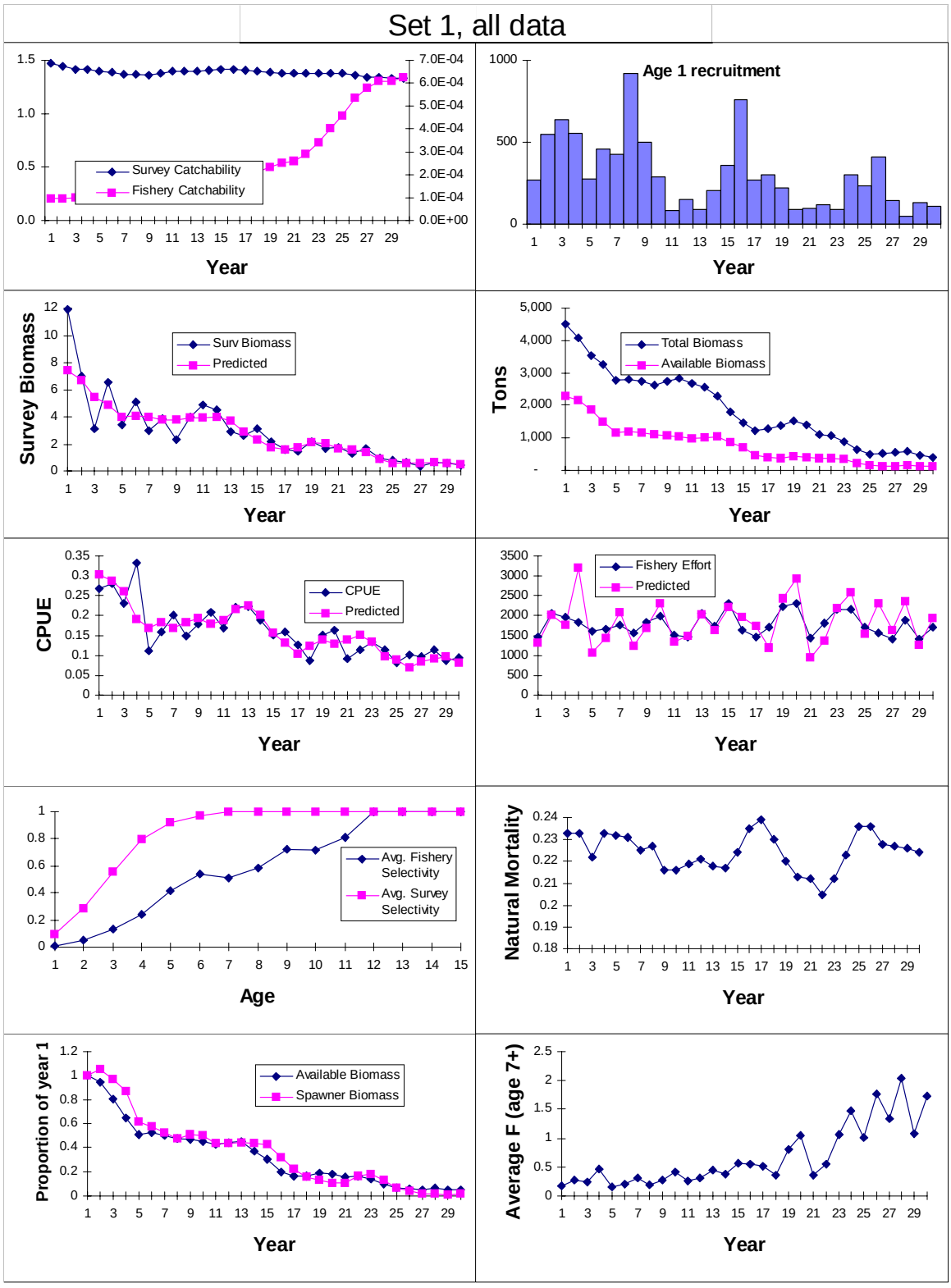

Figure 2. Analyses of data set 1 using both fishery and survey data.

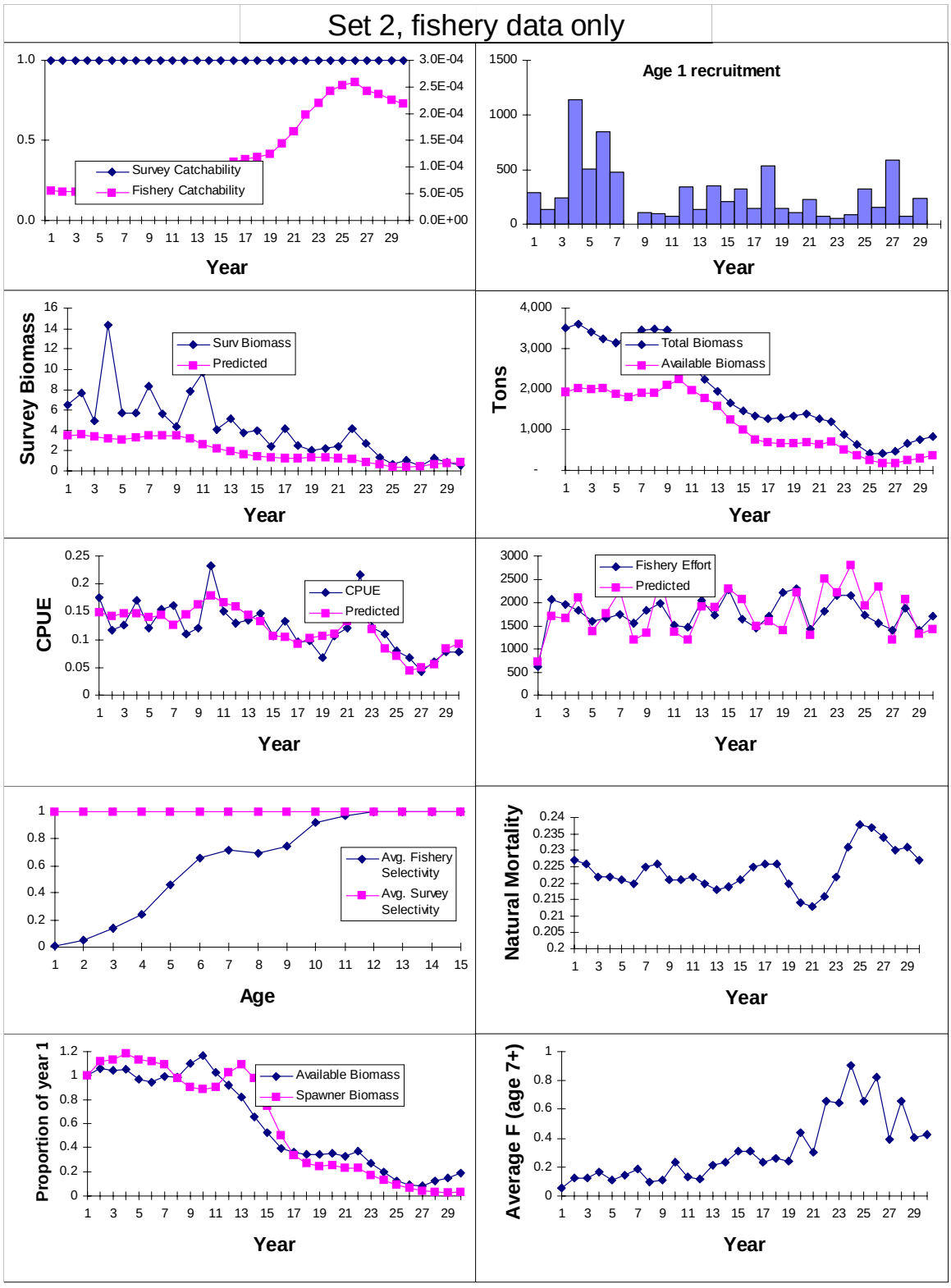

Figure 3. Analyses of data set 2 using ONLY fishery data (plots pertaining to surveys are not relevant).

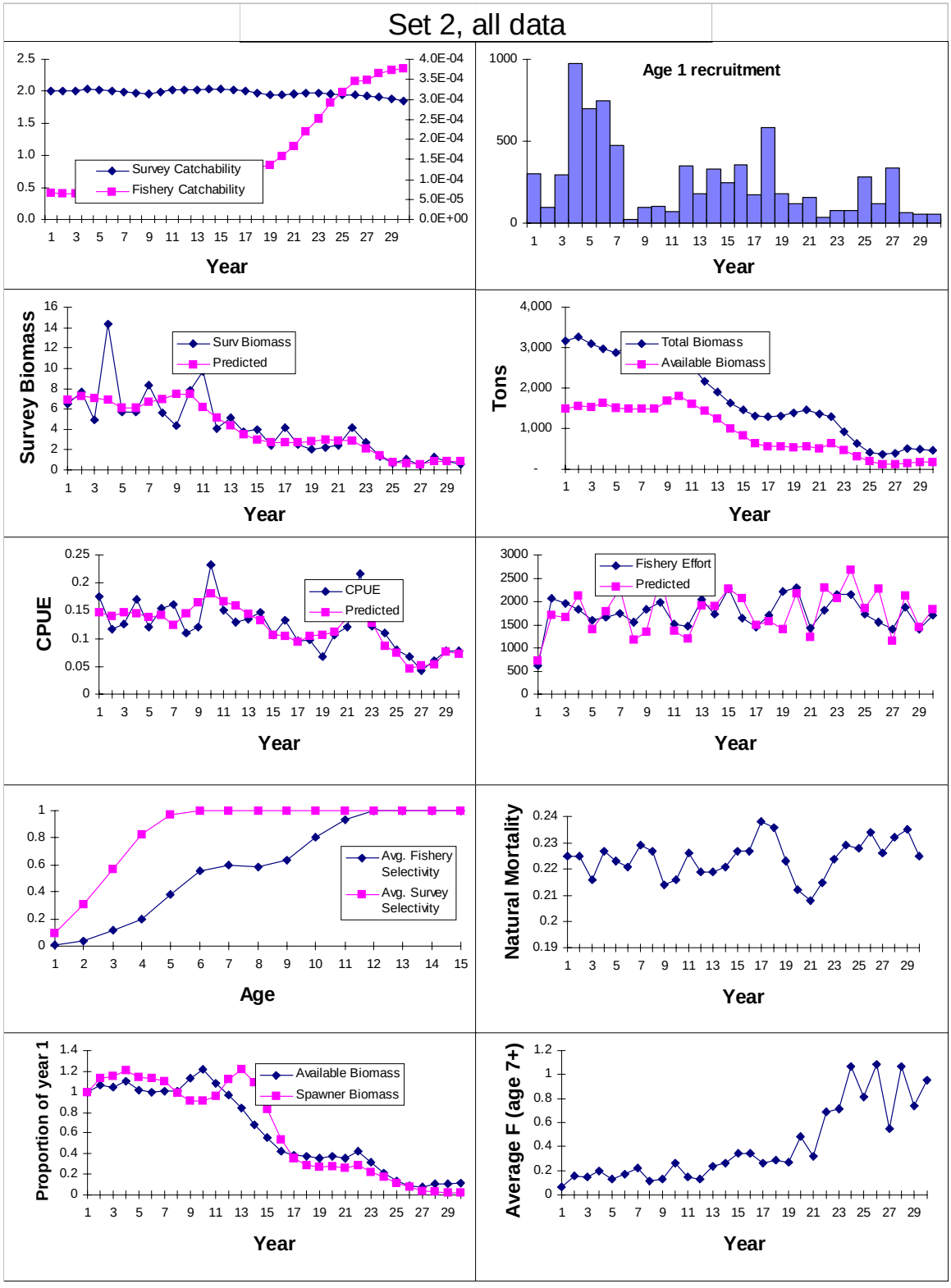

Figure 4. Analyses of data set 4 using both fishery and survey data.

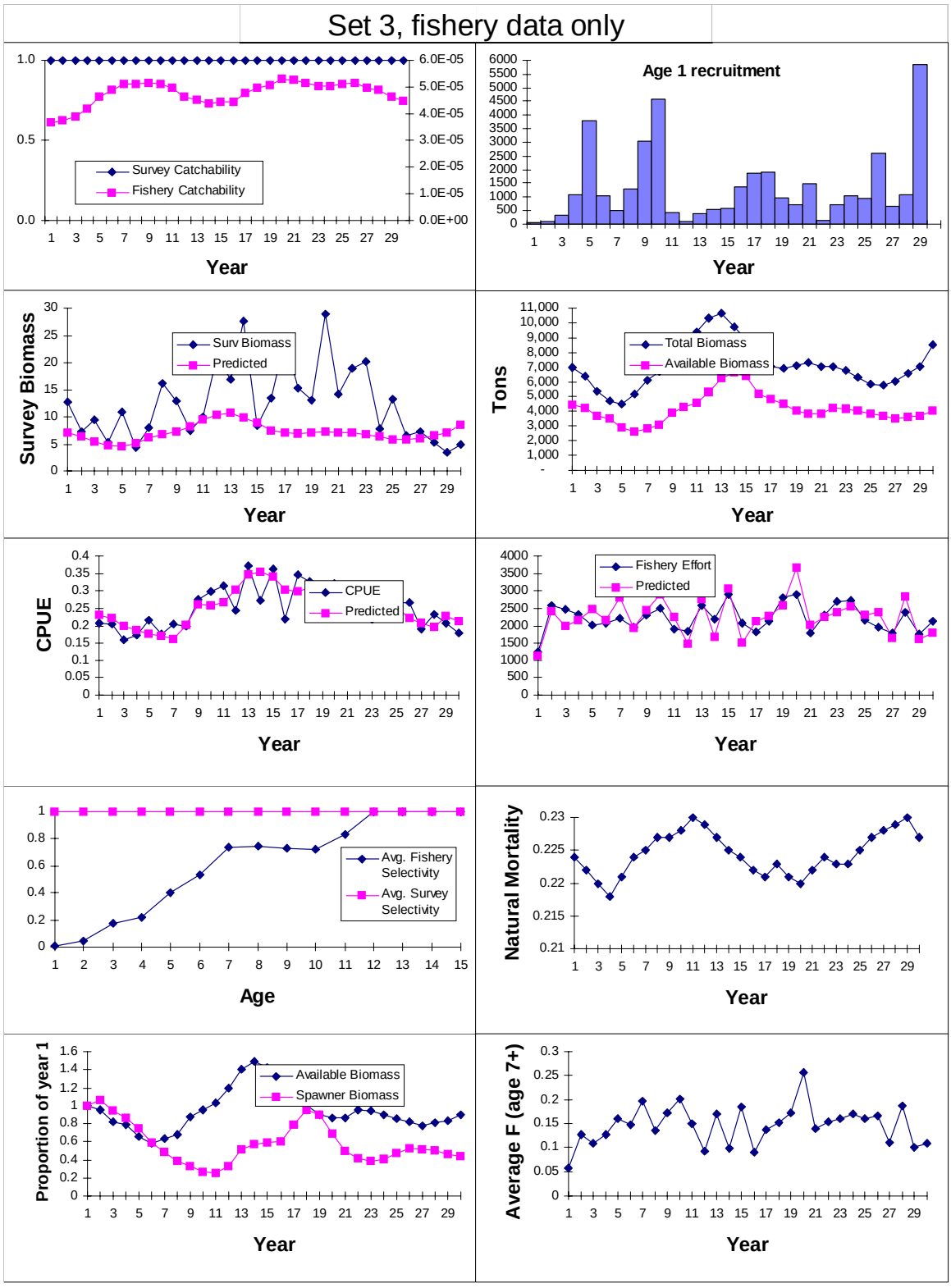

Figure 5. Analyses of data set 3 using ONLY fishery data (plots pertaining to surveys are not relevant).

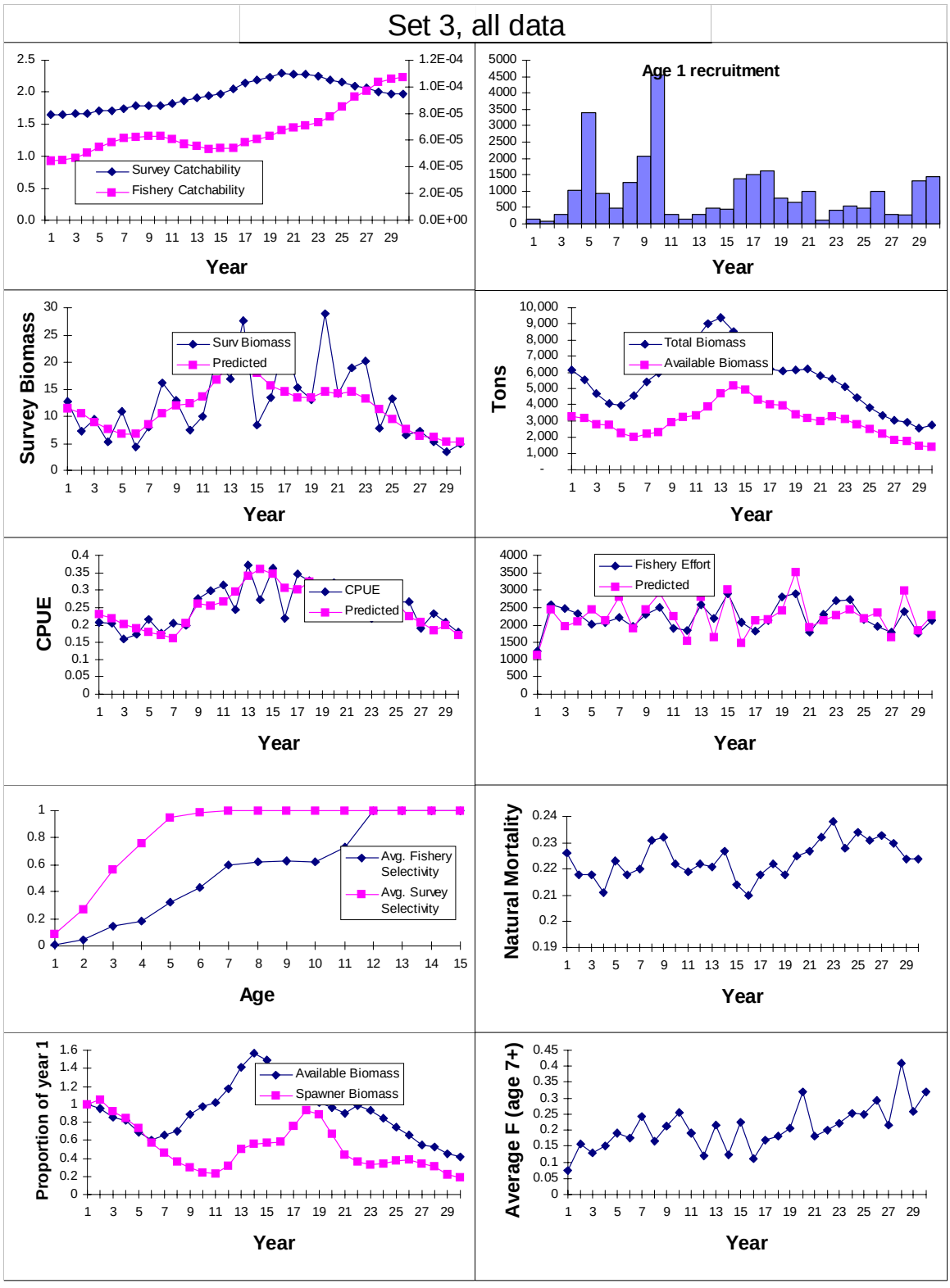

Figure 6. Analyses of data set 3 using both fishery and survey data.

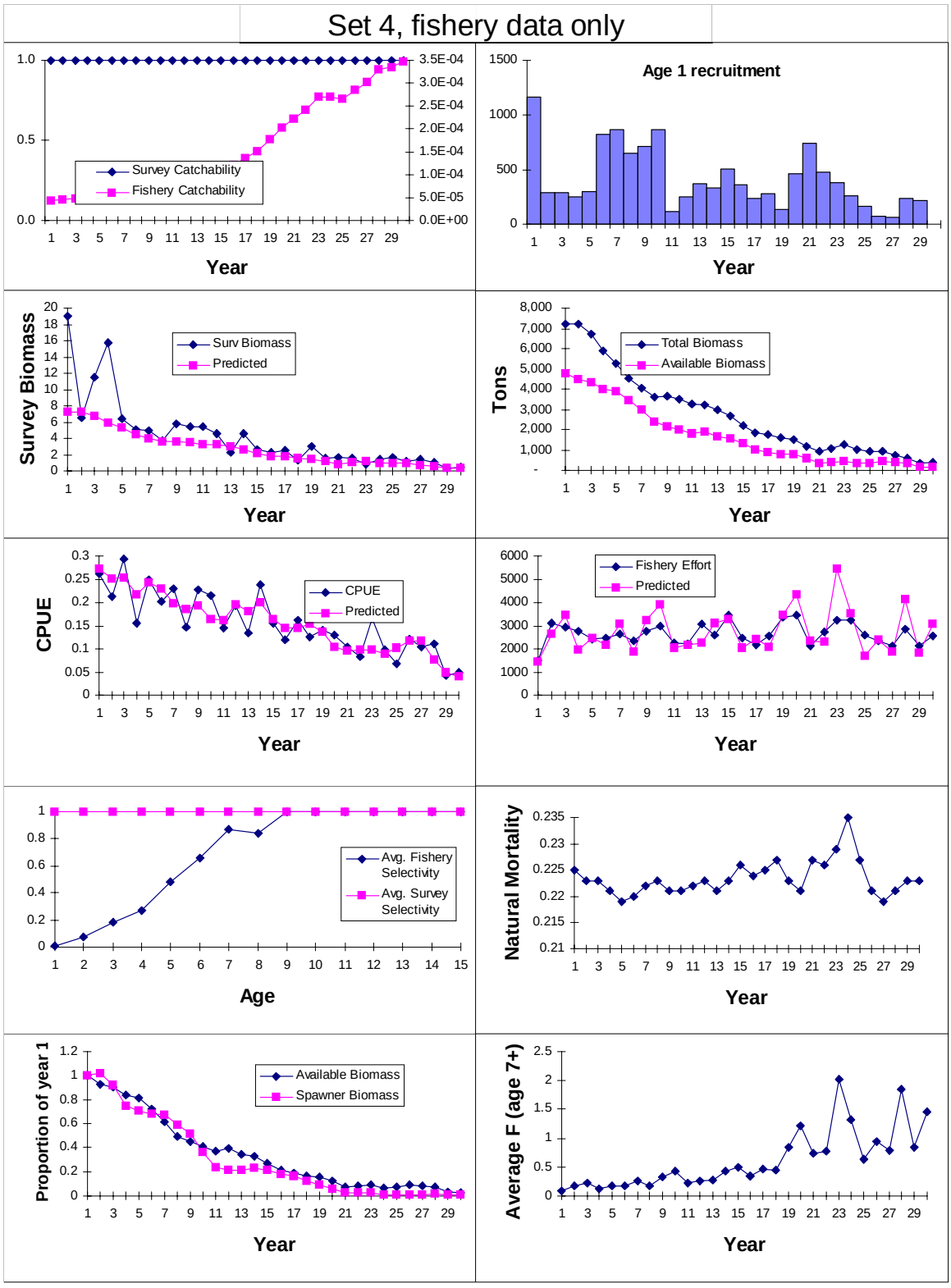

Figure 7. Analyses of data set 4 using ONLY fishery data (plots pertaining to surveys are not relevant).

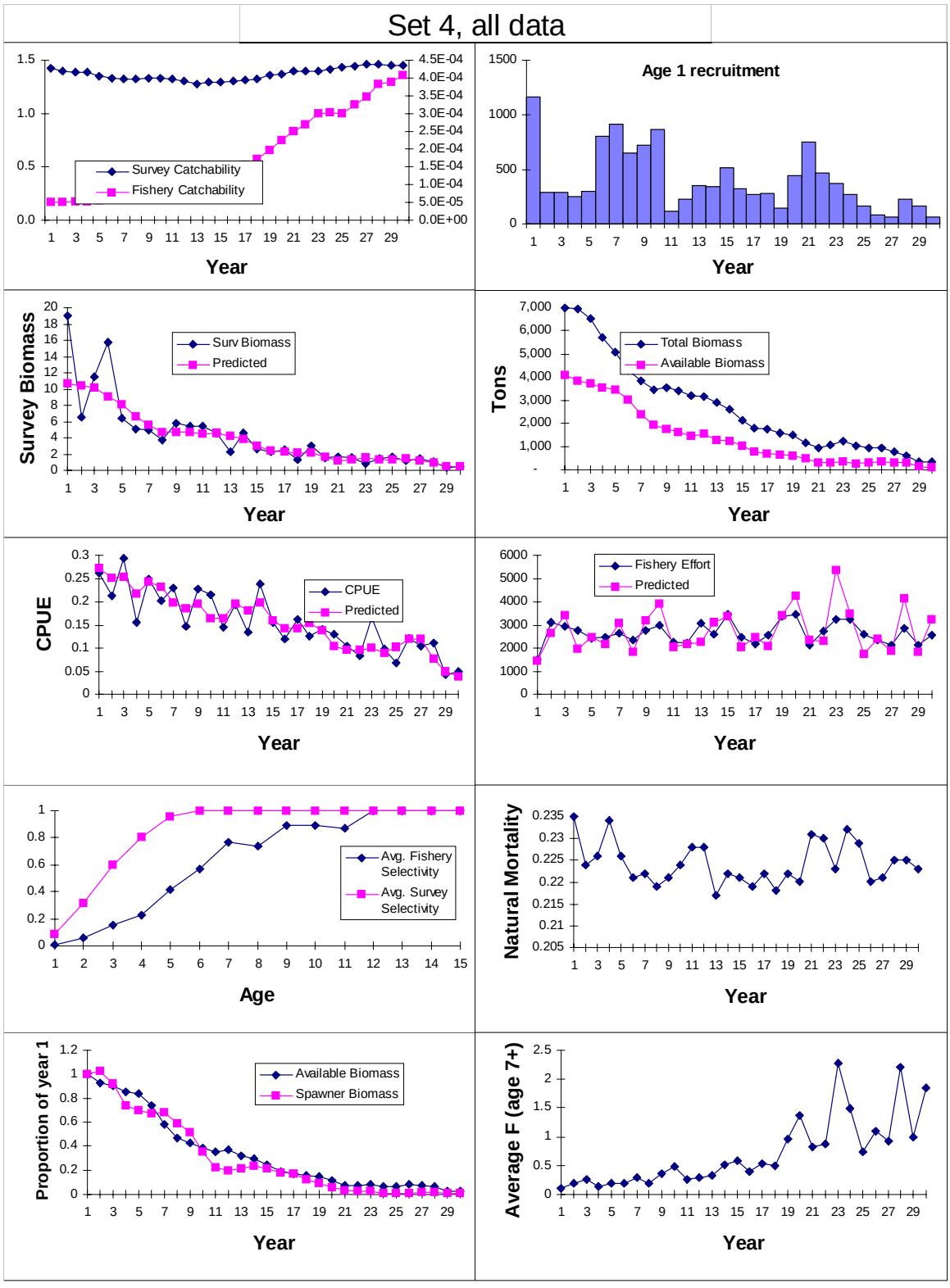

Figure 8. Analyses of data set 4 using both fishery and survey data.

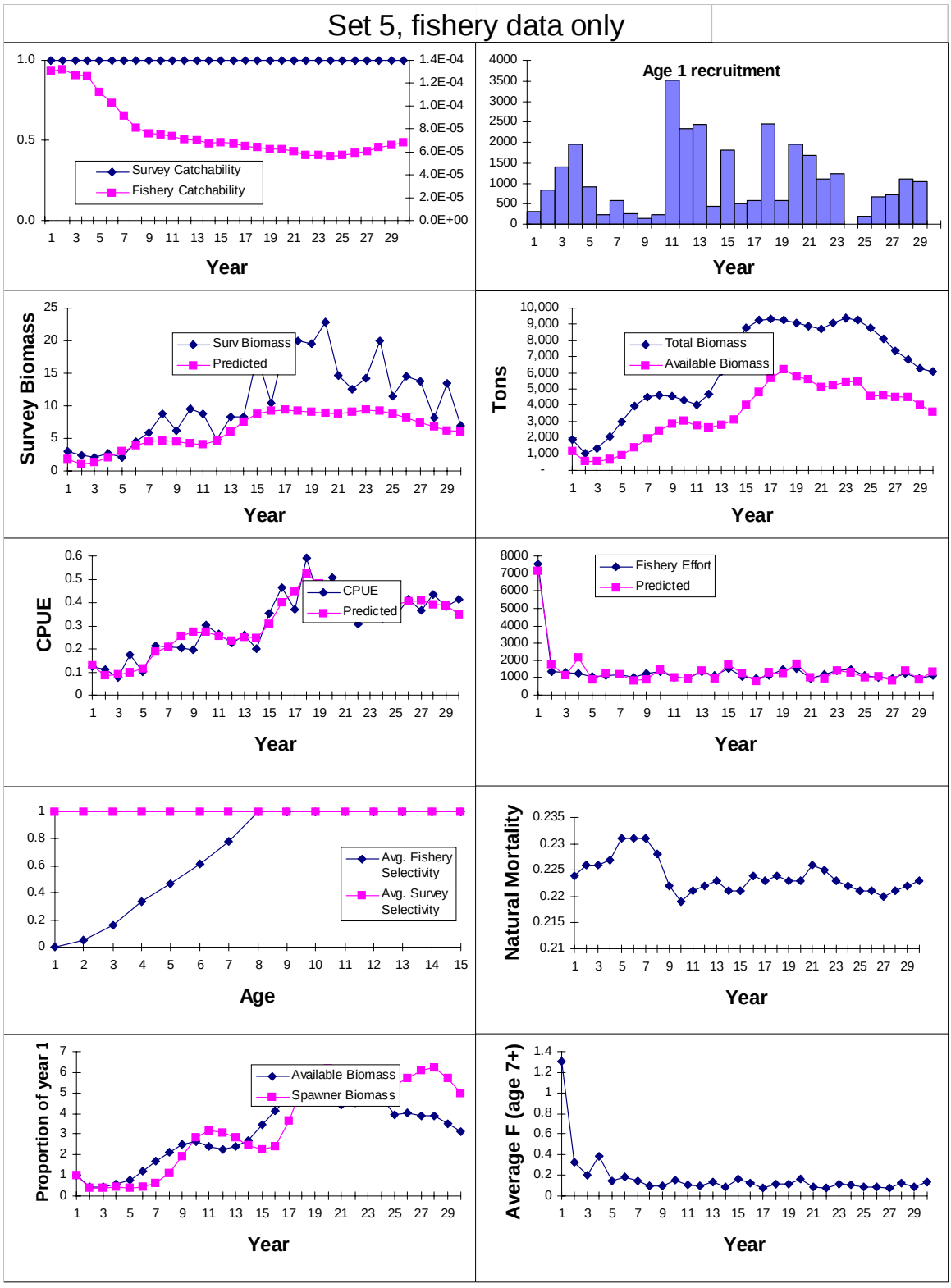

Figure 9. Analyses of data set 5 using ONLY fishery data (plots pertaining to surveys are not relevant).

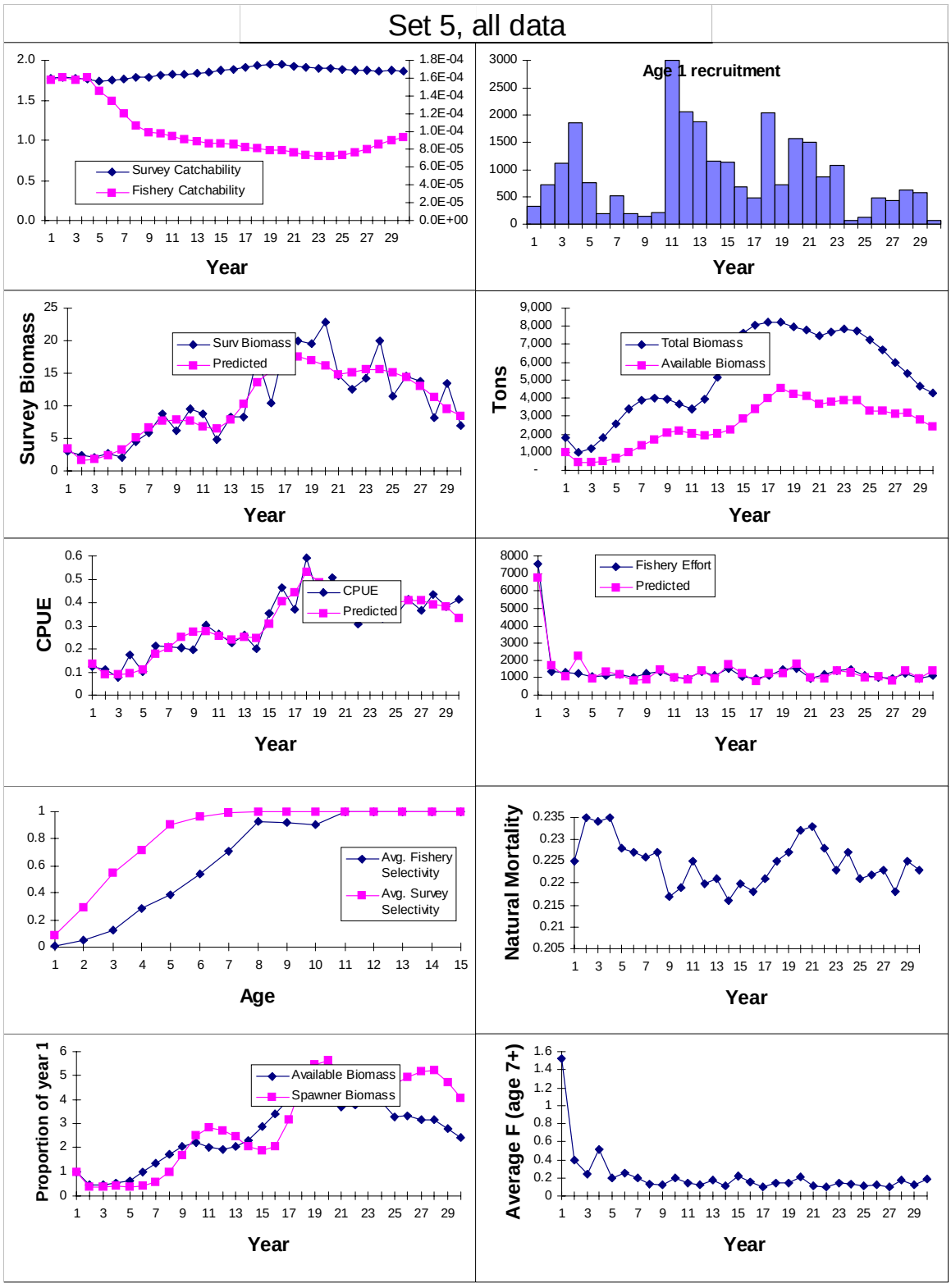

Figure 10. Analyses of data set 5 using both fishery and survey data.

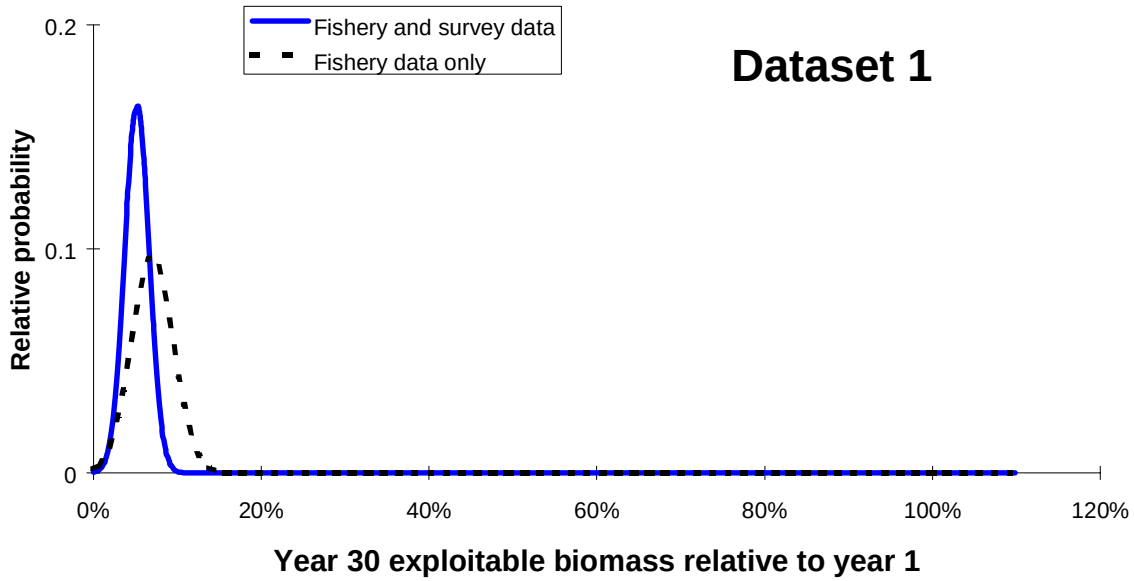

Figure 11. Estimated posterior probability distribution of the depletion (or growth) level of year 30 relative to the first year using both fishery and survey data (solid line) and fishery data alone (broken line).

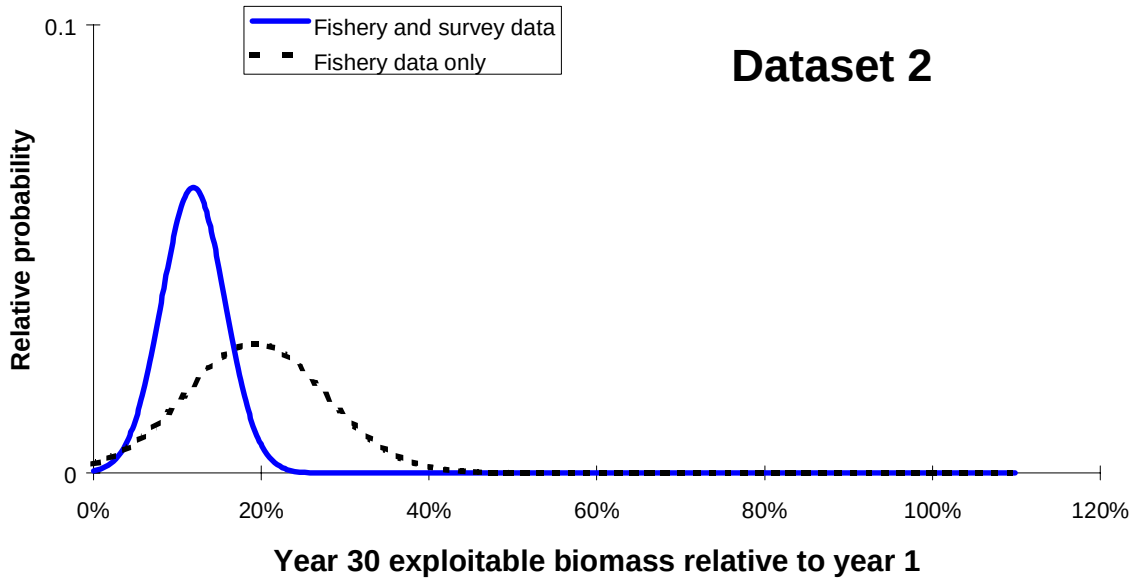

Figure 12. Estimated posterior probability distribution of the depletion (or growth) level of year 30 relative to the first year using both fishery and survey data (solid line) and fishery data alone (broken line).

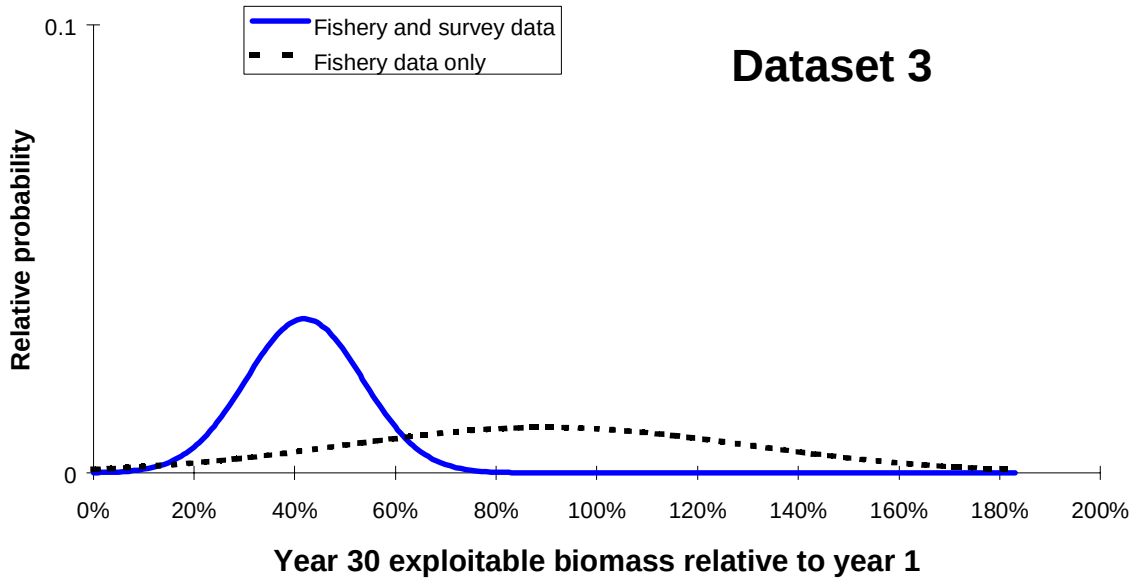

Figure 13. Estimated posterior probability distribution of the depletion (or growth) level of year 30 relative to the first year using both fishery and survey data (solid line) and fishery data alone (broken line).

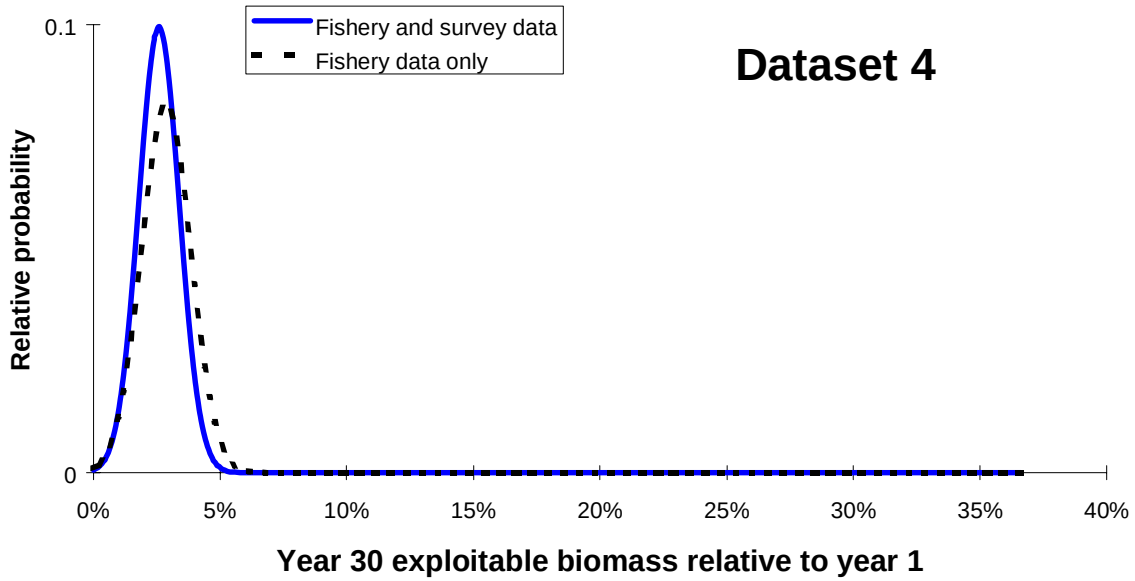

Figure 14. Estimated posterior probability distribution of the depletion (or growth) level of year 30 relative to the first year using both fishery and survey data (solid line) and fishery data alone (broken line).

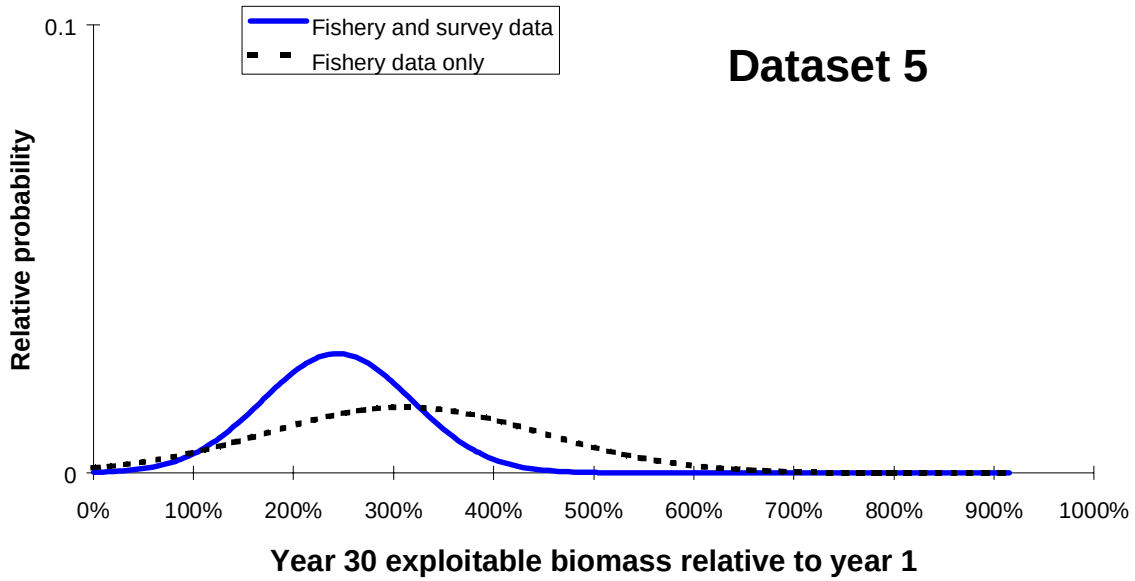

Figure 15. Estimated posterior probability distribution of the depletion (or growth) level of year 30 relative to the first year using both fishery and survey data (solid line) and fishery data alone (broken line).

Appendix I. Example parameter list and standard deviation estimates for data set 1.

index	Parameter name	value	Std Dev	Description
1	log_q	-9.28E+00	1.54E-01	Fishery catchability
2	log_q_devs	2.29E-02	9.41E-02	Catchability deviate, year 2
3	log_q_devs	2.84E-02	9.15E-02	Catchability deviate, year 3
4	log_q_devs	5.13E-02	9.05E-02	Catchability deviate, year 4
5	log_q_devs	-5.86E-02	8.97E-02	Catchability deviate, year 5
6	log_q_devs	2.38E-02	8.96E-02	Catchability deviate, year 6
7	log_q_devs	5.32E-02	8.97E-02	Catchability deviate, year 7
8	log_q_devs	1.88E-02	8.95E-02	Catchability deviate, year 8
9	log_q_devs	6.28E-02	8.96E-02	Catchability deviate, year 9
10	log_q_devs	8.08E-02	8.98E-02	Catchability deviate, year 10
11	log_q_devs	5.12E-02	8.95E-02	Catchability deviate, year 11
12	log_q_devs	7.55E-02	8.95E-02	Catchability deviate, year 12
13	log_q_devs	7.12E-02	8.98E-02	Catchability deviate, year 13
14	log_q_devs	7.32E-02	8.95E-02	Catchability deviate, year 14
15	log_q_devs	8.52E-02	8.96E-02	Catchability deviate, year 15
16	log_q_devs	9.26E-02	8.99E-02	Catchability deviate, year 16
17	log_q_devs	5.79E-02	8.96E-02	Catchability deviate, year 17
18	log_q_devs	2.27E-02	8.97E-02	Catchability deviate, year 18
19	log_q_devs	9.37E-02	9.03E-02	Catchability deviate, year 19
20	log_q_devs	7.71E-02	8.98E-02	Catchability deviate, year 20
21	log_q_devs	2.93E-02	8.96E-02	Catchability deviate, year 21
22	log_q_devs	1.11E-01	9.02E-02	Catchability deviate, year 22
23	log_q_devs	1.70E-01	8.98E-02	Catchability deviate, year 23
24	log_q_devs	1.67E-01	9.00E-02	Catchability deviate, year 24
25	log_q_devs	1.33E-01	9.06E-02	Catchability deviate, year 25
26	log_q_devs	1.54E-01	9.08E-02	Catchability deviate, year 26
27	log_q_devs	7.67E-02	9.15E-02	Catchability deviate, year 27
28	log_q_devs	4.82E-02	9.31E-02	Catchability deviate, year 28
29	log_q_devs	3.76E-03	9.39E-02	Catchability deviate, year 29
30	log_q_devs	2.68E-02	9.56E-02	Catchability deviate, year 30
31	log_surv_q	3.86E-01	1.13E-01	Survey catchability
32	log_surv_q_devs	-1.79E-02	4.41E-02	Survey catchability, year 2
33	log_surv_q_devs	-2.02E-02	4.37E-02	Survey catchability, year 3
34	log_surv_q_devs	-1.50E-04	4.34E-02	Survey catchability, year 4
35	log_surv_q_devs	-1.11E-02	4.32E-02	Survey catchability, year 5
36	log_surv_q_devs	-4.93E-03	4.31E-02	Survey catchability, year 6
37	log_surv_q_devs	-1.30E-02	4.30E-02	Survey catchability, year 7
38	log_surv_q_devs	-3.39E-03	4.29E-02	Survey catchability, year 8
39	log_surv_q_devs	-5.09E-03	4.29E-02	Survey catchability, year 9
40	log_surv_q_devs	1.17E-02	4.29E-02	Survey catchability, year 10
41	log_surv_q_devs	1.08E-02	4.28E-02	Survey catchability, year 11
42	log_surv_q_devs	2.80E-03	4.28E-02	Survey catchability, year 12
43	log_surv_q_devs	-1.59E-03	4.28E-02	Survey catchability, year 13
44	log_surv_q_devs	6.56E-03	4.28E-02	Survey catchability, year 14
45	log_surv_q_devs	1.04E-02	4.28E-02	Survey catchability, year 15
46	log_surv_q_devs	4.76E-04	4.28E-02	Survey catchability, year 16
47	log_surv_q_devs	-7.13E-03	4.28E-02	Survey catchability, year 17
48	log_surv_q_devs	-9.41E-03	4.28E-02	Survey catchability, year 18
49	log_surv_q_devs	-4.24E-03	4.29E-02	Survey catchability, year 19
50	log_surv_q_devs	-6.45E-03	4.29E-02	Survey catchability, year 20
51	log_surv_q_devs	-7.50E-04	4.29E-02	Survey catchability, year 21
52	log_surv_q_devs	-3.56E-03	4.29E-02	Survey catchability, year 22
53	log_surv_q_devs	4.76E-03	4.30E-02	Survey catchability, year 23
54	log_surv_q_devs	-2.03E-03	4.31E-02	Survey catchability, year 24
55	log_surv_q_devs	-1.28E-03	4.33E-02	Survey catchability, year 25
56	log_surv_q_devs	-1.05E-02	4.34E-02	Survey catchability, year 26
57	log_surv_q_devs	-1.57E-02	4.36E-02	Survey catchability, year 27
58	log_surv_q_devs	-8.86E-04	4.38E-02	Survey catchability, year 28
59	log_surv_q_devs	-3.37E-03	4.40E-02	Survey catchability, year 29
60	log_surv_q_devs	-4.16E-03	4.42E-02	Survey catchability, year 30
61	sel_coffs	-4.59E+00	3.25E-01	Selectivity coefficient, age 1
62	sel_coffs	-2.18E+00	2.59E-01	Selectivity coefficient, age 2
63	sel_coffs	-1.28E+00	2.52E-01	Selectivity coefficient, age 3
64	sel_coffs	-6.90E-01	2.53E-01	Selectivity coefficient, age 4
65	sel_coffs	-1.40E-01	2.45E-01	Selectivity coefficient, age 5
66	sel_coffs	1.22E-01	2.40E-01	Selectivity coefficient, age 6
67	sel_coffs	7.00E-02	2.38E-01	Selectivity coefficient, age 7
68	sel_coffs	2.01E-01	2.48E-01	Selectivity coefficient, age 8
69	sel_coffs	4.11E-01	2.43E-01	Selectivity coefficient, age 9
70	sel_coffs	4.06E-01	2.46E-01	Selectivity coefficient, age 10
71	sel_coffs	5.33E-01	2.54E-01	Selectivity coefficient, age 11
72	sel_coffs	7.39E-01	2.53E-01	Selectivity coefficient, age 12+
73	surv_sel_coffs	-2.16E+00	2.69E-01	Survey selectivity coefficient, age1
74	surv_sel_coffs	-9.88E-01	2.48E-01	Survey selectivity coefficient, age2
75	surv_sel_coffs	-2.96E-01	2.43E-01	Survey selectivity coefficient, age3
76	surv_sel_coffs	4.03E-02	2.41E-01	Survey selectivity coefficient, age4
77	surv_sel_coffs	1.70E-01	2.40E-01	Survey selectivity coefficient, age5
78	surv_sel_coffs	2.37E-01	2.41E-01	Survey selectivity coefficient, age6
79	surv_sel_coffs	2.69E-01	2.35E-01	Survey selectivity coefficient, age7
80	surv_sel_coffs	2.61E-01	2.33E-01	Survey selectivity coefficient, age8
81	surv_sel_coffs	2.07E-01	2.34E-01	Survey selectivity coefficient, age9
82	surv_sel_coffs	1.61E-01	2.35E-01	Survey selectivity coefficient, age10
83	surv_sel_coffs	1.32E-01	2.37E-01	Survey selectivity coefficient, age11
84	surv_sel_coffs	1.14E-01	2.42E-01	Survey selectivity coefficient, age12+
85	sel_devs	-1.29E-02	1.19E-01	Selectivity deviation, age 1 year 3
86	sel_devs	1.19E-01	1.06E-01	Selectivity deviation, age 2 year 3
87	sel_devs	9.12E-02	1.03E-01	Selectivity deviation, age 3 year 3
88	sel_devs	-5.20E-02	1.05E-01	Selectivity deviation, age 4 year 3
89	sel_devs	-1.88E-01	1.02E-01	Selectivity deviation, age 5 year 3
90	sel_devs	-4.11E-02	9.97E-02	Selectivity deviation, age 6 year 3
91	sel_devs	1.03E-01	9.94E-02	Selectivity deviation, age 7 year 3
92	sel_devs	2.42E-02	1.05E-01	Selectivity deviation, age 8 year 3
93	sel_devs	-1.15E-01	1.04E-01	Selectivity deviation, age 9 year 3
94	sel_devs	6.46E-03	1.04E-01	Selectivity deviation, age 10 year 3
95	sel_devs	-9.52E-04	1.11E-01	Selectivity deviation, age 11 year 3
96	sel_devs	6.59E-02	1.03E-01	Selectivity deviation, age 12 year 3
97	sel_devs	-2.78E-02	1.17E-01	Selectivity deviation, age 1 year 6
98	sel_devs	-8.11E-02	1.08E-01	Selectivity deviation, age 2 year 6
99	sel_devs	5.38E-02	9.63E-02	Selectivity deviation, age 3 year 6
100	sel_devs	3.85E-02	9.68E-02	Selectivity deviation, age 4 year 6
101	sel_devs	-6.85E-02	1.00E-01	Selectivity deviation, age 5 year 6
102	sel_devs	2.57E-02	9.91E-02	Selectivity deviation, age 6 year 6
103	sel_devs	3.64E-02	9.91E-02	Selectivity deviation, age 7 year 6
104	sel_devs	-3.66E-02	1.01E-01	Selectivity deviation, age 8 year 6
105	sel_devs	-3.14E-02	1.05E-01	Selectivity deviation, age 9 year 6
106	sel_devs	2.34E-02	1.06E-01	Selectivity deviation, age 10 year 6
107	sel_devs	3.97E-02	1.07E-01	Selectivity deviation, age 11 year 6
108	sel_devs	2.79E-02	1.03E-01	Selectivity deviation, age 12 year 6
109	sel_devs	-1.12E-02	1.16E-01	Selectivity deviation, age 1 year 9
110	sel_devs	4.70E-02	1.12E-01	Selectivity deviation, age 2 year 9
111	sel_devs	-2.44E-02	9.32E-02	Selectivity deviation, age 3 year 9
112	sel_devs	2.04E-02	9.53E-02	Selectivity deviation, age 4 year 9
113	sel_devs	4.89E-03	9.97E-02	Selectivity deviation, age 5 year 9
114	sel_devs	-3.79E-02	9.99E-02	Selectivity deviation, age 6 year 9
115	sel_devs	-3.68E-02	9.33E-02	Selectivity deviation, age 7 year 9
116	sel_devs	-3.28E-02	9.38E-02	Selectivity deviation, age 8 year 9
117	sel_devs	-2.57E-02	1.06E-01	Selectivity deviation, age 9 year 9
118	sel_devs	1.25E-02	1.07E-01	Selectivity deviation, age 10 year 9
119	sel_devs	8.57E-02	1.07E-01	Selectivity deviation, age 11 year 9
120	sel_devs	-1.64E-03	1.04E-01	Selectivity deviation, age 12 year 9
121	sel_devs	-4.74E-02	1.16E-01	Selectivity deviation, age 1 year 12
122	sel_devs	-2.38E-02	1.16E-01	Selectivity deviation, age 2 year 12
123	sel_devs	-7.27E-03	9.57E-02	Selectivity deviation, age 3 year 12
124	sel_devs	3.48E-03	9.63E-02	Selectivity deviation, age 4 year 12
125	sel_devs	1.27E-02	1.01E-01	Selectivity deviation, age 5 year 12
126	sel_devs	3.39E-02	9.92E-02	Selectivity deviation, age 6 year 12
127	sel_devs	-3.97E-02	9.32E-02	Selectivity deviation, age 7 year 12
128	sel_devs	-4.85E-02	9.32E-02	Selectivity deviation, age 8 year 12
129	sel_devs	8.37E-04	1.07E-01	Selectivity deviation, age 9 year 12
130	sel_devs	4.18E-02	1.07E-01	Selectivity deviation, age 10 year 12
131	sel_devs	8.35E-02	1.08E-01	Selectivity deviation, age 11 year 12
132	sel_devs	-9.61E-03	1.07E-01	Selectivity deviation, age 12 year 12
133	sel_devs	-6.27E-02	1.16E-01	Selectivity deviation, age 1 year 15
134	sel_devs	-7.63E-02	1.02E-01	Selectivity deviation, age 2 year 15
135	sel_devs	-1.27E-01	9.65E-02	Selectivity deviation, age 3 year 15
136	sel_devs	-7.77E-02	9.73E-02	Selectivity deviation, age 4 year 15
137	sel_devs	-1.43E-02	1.01E-01	Selectivity deviation, age 5 year 15
138	sel_devs	1.28E-02	9.85E-02	Selectivity deviation, age 6 year 15
139	sel_devs	-1.30E-03	9.18E-02	Selectivity deviation, age 7 year 15
140	sel_devs	4.45E-03	9.31E-02	Selectivity deviation, age 8 year 15
141	sel_devs	1.85E-02	1.06E-01	Selectivity deviation, age 9 year 15
142	sel_devs	8.82E-02	1.08E-01	Selectivity deviation, age 10 year 15
143	sel_devs	1.24E-01	1.08E-01	Selectivity deviation, age 11 year 15
144	sel_devs	1.11E-01	1.07E-01	Selectivity deviation, age 12 year 15
145	sel_devs	-2.36E-02	1.16E-01	Selectivity deviation, age 1 year 18
146	sel_devs	5.13E-02	9.48E-02	Selectivity deviation, age 2 year 18
147	sel_devs	1.63E-01	9.38E-02	Selectivity deviation, age 3 year 18
148	sel_devs	1.61E-02	9.33E-02	Selectivity deviation, age 4 year 18
149	sel_devs	4.99E-02	9.89E-02	Selectivity deviation, age 5 year 18
150	sel_devs	-3.54E-02	9.75E-02	Selectivity deviation, age 6 year 18
151	sel_devs	-6.12E-02	9.11E-02	Selectivity deviation, age 7 year 18
152	sel_devs	-5.22E-02	9.50E-02	Selectivity deviation, age 8 year 18

index	Parameter name	value	Std Dev	Description
153	sel_devs	-6.53E-02	1.08E-01	Selectivity deviation, age 9 year 18
154	sel_devs	-5.68E-04	1.09E-01	Selectivity deviation, age 10 year 18
155	sel_devs	-1.76E-02	1.10E-01	Selectivity deviation, age 11 year 18
156	sel_devs	-2.46E-02	1.11E-01	Selectivity deviation, age 12 year 18
157	sel_devs	-4.92E-02	1.17E-01	Selectivity deviation, age 1 year 21
158	sel_devs	8.47E-02	1.00E-01	Selectivity deviation, age 2 year 21
159	sel_devs	3.27E-01	9.35E-02	Selectivity deviation, age 3 year 21
160	sel_devs	1.45E-01	9.47E-02	Selectivity deviation, age 4 year 21
161	sel_devs	4.99E-02	9.79E-02	Selectivity deviation, age 5 year 21
162	sel_devs	-1.12E-01	9.73E-02	Selectivity deviation, age 6 year 21
163	sel_devs	-9.85E-02	8.99E-02	Selectivity deviation, age 7 year 21
164	sel_devs	-1.04E-01	9.50E-02	Selectivity deviation, age 8 year 21
165	sel_devs	-1.06E-01	1.08E-01	Selectivity deviation, age 9 year 21
166	sel_devs	-2.67E-02	1.10E-01	Selectivity deviation, age 10 year 21
167	sel_devs	-4.59E-02	1.10E-01	Selectivity deviation, age 11 year 21
168	sel_devs	-6.46E-02	1.10E-01	Selectivity deviation, age 12 year 21
169	sel_devs	-4.93E-02	1.18E-01	Selectivity deviation, age 1 year 24
170	sel_devs	-1.03E-02	9.95E-02	Selectivity deviation, age 2 year 24
171	sel_devs	-1.26E-01	9.21E-02	Selectivity deviation, age 3 year 24
172	sel_devs	-1.84E-02	9.67E-02	Selectivity deviation, age 4 year 24
173	sel_devs	-1.01E-02	1.02E-01	Selectivity deviation, age 5 year 24
174	sel_devs	9.98E-03	1.06E-01	Selectivity deviation, age 6 year 24
175	sel_devs	7.12E-02	1.06E-01	Selectivity deviation, age 7 year 24
176	sel_devs	9.46E-02	1.08E-01	Selectivity deviation, age 8 year 24
177	sel_devs	9.29E-02	1.10E-01	Selectivity deviation, age 9 year 24
178	sel_devs	4.37E-02	1.10E-01	Selectivity deviation, age 10 year 24
179	sel_devs	-2.77E-02	1.09E-01	Selectivity deviation, age 11 year 24
180	sel_devs	-7.07E-02	1.09E-01	Selectivity deviation, age 12 year 24
181	sel_devs	-1.42E-03	1.19E-01	Selectivity deviation, age 1 year 27
182	sel_devs	4.68E-02	1.05E-01	Selectivity deviation, age 2 year 27
183	sel_devs	2.38E-03	9.28E-02	Selectivity deviation, age 3 year 27
184	sel_devs	4.42E-02	9.67E-02	Selectivity deviation, age 4 year 27
185	sel_devs	1.73E-03	1.03E-01	Selectivity deviation, age 5 year 27
186	sel_devs	-2.83E-02	1.11E-01	Selectivity deviation, age 6 year 27
187	sel_devs	-1.69E-02	1.14E-01	Selectivity deviation, age 7 year 27
188	sel_devs	2.42E-04	1.15E-01	Selectivity deviation, age 8 year 27
189	sel_devs	1.41E-02	1.15E-01	Selectivity deviation, age 9 year 27
190	sel_devs	-2.15E-02	1.15E-01	Selectivity deviation, age 10 year 27
191	sel_devs	-1.90E-02	1.02E-01	Selectivity deviation, age 11 year 27
192	sel_devs	-2.23E-02	1.03E-01	Selectivity deviation, age 12 year 27
193	surv_sel_devs	1.11E-02	7.56E-02	Survey selectivity deviation, age 1 year 3
194	surv_sel_devs	-3.81E-02	7.22E-02	Survey selectivity deviation, age 2 year 3
195	surv_sel_devs	-2.77E-02	7.10E-02	Survey selectivity deviation, age 3 year 3
196	surv_sel_devs	-7.29E-03	7.07E-02	Survey selectivity deviation, age 4 year 3
197	surv_sel_devs	3.19E-03	7.04E-02	Survey selectivity deviation, age 5 year 3
198	surv_sel_devs	1.69E-02	7.09E-02	Survey selectivity deviation, age 6 year 3
199	surv_sel_devs	8.74E-03	6.69E-02	Survey selectivity deviation, age 7 year 3
200	surv_sel_devs	9.67E-03	6.39E-02	Survey selectivity deviation, age 8 year 3
201	surv_sel_devs	1.48E-02	6.44E-02	Survey selectivity deviation, age 9 year 3
202	surv_sel_devs	1.05E-02	6.47E-02	Survey selectivity deviation, age 10 year 3
203	surv_sel_devs	-4.53E-04	6.50E-02	Survey selectivity deviation, age 11 year 3
204	surv_sel_devs	-1.50E-03	6.91E-02	Survey selectivity deviation, age 12 year 3
205	surv_sel_devs	1.84E-02	7.44E-02	Survey selectivity deviation, age 1 year 6
206	surv_sel_devs	-9.56E-03	6.98E-02	Survey selectivity deviation, age 2 year 6
207	surv_sel_devs	-6.25E-03	6.78E-02	Survey selectivity deviation, age 3 year 6
208	surv_sel_devs	-1.25E-02	6.77E-02	Survey selectivity deviation, age 4 year 6
209	surv_sel_devs	6.78E-03	6.83E-02	Survey selectivity deviation, age 5 year 6
210	surv_sel_devs	-7.99E-03	6.91E-02	Survey selectivity deviation, age 6 year 6
211	surv_sel_devs	8.84E-03	6.50E-02	Survey selectivity deviation, age 7 year 6
212	surv_sel_devs	8.45E-05	6.19E-02	Survey selectivity deviation, age 8 year 6
213	surv_sel_devs	4.24E-03	6.21E-02	Survey selectivity deviation, age 9 year 6
214	surv_sel_devs	2.35E-03	6.24E-02	Survey selectivity deviation, age 10 year 6
215	surv_sel_devs	1.42E-03	6.29E-02	Survey selectivity deviation, age 11 year 6
216	surv_sel_devs	-5.84E-03	6.73E-02	Survey selectivity deviation, age 12 year 6
217	surv_sel_devs	2.76E-02	7.34E-02	Survey selectivity deviation, age 1 year 9
218	surv_sel_devs	2.47E-02	6.90E-02	Survey selectivity deviation, age 2 year 9
219	surv_sel_devs	-2.93E-02	6.71E-02	Survey selectivity deviation, age 3 year 9
220	surv_sel_devs	-1.54E-03	6.66E-02	Survey selectivity deviation, age 4 year 9
221	surv_sel_devs	2.40E-03	6.71E-02	Survey selectivity deviation, age 5 year 9
222	surv_sel_devs	1.13E-02	6.82E-02	Survey selectivity deviation, age 6 year 9
223	surv_sel_devs	-4.88E-03	6.44E-02	Survey selectivity deviation, age 7 year 9
224	surv_sel_devs	-3.88E-03	6.15E-02	Survey selectivity deviation, age 8 year 9
225	surv_sel_devs	-9.06E-03	6.17E-02	Survey selectivity deviation, age 9 year 9
226	surv_sel_devs	-9.04E-03	6.21E-02	Survey selectivity deviation, age 10 year 9
227	surv_sel_devs	-2.90E-04	6.26E-02	Survey selectivity deviation, age 11 year 9
228	surv_sel_devs	-7.88E-03	6.69E-02	Survey selectivity deviation, age 12 year 9
229	surv_sel_devs	1.02E-02	7.31E-02	Survey selectivity deviation, age 1 year 12
230	surv_sel_devs	1.48E-03	6.90E-02	Survey selectivity deviation, age 2 year 12
231	surv_sel_devs	1.06E-02	6.72E-02	Survey selectivity deviation, age 3 year 12
232	surv_sel_devs	1.91E-02	6.68E-02	Survey selectivity deviation, age 4 year 12
233	surv_sel_devs	-7.84E-03	6.69E-02	Survey selectivity deviation, age 5 year 12
234	surv_sel_devs	-1.33E-02	6.77E-02	Survey selectivity deviation, age 6 year 12
235	surv_sel_devs	-1.71E-02	6.41E-02	Survey selectivity deviation, age 7 year 12
236	surv_sel_devs	-6.66E-03	6.12E-02	Survey selectivity deviation, age 8 year 12
237	surv_sel_devs	4.59E-03	6.16E-02	Survey selectivity deviation, age 9 year 12
238	surv_sel_devs	-4.91E-05	6.20E-02	Survey selectivity deviation, age 10 year 12
239	surv_sel_devs	-1.96E-03	6.25E-02	Survey selectivity deviation, age 11 year 12
240	surv_sel_devs	9.06E-04	6.68E-02	Survey selectivity deviation, age 12 year 12
241	surv_sel_devs	-5.09E-03	7.27E-02	Survey selectivity deviation, age 1 year 15
242	surv_sel_devs	-4.27E-03	6.85E-02	Survey selectivity deviation, age 2 year 15
243	surv_sel_devs	5.75E-03	6.70E-02	Survey selectivity deviation, age 3 year 15
244	surv_sel_devs	3.40E-02	6.70E-02	Survey selectivity deviation, age 4 year 15
245	surv_sel_devs	-1.41E-03	6.75E-02	Survey selectivity deviation, age 5 year 15
246	surv_sel_devs	-1.82E-02	6.82E-02	Survey selectivity deviation, age 6 year 15
247	surv_sel_devs	-1.06E-02	6.43E-02	Survey selectivity deviation, age 7 year 15
248	surv_sel_devs	-7.57E-03	6.13E-02	Survey selectivity deviation, age 8 year 15
249	surv_sel_devs	-4.00E-03	6.15E-02	Survey selectivity deviation, age 9 year 15
250	surv_sel_devs	-9.29E-05	6.20E-02	Survey selectivity deviation, age 10 year 15
251	surv_sel_devs	4.84E-03	6.25E-02	Survey selectivity deviation, age 11 year 15
252	surv_sel_devs	6.50E-03	6.68E-02	Survey selectivity deviation, age 12 year 15
253	surv_sel_devs	8.95E-03	7.26E-02	Survey selectivity deviation, age 1 year 18
254	surv_sel_devs	-5.25E-03	6.82E-02	Survey selectivity deviation, age 2 year 18
255	surv_sel_devs	2.57E-02	6.61E-02	Survey selectivity deviation, age 3 year 18
256	surv_sel_devs	-1.59E-02	6.64E-02	Survey selectivity deviation, age 4 year 18
257	surv_sel_devs	9.11E-03	6.74E-02	Survey selectivity deviation, age 5 year 18
258	surv_sel_devs	-1.48E-02	6.86E-02	Survey selectivity deviation, age 6 year 18
259	surv_sel_devs	-5.71E-03	6.49E-02	Survey selectivity deviation, age 7 year 18
260	surv_sel_devs	-1.68E-02	6.18E-02	Survey selectivity deviation, age 8 year 18
261	surv_sel_devs	-1.02E-02	6.18E-02	Survey selectivity deviation, age 9 year 18
262	surv_sel_devs	5.18E-03	6.22E-02	Survey selectivity deviation, age 10 year 18
263	surv_sel_devs	5.73E-03	6.26E-02	Survey selectivity deviation, age 11 year 18
264	surv_sel_devs	1.40E-02	6.70E-02	Survey selectivity deviation, age 12 year 18
265	surv_sel_devs	6.90E-03	7.27E-02	Survey selectivity deviation, age 1 year 21
266	surv_sel_devs	1.17E-02	6.86E-02	Survey selectivity deviation, age 2 year 21
267	surv_sel_devs	-2.33E-02	6.66E-02	Survey selectivity deviation, age 3 year 21
268	surv_sel_devs	-2.35E-02	6.62E-02	Survey selectivity deviation, age 4 year 21
269	surv_sel_devs	9.74E-03	6.72E-02	Survey selectivity deviation, age 5 year 21
270	surv_sel_devs	-1.23E-02	6.89E-02	Survey selectivity deviation, age 6 year 21
271	surv_sel_devs	6.25E-03	6.48E-02	Survey selectivity deviation, age 7 year 21
272	surv_sel_devs	-5.37E-03	6.20E-02	Survey selectivity deviation, age 8 year 21
273	surv_sel_devs	-3.99E-03	6.21E-02	Survey selectivity deviation, age 9 year 21
274	surv_sel_devs	6.38E-03	6.23E-02	Survey selectivity deviation, age 10 year 21
275	surv_sel_devs	1.08E-02	6.28E-02	Survey selectivity deviation, age 11 year 21
276	surv_sel_devs	1.67E-02	6.74E-02	Survey selectivity deviation, age 12 year 21
277	surv_sel_devs	8.94E-03	7.31E-02	Survey selectivity deviation, age 1 year 24
278	surv_sel_devs	1.85E-02	6.83E-02	Survey selectivity deviation, age 2 year 24
279	surv_sel_devs	-5.70E-03	6.69E-02	Survey selectivity deviation, age 3 year 24
280	surv_sel_devs	-2.53E-02	6.74E-02	Survey selectivity deviation, age 4 year 24
281	surv_sel_devs	-1.26E-02	6.92E-02	Survey selectivity deviation, age 5 year 24
282	surv_sel_devs	1.37E-02	7.10E-02	Survey selectivity deviation, age 6 year 24
283	surv_sel_devs	-1.76E-02	6.62E-02	Survey selectivity deviation, age 7 year 24
284	surv_sel_devs	-8.21E-03	6.28E-02	Survey selectivity deviation, age 8 year 24
285	surv_sel_devs	-4.05E-04	6.27E-02	Survey selectivity deviation, age 9 year 24
286	surv_sel_devs	4.40E-03	6.29E-02	Survey selectivity deviation, age 10 year 24
287	surv_sel_devs	1.07E-02	6.33E-02	Survey selectivity deviation, age 11 year 24
288	surv_sel_devs	1.36E-02	6.81E-02	Survey selectivity deviation, age 12 year 24
289	surv_sel_devs	2.80E-03	7.57E-02	Survey selectivity deviation, age 1 year 27
290	surv_sel_devs	2.16E-02	7.11E-02	Survey selectivity deviation, age 2 year 27
291	surv_sel_devs	2.48E-03	6.80E-02	Survey selectivity deviation, age 3 year 27
292	surv_sel_devs	-2.30E-02	6.86E-02	Survey selectivity deviation, age 4 year 27
293	surv_sel_devs	-4.41E-03	7.06E-02	Survey selectivity deviation, age 5 year 27
294	surv_sel_devs	5.45E-03	7.31E-02	Survey selectivity deviation, age 6 year 27
295	surv_sel_devs	-5.57E-03	6.89E-02	Survey selectivity deviation, age 7 year 27
296	surv_sel_devs	-3.45E-03	6.52E-02	Survey selectivity deviation, age 8 year 27
297	surv_sel_devs	-2.55E-03	6.51E-02	Survey selectivity deviation, age 9 year 27
298	surv_sel_devs	7.67E-04	6.51E-02	Survey selectivity deviation, age 10 year 27
299	surv_sel_devs	1.66E-03	6.53E-02	Survey selectivity deviation, age 11 year 27
300	surv_sel_devs	4.17E-03	7.01E-02	Survey selectivity deviation, age 12 year 27
301	log_avginit	8.69E-01	9.11E+01	Log Mean initial numbers at age
302	log_avgrec	5.46E+00	4.85E-02	Log Mean average recruitment
303	log_recdevs	1.38E-01	1.79E-01	recruitment deviate year 1
304	log_recdevs	8.50E-01	1.17E-01	recruitment deviate year 2
305	log_recdevs	9.99E-01	1.07E-01	recruitment deviate year 3
306	log_recdevs	8.61E-01	1.10E-01	recruitment deviate year 4
307	log_recdevs	1.58E-01	1.57E-01	recruitment deviate year 5
308	log_recdevs	6.69E-01	1.17E-01	recruitment deviate year 6

index	Parameter name	value	Std Dev	Description
309	log_recdevs	6.05E-01	1.20E-01	recruitment deviate year 7
310	log_recdevs	1.36E+00	8.69E-02	recruitment deviate year 8
311	log_recdevs	7.60E-01	1.08E-01	recruitment deviate year 9
312	log_recdevs	1.98E-01	1.88E-01	recruitment deviate year 10
313	log_recdevs	-1.01E+00	3.13E-01	recruitment deviate year 11
314	log_recdevs	-4.30E-01	1.40E-01	recruitment deviate year 12
315	log_recdevs	-9.31E-01	1.70E-01	recruitment deviate year 13
316	log_recdevs	-1.47E-01	1.12E-01	recruitment deviate year 14
317	log_recdevs	4.34E-01	9.24E-02	recruitment deviate year 15
318	log_recdevs	1.17E+00	7.88E-02	recruitment deviate year 16
319	log_recdevs	1.41E-01	1.35E-01	recruitment deviate year 17
320	log_recdevs	2.39E-01	1.01E-01	recruitment deviate year 18
321	log_recdevs	-4.16E-02	1.03E-01	recruitment deviate year 19
322	log_recdevs	-9.36E-01	1.53E-01	recruitment deviate year 20
323	log_recdevs	-9.09E-01	1.26E-01	recruitment deviate year 21
324	log_recdevs	-6.80E-01	1.11E-01	recruitment deviate year 22
325	log_recdevs	-9.40E-01	1.36E-01	recruitment deviate year 23
326	log_recdevs	2.58E-01	7.53E-02	recruitment deviate year 24
327	log_recdevs	-7.30E-03	8.87E-02	recruitment deviate year 25
328	log_recdevs	5.52E-01	7.82E-02	recruitment deviate year 26
329	log_recdevs	-4.69E-01	1.28E-01	recruitment deviate year 27
330	log_recdevs	-1.54E+00	2.02E-01	recruitment deviate year 28
331	log_recdevs	-5.72E-01	2.16E-01	recruitment deviate year 29
332	log_recdevs	-7.85E-01	3.81E-01	recruitment deviate year 30
333	log_initdevs	5.11E+00	9.11E+01	Initial age composition deviates, age 2
334	log_initdevs	4.74E+00	9.11E+01	Initial age composition deviates, age 3
335	log_initdevs	3.85E+00	9.11E+01	Initial age composition deviates, age 4
336	log_initdevs	5.42E+00	9.11E+01	Initial age composition deviates, age 5
337	log_initdevs	3.29E+00	9.11E+01	Initial age composition deviates, age 6
338	log_initdevs	5.13E+00	9.11E+01	Initial age composition deviates, age 7
339	log_initdevs	-8.36E+00	4.63E+02	Initial age composition deviates, age 8
340	log_initdevs	-7.80E+00	4.95E+02	Initial age composition deviates, age 9
341	log_initdevs	3.88E+00	9.11E+01	Initial age composition deviates, age 10
342	log_initdevs	-6.87E+00	5.51E+02	Initial age composition deviates, age 11
343	log_initdevs	2.38E+00	9.11E+01	Initial age composition deviates, age 12
344	log_initdevs	-7.01E+00	5.42E+02	Initial age composition deviates, age 13
345	log_initdevs	3.57E+00	9.11E+01	Initial age composition deviates, age 14
346	log_initdevs	-7.34E+00	5.24E+02	Initial age composition deviates, age 15
347	effort_devs	-1.14E-01	1.46E-01	Annual deviation in effective effort, year 1
348	effort_devs	-2.78E-02	1.33E-01	Annual deviation in effective effort, year 2
349	effort_devs	-1.14E-01	1.26E-01	Annual deviation in effective effort, year 3
350	effort_devs	5.50E-01	1.23E-01	Annual deviation in effective effort, year 4
351	effort_devs	-4.12E-01	1.23E-01	Annual deviation in effective effort, year 5
352	effort_devs	-1.47E-01	1.21E-01	Annual deviation in effective effort, year 6
353	effort_devs	1.72E-01	1.21E-01	Annual deviation in effective effort, year 7
354	effort_devs	-2.20E-01	1.21E-01	Annual deviation in effective effort, year 8
355	effort_devs	-8.99E-02	1.21E-01	Annual deviation in effective effort, year 9
356	effort_devs	1.48E-01	1.22E-01	Annual deviation in effective effort, year 10
357	effort_devs	-1.21E-01	1.22E-01	Annual deviation in effective effort, year 11
358	effort_devs	2.13E-02	1.22E-01	Annual deviation in effective effort, year 12
359	effort_devs	-1.02E-02	1.22E-01	Annual deviation in effective effort, year 13
360	effort_devs	-5.99E-02	1.21E-01	Annual deviation in effective effort, year 14
361	effort_devs	-3.72E-02	1.21E-01	Annual deviation in effective effort, year 15
362	effort_devs	1.74E-01	1.22E-01	Annual deviation in effective effort, year 16
363	effort_devs	1.76E-01	1.23E-01	Annual deviation in effective effort, year 17
364	effort_devs	-3.55E-01	1.24E-01	Annual deviation in effective effort, year 18
365	effort_devs	8.30E-02	1.24E-01	Annual deviation in effective effort, year 19
366	effort_devs	2.39E-01	1.23E-01	Annual deviation in effective effort, year 20
367	effort_devs	-4.11E-01	1.24E-01	Annual deviation in effective effort, year 21
368	effort_devs	-2.94E-01	1.23E-01	Annual deviation in effective effort, year 22
369	effort_devs	1.62E-02	1.22E-01	Annual deviation in effective effort, year 23
370	effort_devs	1.72E-01	1.23E-01	Annual deviation in effective effort, year 24
371	effort_devs	-1.10E-01	1.26E-01	Annual deviation in effective effort, year 25
372	effort_devs	3.89E-01	1.25E-01	Annual deviation in effective effort, year 26
373	effort_devs	1.42E-01	1.27E-01	Annual deviation in effective effort, year 27
374	effort_devs	2.22E-01	1.29E-01	Annual deviation in effective effort, year 28
375	effort_devs	-1.15E-01	1.34E-01	Annual deviation in effective effort, year 29
376	effort_devs	1.34E-01	1.69E-01	Annual deviation in effective effort, year 30
377	surv_effort_devs	4.47E-01	1.18E-01	Annual deviation in effective survey effort, year 1
378	surv_effort_devs	5.75E-02	1.11E-01	Annual deviation in effective survey effort, year 2
379	surv_effort_devs	-5.01E-01	1.07E-01	Annual deviation in effective survey effort, year 3
380	surv_effort_devs	2.74E-01	1.05E-01	Annual deviation in effective survey effort, year 4
381	surv_effort_devs	-1.54E-01	1.04E-01	Annual deviation in effective survey effort, year 5
382	surv_effort_devs	2.02E-01	1.03E-01	Annual deviation in effective survey effort, year 6
383	surv_effort_devs	-2.41E-01	1.02E-01	Annual deviation in effective survey effort, year 7
384	surv_effort_devs	4.25E-02	1.01E-01	Annual deviation in effective survey effort, year 8
385	surv_effort_devs	-4.19E-01	1.01E-01	Annual deviation in effective survey effort, year 9
386	surv_effort_devs	2.09E-02	1.01E-01	Annual deviation in effective survey effort, year 10
387	surv_effort_devs	2.01E-01	1.01E-01	Annual deviation in effective survey effort, year 11
388	surv_effort_devs	1.10E-01	1.00E-01	Annual deviation in effective survey effort, year 12
389	surv_effort_devs	-2.04E-01	1.00E-01	Annual deviation in effective survey effort, year 13
390	surv_effort_devs	-9.54E-02	1.01E-01	Annual deviation in effective survey effort, year 14
391	surv_effort_devs	2.48E-01	1.01E-01	Annual deviation in effective survey effort, year 15
392	surv_effort_devs	1.90E-01	1.02E-01	Annual deviation in effective survey effort, year 16
393	surv_effort_devs	5.72E-02	1.02E-01	Annual deviation in effective survey effort, year 17
394	surv_effort_devs	-1.29E-01	1.02E-01	Annual deviation in effective survey effort, year 18
395	surv_effort_devs	5.54E-02	1.01E-01	Annual deviation in effective survey effort, year 19
396	surv_effort_devs	-1.43E-01	1.01E-01	Annual deviation in effective survey effort, year 20
397	surv_effort_devs	7.03E-02	1.02E-01	Annual deviation in effective survey effort, year 21
398	surv_effort_devs	-2.08E-01	1.02E-01	Annual deviation in effective survey effort, year 22
399	surv_effort_devs	1.70E-01	1.02E-01	Annual deviation in effective survey effort, year 23
400	surv_effort_devs	-1.89E-02	1.04E-01	Annual deviation in effective survey effort, year 24
401	surv_effort_devs	2.30E-01	1.07E-01	Annual deviation in effective survey effort, year 25
402	surv_effort_devs	1.30E-01	1.06E-01	Annual deviation in effective survey effort, year 26
403	surv_effort_devs	-3.69E-01	1.07E-01	Annual deviation in effective survey effort, year 27
404	surv_effort_devs	6.21E-02	1.11E-01	Annual deviation in effective survey effort, year 28
405	surv_effort_devs	1.99E-02	1.24E-01	Annual deviation in effective survey effort, year 29
406	surv_effort_devs	-1.04E-01	1.49E-01	Annual deviation in effective survey effort, year 30
407	M_devs	3.56E-02	1.43E-01	Annual deviation in natural mortality rate, year 1
408	M_devs	3.55E-02	1.42E-01	Annual deviation in natural mortality rate, year 2
409	M_devs	-1.28E-02	1.38E-01	Annual deviation in natural mortality rate, year 3
410	M_devs	3.59E-02	1.42E-01	Annual deviation in natural mortality rate, year 4
411	M_devs	2.89E-02	1.41E-01	Annual deviation in natural mortality rate, year 5
412	M_devs	2.45E-02	1.40E-01	Annual deviation in natural mortality rate, year 6
413	M_devs	9.94E-04	1.39E-01	Annual deviation in natural mortality rate, year 7
414	M_devs	8.61E-03	1.39E-01	Annual deviation in natural mortality rate, year 8
415	M_devs	-3.92E-02	1.36E-01	Annual deviation in natural mortality rate, year 9
416	M_devs	-4.10E-02	1.36E-01	Annual deviation in natural mortality rate, year 10
417	M_devs	-2.60E-02	1.37E-01	Annual deviation in natural mortality rate, year 11
418	M_devs	-1.90E-02	1.38E-01	Annual deviation in natural mortality rate, year 12
419	M_devs	-3.16E-02	1.37E-01	Annual deviation in natural mortality rate, year 13
420	M_devs	-3.63E-02	1.37E-01	Annual deviation in natural mortality rate, year 14
421	M_devs	-3.09E-03	1.39E-01	Annual deviation in natural mortality rate, year 15
422	M_devs	4.50E-02	1.42E-01	Annual deviation in natural mortality rate, year 16
423	M_devs	5.96E-02	1.43E-01	Annual deviation in natural mortality rate, year 17
424	M_devs	2.21E-02	1.40E-01	Annual deviation in natural mortality rate, year 18
425	M_devs	-2.20E-02	1.38E-01	Annual deviation in natural mortality rate, year 19
426	M_devs	-5.39E-02	1.36E-01	Annual deviation in natural mortality rate, year 20
427	M_devs	-5.88E-02	1.35E-01	Annual deviation in natural mortality rate, year 21
428	M_devs	-9.17E-02	1.33E-01	Annual deviation in natural mortality rate, year 22
429	M_devs	-6.11E-02	1.36E-01	Annual deviation in natural mortality rate, year 23
430	M_devs	-6.82E-03	1.39E-01	Annual deviation in natural mortality rate, year 24
431	M_devs	4.97E-02	1.43E-01	Annual deviation in natural mortality rate, year 25
432	M_devs	4.88E-02	1.43E-01	Annual deviation in natural mortality rate, year 26
433	M_devs	1.22E-02	1.41E-01	Annual deviation in natural mortality rate, year 27
434	M_devs	8.35E-03	1.41E-01	Annual deviation in natural mortality rate, year 28
435	M_devs	3.99E-03	1.40E-01	Annual deviation in natural mortality rate, year 29
436	M_devs	-6.03E-03	1.41E-01	Annual deviation in natural mortality rate, year 30
437	avg_F	4.75E-01	4.58E-02	Average full selection fishing mortality rate
438	predicted_N	8.51E+01	3.45E+01	Year 31 numbers at age 2
439	predicted_N	7.39E+01	1.99E+01	Year 31 numbers at age 3
440	predicted_N	1.58E+01	4.74E+00	Year 31 numbers at age 4
441	predicted_N	2.26E+01	6.47E+00	Year 31 numbers at age 5
442	predicted_N	2.51E+01	7.73E+00	Year 31 numbers at age 6
443	predicted_N	4.87E+00	1.93E+00	Year 31 numbers at age 7
444	predicted_N	2.15E+00	1.02E+00	Year 31 numbers at age 8
445	predicted_N	2.20E-01	1.25E-01	Year 31 numbers at age 9
446	predicted_N	8.06E-02	5.29E-02	Year 31 numbers at age 10
447	predicted_N	1.28E-02	1.09E-02	Year 31 numbers at age 11
448	predicted_N	2.40E-03	2.55E-03	Year 31 numbers at age 12
449	predicted_N	1.11E-03	1.43E-03	Year 31 numbers at age 13
450	predicted_N	2.87E-04	4.56E-04	Year 31 numbers at age 14
451	predicted_N	5.92E-05	1.10E-04	Year 31 numbers at age 15
452	avail_biomass	2.30E+06	3.21E+05	Estimate of available biomass, Year 1
453	avail_biomass	2.17E+06	3.08E+05	Estimate of available biomass, Year 2
454	avail_biomass	1.85E+06	2.53E+05	Estimate of available biomass, Year 3
455	avail_biomass	1.49E+06	2.15E+05	Estimate of available biomass, Year 4
456	avail_biomass	1.16E+06	1.73E+05	Estimate of available biomass, Year 5
457	avail_biomass	1.20E+06	1.58E+05	Estimate of available biomass, Year 6
458	avail_biomass	1.15E+06	1.53E+05	Estimate of available biomass, Year 7
459	avail_biomass	1.09E+06	1.41E+05	Estimate of available biomass, Year 8
460	avail_biomass	1.08E+06	1.43E+05	Estimate of available biomass, Year 9
461	avail_biomass	1.03E+06	1.51E+05	Estimate of available biomass, Year 10
462	avail_biomass	9.82E+05	1.47E+05	Estimate of available biomass, Year 11
463	avail_biomass	1.02E+06	1.52E+05	Estimate of available biomass, Year 12
464	avail_biomass	1.04E+06	1.58E+05	Estimate of available biomass, Year 13

index	Parameter name	value	Std Dev	Description
465	avail_biomass	8.56E+05	1.28E+05	Estimate of available biomass, Year 14
466	avail_biomass	6.91E+05	1.04E+05	Estimate of available biomass, Year 15
467	avail_biomass	4.58E+05	7.55E+04	Estimate of available biomass, Year 16
468	avail_biomass	3.85E+05	6.39E+04	Estimate of available biomass, Year 17
469	avail_biomass	3.70E+05	5.99E+04	Estimate of available biomass, Year 18
470	avail_biomass	4.32E+05	7.25E+04	Estimate of available biomass, Year 19
471	avail_biomass	4.10E+05	7.44E+04	Estimate of available biomass, Year 20
472	avail_biomass	3.55E+05	6.62E+04	Estimate of available biomass, Year 21
473	avail_biomass	3.68E+05	7.19E+04	Estimate of available biomass, Year 22
474	avail_biomass	3.25E+05	6.33E+04	Estimate of available biomass, Year 23
475	avail_biomass	2.25E+05	4.39E+04	Estimate of available biomass, Year 24
476	avail_biomass	1.48E+05	2.69E+04	Estimate of available biomass, Year 25
477	avail_biomass	1.31E+05	2.40E+04	Estimate of available biomass, Year 26
478	avail_biomass	1.14E+05	2.21E+04	Estimate of available biomass, Year 27
479	avail_biomass	1.44E+05	3.11E+04	Estimate of available biomass, Year 28
480	avail_biomass	1.22E+05	2.82E+04	Estimate of available biomass, Year 29
481	avail_biomass	1.20E+05	3.01E+04	Estimate of available biomass, Year 30
482	ratio_N	2.15E-01	9.17E-02	Year 31 N / Year 1 N, Age 2
483	ratio_N	2.70E-01	8.83E-02	Year 31 N / Year 1 N, Age 3
484	ratio_N	1.41E-01	9.08E-02	Year 31 N / Year 1 N, Age 4
485	ratio_N	4.21E-02	1.36E-02	Year 31 N / Year 1 N, Age 5
486	ratio_N	3.90E-01	4.89E-01	Year 31 N / Year 1 N, Age 6
487	ratio_N	1.20E-02	5.06E-03	Year 31 N / Year 1 N, Age 7
488	ratio_N	3.84E+03	1.89E+06	Year 31 N / Year 1 N, Age 8
489	ratio_N	2.25E+02	1.19E+05	Year 31 N / Year 1 N, Age 9
490	ratio_N	7.00E-04	4.84E-04	Year 31 N / Year 1 N, Age 10
491	ratio_N	5.16E+00	3.05E+03	Year 31 N / Year 1 N, Age 11
492	ratio_N	9.33E-05	1.44E-04	Year 31 N / Year 1 N, Age 12
493	ratio_N	5.17E-01	3.00E+02	Year 31 N / Year 1 N, Age 13
494	ratio_N	3.39E-06	5.43E-06	Year 31 N / Year 1 N, Age 14
495	ratio_N	3.82E-02	2.14E+01	Year 31 N / Year 1 N, Age 15
496	pred_B	2.95E+05	8.00E+04	Predicted Biomass year 31
497	log_avg_M	2.24E-01	5.78E-03	Average natural mortality rate
498	biomass_ratio	5.21E-02	1.45E-02	Year 30 stock size relative to year 1