Sensitivity analysis of the 1998 Large Coastal Shark Evaluation Workshop results to new data and model formulations following recommendations from peer reviews

by

Enric Cortés, National Marine Fisheries Service, Southeast Fisheries Science Center, Panama City Laboratory, 3500 Delwood Beach Road, Panama City, FL 32408

April 2002

Sustainable Fisheries Division Contribution SFD-01/02-167

BACKGROUND

As a result of litigation, the 1998 Large Coastal Shark Evaluation Workshop Report was sent out for external peer-review. Two organizations, the Center for Independent Experts (CIE) and the National Resources Consultants (NRC), were selected to implement the review process, which resulted in a total of seven reviews. The present document addresses some of the criticisms and recommendations contained in those reviews. Specifically, it describes the sensitivity trial results obtained from using the 1998 data to evaluate the recommended range of alternative model and data formulations. Ensuing documents will address additional issues, such as using other model (e.g., age-structured) and data (at least up to 2000) formulations useful for an updated assessment.

Rather than addressing each reviewer's specific criticisms individually, the present document groups the sensitivity tests undertaken into several general categories. Specifically, sensitivity tests presented herein address (listed in alphabetical order):

- Changes in the catch series
- Changes in the CPUE time series
- Changes in the form of the stock assessment model
- Changes in the importance function used for Bayesian estimation
- Changes in the method used for numerical integration
- Changes in the methods to weight the CPUE time series
- Changes in prior distributions
- Changes in the structural assumptions of the models

METHODS AND MODELS

Stock Assessment Models

1. Bayesian Surplus Production Model using the SIR algorithm, two forms of the population dynamics model, and two different weighting schemes

The surplus production model applied in the 1998 SEW using Bayesian statistical techniques was a modified Schaefer model that had been previously used in the 1996 SEW (NMFS 1996). This version of the Schaefer model was proposed by Prager (1994) and includes fishing mortality (F) explicitly in the surplus production function, such that when population abundance is expressed in numbers, it becomes:

$$\frac{dN_t}{dt} = (r - F_t)N_t - \frac{r}{K}N_t^{\ 2}$$

where N_t is stock abundance in year t, r is the intrinsic rate of increase from the logistic equation, K is carrying capacity, and F_t is the instantaneous fishing mortality rate in year t. After integration with respect to time and with $\alpha_t = r\text{-}F_t$ and $\beta = r/K$, the equation above can take two forms:

$$N_{t+1} = \frac{\alpha_t N_t e^{\alpha_t}}{\alpha_t + \beta N_t(e^{\alpha_t} - 1)}$$

when $\alpha_t \neq 0$, or

$$N_{t+1} = \frac{N_t}{1 + \beta N_t}$$

when $\alpha_t=0$.

As detailed in Prager (1994) and McAllister et al. (2001), F_t must be solved iteratively from two different equations (when $\alpha_t \neq 0$ or when $\alpha_t=0$) in which F_t occurs on both sides of the equation. This version of the model will be referred to as the "Prager form" in this document.

The discrete version of the surplus production model without the Prager modification (which was used by at least one of the two reviewers that attempted to duplicate results reported in the 1998 SEW report) was also used in the sensitivity trials conducted to determine the effect of introducing changes in the form of the stock assessment model. This version is simply:

$$N_{t+1} = N_t + rN_t\left(1-\left(\frac{N_t}{K}\right)\right) - C_t$$

where C_t is catch in year t. This version of the model will be referred to as the "discrete form" in this document.

The expected catch rate (CPUE) for each of the available time series j in year t is given by:

$$\hat{I}_{j,t} = q_j N_t e^{\varepsilon}$$

where q_j is the catchability coefficient for CPUE series j, and e^{ε} is the residual error, which is assumed to be lognormally distributed. Coefficients of variation (CV) were available in some CPUE series ($CV_{j,t}$), and were used as weights for each series, such that:

$$\sigma_{j,t}{}^2 = c_j CV_{j,t}{}^2 \sigma_j{}^2$$

where c_j is a constant for series j that makes the weights sum to 1, and σ_j^2 is the arithmetic mean for the variance of CPUE series j.

The log likelihood function of the abundance indices is expressed as:

$$\ln L = -\sum_{j=1}^{j=s}\sum_{t=1}^{t=y} \left\{ \frac{0.5}{c_j CV_{j,t}{}^2 \sigma_j{}^2}\left[\ln\left(\frac{I_{j,t}}{q_j N_t}\right)\right]^2 - 0.5\ln(c_j CV_{j,t}{}^2 \sigma_j{}^2) \right\}$$

where s is the number of CPUE series and y is the number of years in each CPUE series.

The average σ_j^2 and q_j for each CPUE series were assumed to follow a uniform distribution on the log scale, but were integrated from the joint posterior distribution using the method described by Walters and Ludwig (1994). In another form of the model, all CPUE data points from all series were assumed to have the same variance (σ^2=1), which is equivalent to having no weighting or having an equal weighting scenario.

Prior probability distributions, alternative hypotheses, and performance indicators

Alternative hypotheses were generated by drawing alternative values from the parameters assigned priors (r, K, N_{1974}/K, and C_0). Performance indicators included the maximum sustainable yield (MSC=rK/4), the stock abundance in the last year of data (N_{1998}), the ratio of stock abundance in the last year of data to carrying capacity (N_{1998}/K), and the replacement yield for 1998 (RY_{1998}).

The prior chosen for K in the base-case scenario was uninformative, as little is known about the carrying capacity of shark populations. The prior distribution for the large coastal shark complex and sandbar shark was uniform on the log of K over the range $1x10^{-12}$ to $1x10^{12}$ individuals. This prior is proportional to the inverse of K and so assigns less credibility to higher values of K (McAllister and Kirkwood 1998). For blacktip shark, the range of the prior for K was $1x10^{-12}$ to $8x10^{8}$ individuals.

The informative prior chosen for r was based on results from documents presented at the 1998 SEW (appendix 2 of the 1996 SEW [SB-IV-31]; SB-IV-10) and on some ad-hoc calculations by the Committee. The upper bound, or absolute biological upper limit, of the intrinsic rate of increase assuming geometric growth was used in each case as the estimate of the mean. Note that the values used are higher than those used by McAllister et al. (2001). Thus, it is important to note that the values used in the 1998 SEW were high from a biological perspective. Recent estimates of intrinsic rates of increase obtained using both density-independent (Cortés, in press) and density-dependent (Smith et al. 1998) theory support considerably lower values of r for most species of sharks—including the sandbar and blacktip—in the large coastal complex (values of r for the most representative species all <0.07 for both density-independent and density-dependent estimates). While the surplus production model used assumes closed populations, it can be argued that the relatively high values of r used may be considered a proxy for net immigration into the stocks, thus alleviating the violation of a closed population assumption.

The priors for r were lognormal pdfs with mean=0.113, 0.117, and 0.136 for the large coastal complex, sandbar, and blacktip, respectively. The SD in the logarithm of r (σ_r) was set equal to 0.7 in all cases. It is calculated as (McAllister et al. 2001):

$$\sigma_r = \sqrt{\ln\left(1+\left(\frac{SD_r}{\bar{X}_r}\right)^2\right)}$$

This pdf makes values of r<0 impossible and concentrates most of the density towards the lower values of r. However, it also allows for high values of r that are unlikely for closed populations and even for open populations of sharks (e.g., see Table 30).

Informative priors were also used to describe the ratio of the stock abundance in 1974 with respect to K (N_{1974}/K) and the average catch from 1974 to 1980 (C_0). For N_{1974}/K, the prior was lognormal with mean=1 and SD in the logarithm of r of 0.20 in all cases. This prior reduces the probability that N_{1974}/K will be much higher than K since most of the values will be closer to unity. The prior for C_0 was also lognormal with mean=487 300, 135 900, and 303,800 individuals (the mean of the observed catches) for the large coastal complex, sandbar, and blacktip, respectively. The SD in the logarithm of C_0 was 0.51, 0.53, and 0.43, respectively.

Method of numerical integration

Numerical integration was carried out using the sampling/importance resampling (SIR) algorithm (Berger 1985, McAllister and Kirkwood 1998, McAllister et al. 2001). The marginal posterior distributions for each of the population parameters of interest were obtained by integrating the joint probability with respect to all the other parameters. Posterior CVs for each population parameter estimate were computed by dividing the posterior SD by the posterior expected value (mean) of the parameter of interest. The importance function used in the SIR algorithm was the multivariate Student t distribution, with its mean based on the posterior mode of θ (vector of parameter estimates K, r, N_{74}/K, and C_0), and the covariance of θ based on the Hessian estimate of the covariance at the mode (see McAllister and Kirkwood and references therein for details).

It has become apparent after the 1998 SEW report was written, however, that the Student t distribution used to sample from the posterior distribution for blacktip shark was inadequate and likely failed to converge to the posterior distribution. This resulted in the underestimation of expected values of the parameters because their right tail was not sampled appropriately by the importance function (McAllister et al., in prep.). To overcome this problem, one solution is to use a variety of importance functions and compare the marginal posterior distributions of the parameters. McAllister et al. (in prep.) have found that making the importance function more diffuse by multiplying the variance estimated from the Hessian matrix by a factor of 2 or more allows for the importance function to adequately sample from the posterior distribution.

The effect of the importance function is evidenced in the results for blacktip. Unlike for the large coastal complex and sandbar, a large portion of the posterior distribution had not been sampled by the importance function, thus underestimating the results. An additional reason for the unreliability of the results reported for blacktip in the 1998 SEW lies in the data themselves. The CPUE series that the model was fitted to show conflicting trends, with the longer Early Rec series and the Gulf Reef logs series indicating an increasing trend, but the remaining, shorter five series indicating a decreasing trend over time. The effect of the series considered on results will be shown in the sensitivity analysis section.

Decision analysis

Posterior expected values for several indices of policy performance were calculated using the resampling portion of the SIR algorithm, which involves randomly drawing 5,000 values of θ with replacement from the discrete approximation to the posterior distribution of θ, with the probability of drawing each value of θ being proportional to the posterior probability calculated during the importance sampling phase. Details of this procedure can be found in McAllister and Kirkwood (1998) and McAllister et al. (2001), and references therein. Once a value of θ was drawn, the model was projected from 1974 to 1998, and then to 2028, while applying one of the constant TAC (total allowable catch) policies (0, 10%, 20%, 30%, 40%, and 50% of 1995 catch) from 1999 on. The projections included calculating the expected value of N_{fin}/K (with $_{fin}$=2008, 2018, and 2028), the expected value of the ratio of N_{fin} to the stock abundance that would result in MSY (N_{fin} /N_{MSY}), the probability that N_{fin} were <0.2K, and the probability that N_{fin} were >N_{1998}.

2. Bayesian Surplus Production Model using State-Space methodology and MCMC for numerical integration

A nonequilibrium Schaefer surplus production model was also used to describe the population dynamics of the large coastal shark complex, sandbar, and blacktip sharks using state-space methodology and a Markov Chain Monte Carlo (MCMC) method for numerical integration as an alternative to the SPM originally used in the 1998 SEW and described here under (1). The model used was that described by Meyer and Millar (1999a), originally developed in BUGS, and recoded here in WINBUGS (Spiegelhalter et al. 2000). In this approach, a state-space model accounts for both process error and observation error in a unified analytical framework that uses a MCMC method called Gibbs sampling (Gilks et al. 1996) to sample from the joint posterior distribution.

State-space models can be used to relate observed catch rates (I_t) to unobserved states (biomass, B_t) through a stochastic observation model for I_t given B_t. A description of state-space models can be found in Meyer and Millar (1999b) and Millar and Meyer (1999). Millar and Meyer (1999a) implemented a nonlinear, nonnormal state-space model assuming lognormal error structures and a reparametrization by expressing the annual biomass as a proportion of carrying capacity ($P_t = B_t/K$). In the present implementation, this Bayesian model includes the joint prior distribution of all unobservable quantities, i.e., K, r, N_{1974}/K, C_0, q, σ^2 (process error variance), and τ^2 (observation error variance) and the unknown states P_1,….,P_t, and the joint distribution of the observable quantities, i.e., the CPUE indices I_1,….,I_t. Bayesian inference then uses the posterior distribution of the unobserved quantities given the data (see Meyer and Millar 1999a for a full description of the model).

As in the original model developed by Millar and Meyer (1999a), the present implementation used inverse gamma distributions as priors for σ^2 and τ^2, but the MLEs for q in each CPUE time series were used instead of one prior for q for each series. The geometric average of the time series of individual q estimates for each CPUE series was used as an analytic solution for the estimate of q that maximizes the likelihood function (Punt 1988; Hilborn and Mangel 1997):

$$\hat{q} = e^{\frac{1}{y}\sum_t \ln\left(\frac{I_t}{\hat{B}_t}\right)}$$

where y is the number of years in each CPUE series.

The prior for σ^2 was an inverse gamma distribution with the 10% and 90% quantiles set at 0.04 and 0.08, and the priors for τ^2 (one for each individual CPUE series) were also described by an inverse gamma distribution with the 10% and 90% quantiles set at 0.05 and 0.15. In an alternative scenario, one single value of τ^2 was used for all series and given an inverse gamma distribution. No CV^2 s were used in any of the scenarios run in Winbugs. All runs were based on two chains of initial values (where the P_t values were set equal to 0.5 and 1.0, respectively) to account for over-dispersed initial values (Spiegelhalter et al. 2000), and included a 5,000 sample burn-in phase followed by a 100,000 iteration phase.

RESULTS

Baseline analyses (with two forms of the model and two separate importance functions)

The baseline analyses reported in the 1998 SEW (Tables 7-9 therein) were rerun using the same, but updated, software (Mc Allister et al. 2001; Mc Allister and Babcock, in prep.) and compared to the results reported by the two reviewers who attempted to replicate the analyses (Haist and Punt). The two forms of the surplus production model (SPM) described above (Prager form and discrete form) were evaluated using two different importance functions: 1) the importance function used for the 1998 SEW (which will be referred to as the "original importance function"), and 2) an importance function in which the variance obtained form the Hessian matrix was multiplied by a factor of 2 (as described earlier).

Large coastal complex

Results of the baseline analysis for the large coastal shark complex with the original importance function (Table 1) are very similar regardless of the form of the model used. Stock abundance in 1998 (N_{1998}) and N_{1998}/K are slightly lower than reported in the 1998 SEW report, whereas the Maximum Sustainable Catch (MSC) is slightly higher. Results for this baseline analysis are a little more pessimistic than found by the two reviewers, especially the predictions of N_{1998} and N_{1998}/K.

These and all other tables for the sensitivity trials include a decision analysis section that summarizes the consequences of alternative harvesting policies. Predictions from both the Prager and discrete versions of the SPM model indicate that, with the exception of a no-take policy after 30 years, no management action would result in the stock reaching MSY (MSC, here). Compared to Punt's review findings, which included predictions of N_{2019}/K with 0%, 30%, and 50% of the 1995 catch TAC options, the present predictions are more pessimistic (0.37 vs. 0.50 for the no-take option, 0.02 vs. 0.17 for the 30% TAC option, and 0.01 vs. 0.04 for the 50% TAC option).

Results obtained using the variance expansion factor of two (Table 2) were nearly identical to those obtained with the original importance function, with the projections being slightly more optimistic. Conclusions for the large coastal complex are thus unaffected by the form of the model used (Prager vs. discrete) or the importance function. The marginal posterior distributions of the most representative parameters obtained using the two importance functions with the Prager form of the SPM are shown in Figures 1 and 2.

Sandbar shark

Results of the baseline analysis for the sandbar shark using the original importance function are also almost identical regardless of the form of the model used (Table 3). Stock abundance in 1998 (N_{1998}) and N_{1998}/K are slightly lower than reported in the 1998 SEW, but MSC is slightly higher. As with the large coastal shark complex, predictions of N_{1998}, N_{1998}/K, and MSC for this baseline analysis are a little more pessimistic than found by the two reviewers. Projections continue to indicate that a 50% TAC option would not suffice to restore the stock to MSC levels after 10, 20, or 30 years. A no-take policy would almost achieve MSC after 10 years only, and a TAC of 20% of the 1995 catch would yield MSC after 20 years. The prediction for a no-take option after 20 years is similar to that by Punt (0.62-0.64 vs. 0.72), but the predictions for the 30% and 50% TAC options after 20 years are a little more pessimistic that those of Punt (0.42 vs. 0.56, and 0.28 vs. 0.43, respectively).

Results obtained using the variance expansion factor of two (Table 4) are a little more optimistic, but still a little lower than those found by the two reviewers. Conclusions for the sandbar shark are also unaffected by the form of the model used (Prager vs. discrete) or the importance function. The marginal posterior distributions of the most representative parameters obtained using the two importance functions with the Prager form of the SPM are shown in Figures 3 and 4.

Blacktip shark

Results of the baseline analysis for the blacktip shark using the original importance function as reported in the 1998 SEW and in the present analysis, and those reported by the two reviewers are the most dissimilar (Table 5). Stock abundance in 1998 (N_{1998}),

N_{1998}/K, and MSC are much lower than found by the reviewers. Consequently, predictions of future trends are also very different: a no-take policy would result in N_{2018}/K=0.64-0.67 compared to N_{2019}/K=0.81 found by Punt, and the 30% and 50% TAC options after 20 years are even more different (0.32-0.34 vs. 0.65, and 0.14-0.15 vs. 0.55, respectively).

As discussed in the Methods and Models section, results for the blacktip shark are highly influenced by the importance function used, largely because the seven CPUE series that the model is fitted to have contradictory trends. When the variance expansion factor of two was used in the importance function, results became much more optimistic, especially with the discrete form of the SPM (Table 6). Results obtained with the Prager form SPM were similar to those obtained by Punt and a little more optimistic than those reported by Haist. When using the discrete version of the SPM, results became considerably higher. Conclusions for the blacktip shark are thus directly affected by the importance function used and, to a lesser extent, by the form of the surplus production model used. The marginal posterior distributions of the most representative parameters obtained using the two importance functions with the Prager form of the SPM are shown in Figures 5 and 6. Note that the distributions for K and N_{1998} show more density in the right tail and that N_{1998}/K seems to follow a bimodal distribution (Fig. 6).

Sensitivity analyses

Sensitivity tests incorporated the following modifications to the base-case scenarios, which used the priors described above for the large coastal shark complex, sandbar, and blacktip sharks. All sensitivity trials used the importance function with a variance expansion factor of two and were run with the Prager form SPM only, except for the scenarios described in section A.1, which included both forms of the SPM and the two separate importance functions.

A. Changes in the catch series

A.1. Alternative catch scenarios presented in the 1998 SEW report

Alternative catch scenarios were presented in the 1998 SEW report (Tables 7-9) for the large coastal shark complex, sandbar, and blacktip sharks. These alternative catch series (presented in Table 3 of the 1998 SEW report for the large coastal complex) accounted for potential underreporting in the commercial fishery by multiplying the catches from 1981-1985, 1986-1992, and 1993, by a factor of 1.5, 2, and 1.5, respectively, assuming that discards in the bottom longline fishery were 10,000 individuals during 1981-1986, and assuming that the recreational catch for 1983 was the geometric mean value of the 1982 and 1984 estimates. Similarly, alternative catch series for the sandbar and blacktip sharks were constructed by multiplying the commercial catches from 1986 by a factor of 1.5, those from 1987-1992 by a factor of 2, and those from 1993 by a factor of 1.5. Baseline and alternative catch series are given in Appendix 1. The priors for K, r, and N_{1974}/K in the alternative catch series scenarios were the same as those in the baseline analyses, but the mean for the lognormal prior of C_0 was set at 543 500, 187 300, and 381 700 individuals (the mean of the 1981-1997 or 1986-1997 catches) for the large coastal complex, sandbar, and blacktip, respectively. The SD in the logarithm of r was left unchanged.

For the large coastal complex, using the alternative catch series with the original importance function increased the predictions of K, N_{1998}, N_{1998}/K, and RY_{1998}, but decreased the expected value of r and MSC (Table 7). Projections in the decision analysis changed very little, becoming slightly more optimistic. Results obtained using the variance expansion factor of two in the importance function (Table 8) were nearly identical to those obtained with the original importance function. Considering this alternative catch series thus had essentially no effect on the conclusions derived from the baseline analysis.

For sandbar shark, results from the Prager and the discrete SPM forms with the original importance function were slightly different, and they also differed from those in the 1998 SEW report (Table 9), possibly because the prior used for C_0 was different. The projections from the decision analysis were a little more optimistic than those from the baseline analysis, with a 20% TAC option allowing recovery to MSC after 10 years according to the discrete form of the SPM. Results obtained using the variance expansion factor of two in the importance function (Table 10) were a little more optimistic in general than those obtained with the original importance function. For sandbar, the main conclusions derived from the baseline analysis were not strongly affected .

For blacktip shark, results from both forms of the model with the original importance function were very similar and also similar to those reported in the 1998 SEW report (Table 11). The projections from the decision analysis were a little more pessimistic than those from the baseline analysis (Table 5). As in the baseline analysis, using the variance expansion factor of two in the importance function yielded much more optimistic results (Table 12) and indicated no need for rebuilding, especially when using the discrete form SPM. Conclusions for the blacktip shark are directly affected by the importance function used and, to a lesser extent, by the form of the surplus production model used, as was also found in the baseline analysis.

A.2. Alternative catch scenario proposed by Haist

An additional sensitivity trial was run for the large coastal complex, incorporating the catch series proposed by Haist. This alternative catch series addressed concerns identified in the Industry Position Statement that the alternative catch series used in the 1998 SEW report underestimated true catches and did not take account of catches occurring outside U.S. waters. Haist thus multiplied the baseline catches from 1981-1985 and from 1986-1992 by a factor of 2 and 3, respectively, and included non-U.S. catches of 100 000 individuals per year from 1981-1997 (Appendix 2). The results obtained with the Prager form of the SPM were a bit more optimistic than those from the baseline analysis, but still a little more pessimistic than those found by Haist (Table 13). As indicated by Haist, however, the main conclusion from the baseline analysis remained unchanged.

B. Changes in prior distributions

B.1. Decreasing the upper bound of K

Haist considered a set of sensitivity scenarios in which the upper bound of the carrying capacity, K, was lowered. Decreasing the upper bound of K from $1x10^{12}$ to $20x10^6$ individuals had no effect on results for the large coastal complex (Table 14). For sandbar, the same decrease in the upper bound of K had no effect on results, and a further decrease to $12x10^6$ individuals had essentially no effect either (Table 15). For blacktip, a decrease of the upper bound of K from $8x10^8$ to $20x10^6$ individuals slightly decreased the predictions, whereas decreasing it to $12x10^6$ individuals had a more accentuated effect, further decreasing the predictions (Table 16). In general, none of the conclusions derived from the baseline analyses changed by applying this set of sensitivity trials, except when decreasing the upper bound of K for blacktip to a considerably lower value, which would then indicate the need for some degree of rebuilding.

B.2. Dividing by two the CV of r

Dividing the CV for the intrinsic rate of increase, r, by two (scenarios run by Punt) for the large coastal complex resulted in the same level of stock depletion, reduced the estimate of stock abundance in 1998, but increased the estimates of MSC and RY_{1998}, making the projections in the decision analysis generally less pessimistic than those from the baseline analysis (Table 17). For sandbar, a similar pattern was observed when reducing the CV of r by 50%, and projections became a little less pessimistic (Table 17). For blacktip, the stock was projected to be a little more depleted, but still above MSC (Table 17). In general, the same level of discrepancy with respect to the results found by Punt in the baseline analyses persisted in these sensitivity trials. The conclusions regarding the status of the three groupings remained unaffected.

B.3. Decreasing the upper bound of K and the mean of r

A further sensitivity trial for the sandbar shark that reduced the mean value of r from 0.113 to 0.07 and K to $12x10^6$ individuals (one sensitivity trial run by Haist) was run. This resulted in lower expected values of K, r, N_{1998}/K, MSC, and RY_{1998}, but N_{1998} increased a little, with the ensuing projections becoming more pessimistic (Table 18), but not affecting significantly the conclusions on stock status.

C. Changes in the weighting schemes for the CPUE series, the form of the stock assessment model, and the method of numerical integration

Changing the weighting scheme by assuming that all CPUE data points from all series had equal variance (σ^2=1) or, in other words, assuming an equal weighting scenario (see Stock Assessment Models section above) yielded results similar to those of Punt's equal weighting scenario. Both forms of the SPM model—the Prager form and the discrete form—resulted in higher values of K and N_{1998}, and lower values of r, MSC, and RY_{1998} than found by Punt, but N_{1998}/K was similar (Table 19). The results and projections were less pessimistic than those found in the baseline scenario, indicating that MSC could almost be reached after 20 years—as opposed to 30 years in the baseline analysis—with a no-take policy.

For sandbar, the SPM models yielded results similar to those of Punt, with N_{1998} and stock depletion in 1998 being a little higher, and MSC and RY_{1998} somewhat lower (Table 20). The results were also similar to those found in the baseline analysis, with stock depletion in 1998 being less pronounced. Model projections varied very little (Table 20).

For blacktip, the Prager form of the SPM yielded results similar to those of Punt, with stock depletion in 1998, N_{1998}, MSC, and RY_{1998} being close (Table 21). Results with this equal weighting scenario were substantially more optimistic than those found in the baseline analysis with the Prager form and the importance function incorporating the variance expansion factor of two. As in Punt's review, the estimates of N_{1998}, N_{1998}/K, MSC, and RY_{1998} all increased considerably (Table 21). Results for blacktip were therefore sensitive to the weighting scheme used.

Further sensitivity trials were run utilizing the state-space SPM model described in the Stock Assessment Models section. Two configurations were tested, one in which one value of τ^2 (the observation error variance) was estimated for each series, and one in which a single value of τ^2 was estimated for all series combined. This model further differed from the discrete SPM model in that it considered process error (with variance σ^2), it assumed an inverse gamma distribution for both τ^2 and σ^2, and it used a different method for numerical integration (MCMC with the Gibbs sampler instead of the SIR algorithm). Despite these different formulations, results from these trials using Winbugs were generally similar to those found with the SPM/SIR algorithm and those found by Punt for the large coastal complex, sandbar, and blacktip (Tables 19-21). For sandbar, Winbugs results obtained using the first formulation were higher than those found by Punt or with the SPM/SIR models, but results from the second formulation were closer (Table 20). For blacktip, the main difference was that the Winbugs models predicted a much lower value of r, which resulted in a lower value of MSC, but the predictions of K, N_{1998}, and N_{1998}/K were similar (Table 21). Results for the three groupings were thus pretty insensitive to the combined effect of using a different method of numerical integration for the Bayesian models, slightly structurally different population dynamics models, and different prior distributions for the error terms.

D. Changes in the structural assumptions of the model

Changing the structure of the model by assuming that the fishery had started in 1969 instead of 1974 (one of the scenarios considered in Punt's review) affected little the output parameters and projections for the three groupings (Table 22). For the large coastal complex and sandbar, the results became a little more pessimistic, whereas for blacktip they barely changed. These results agree with Punt's findings and do not affect the conclusions from the baseline analyses.

E. Changes in the CPUE time series

E.1. Decreasing the upper bound for K and changing the CPUE series used

Haist ran a sensitivity trial for the large coastal complex using only those CPUE series that the large coastal complex and sandbar or blacktip had in common. Using these eight CPUE series (Shark Observer, SC LL, Virginia LL, pelagic logbook, Early Rec [MRFSS,HBOAT,TX1], Late Rec [MRFSS,HBOAT,TX2], NMFS LL NE, and NMFS LL SE) of the 17 available, removing the 1983 data point from the Early Rec series, while decreasing the upper bound for K to $20x10^6$ individuals (this latter change was shown earlier not to have an effect on results) resulted in no substantial change with respect to the findings of the baseline analysis (Table 23). The expected values of the estimates of N_{1998} and N_{1998}/K found by Haist in the baseline analysis decreased somewhat, whereas the MSC increased; in contrast, the estimates of N_{1998}, N_{1998}/K, and MSC all increased when using the Prager form SPM. The estimates of N_{1998}, N_{1998}/K, and MSC found by Haist and with the Prager form were very close.

For sandbar, removing the 1983 data point from the Early Rec series while decreasing the upper bound for K to $12x10^6$ individuals (this latter change was shown earlier not to have an effect on results) also resulted in no substantial change with respect to the findings of the baseline analysis (Table 23). The expected values of the estimates of N_{1998} and MSC found by Haist in the baseline analysis slightly decreased and N_{1998}/K increased, whereas when using the Prager form SPM the estimates of N_{1998} and N_{1998}/K increased and that of MSC decreased. In contrast to the results for the large coastal complex, the estimates of N_{1998}, N_{1998}/K, and MSC found by Haist and with the Prager form were substantially different, but still indicated stock depletion below MSC levels (Table 23).

For blacktip, removing the Gulf Reef logs series—the only series used for blacktip that was based on biomass—while decreasing the upper bound for K to $12x10^6$ individuals (this latter change was shown earlier to have a substantial effect on results) resulted in a considerably more pessimistic outlook than found in the baseline analysis (Table 23). The expected values of all quantities found by Haist in the baseline analysis decreased very substantially, with the estimates of N_{1998}/K and MSC decreasing by about one third and that of N_{1998} by over one half. Using the Prager form SPM also reduced all estimated quantities to various degrees. The quantities estimated by Haist and the Prager form SPM differed, but somewhat less than in the baseline analysis. This scenario indicated that the stock was below MSC levels. It can be concluded that inclusion of the Gulf Reef logs (biomass) series coupled with the assumption of a considerably higher upper bound for K (baseline scenario) results in a considerably more optimistic outlook than when that series is ignored and the upper bound for K is considerably lowered.

E.2. Removing the shorter CPUE series

Punt considered a set of scenarios in which only those CPUE series with 5 points or more were used to fit the model. For the large coastal complex, this resulted in 6 series being eliminated (Shark Observer, Jax, NC#, SC LL, NMFS LL NE, and NMFS LL SE). Fitting the 11 remaining series resulted in no substantial change with respect to the findings of the baseline analysis (Table 24). The expected value of N_{1998}/K increased a little in Punt's analysis, and the estimates of N_{1998}, N_{1998}/K, MSC, and RY_{1998} increased when using the Prager form SPM. The absolute discrepancy in the prediction of N_{1998}/K between Punt's analysis and the Prager form SPM persisted. For sandbar, five of the eight series were eliminated, leaving only the Virginia LL, and Early and Late Rec series in the analysis. This change had little effect on Punt's estimate of N_{1998}/K, which increased only from 0.34 to 0.35, and increased the predictions of N_{1998}, N_{1998}/K, and RY_{1998} with the Prager form SPM (Table 24). The predictions of r, N_{1998}/K, and RY_{1998} between Punt's analysis and the Prager form SPM were very close.

For blacktip, three of the seven series were eliminated, leaving the pelagic logbook, Early Rec, Late Rec, and Gulf Reef logs series in the analysis. This change decreased Punt's estimate of N_{1998}/K from 0.54 to 0.46, but increased that obtained with the Prager form SPM from 0.56 to 0.61, and also increased the estimates of N_{1998}, MSC, and RY_{1998} (Table 24). In contrast to the findings with the large coastal complex or sandbar, the difference in the prediction of N_{1998}/K between Punt's analysis and the Prager form SPM increased appreciably. For blacktip, Punt's results became more pessimistic and those from the Prager form SPM, more optimistic. It can be concluded that the combined effect of the three series eliminated (Shark Observer, NMFS LL NE, and NMFS LL SE) was to affect negatively the results, as will be further discussed in subsequent scenarios. However, the main conclusions from the baseline analyses for the three groupings were not affected by eliminating the shorter CPUE time series.

E.3. Removing the two MRFSS (Early Rec and Late Rec) series

Another set of scenarios considered by Punt consisted of eliminating the two MRFSS CPUE series (Early and Late Rec). For the large coastal complex, this modification resulted in little change with respect to the findings of the baseline analysis in Punt's review (Table 25). The expected value of N_{1998}/K in Punt's analysis decreased from 0.21 to 0.20, whereas the estimates of N_{1998}, N_{1998}/K, and RY_{1998} decreased a little further, and that of MSC slightly increased, when using the Prager form SPM. The difference in the prediction of N_{1998}/K between Punt's analysis and the Prager form SPM changed little. For sandbar, eliminating the two MRFSS series resulted in an increase from 0.34 to 0.39 in N_{1998}/K in Punt's analysis, whereas N_{1998}, N_{1998}/K, MSC, and RY_{1998} all decreased with the Prager form SPM (Table 25). As a result, the difference in the prediction of N_{1998}/K between Punt's analysis and the Prager form SPM doubled.

For blacktip, elimination of the two recreational series yielded substantially lower estimated quantities in both Punt's analysis and with the Prager form SPM. The expected value of N_{1998}/K decreased from 0.54 to 0.37 in Punt's analysis and from 0.56 to 0.36 with the Prager form SPM (Table 25). All quantities, except C_0, decreased with the Prager form SPM. The estimates of r and RY_{1998} were almost identical between the two models. This scenario indicated that stock depletion was below MSC levels, and that the two recreational series (due to the strong positive trend of the Early Rec series as will be discussed later) had a strong influence in positively affecting the outcome of the analysis for blacktip (Table 25).

E.4. Removing the Virginia Longline fishery-independent CPUE series

To address some of the concerns in the Industry Position Statement regarding the lack of standardization of the Virginia LL series with respect to environmental conditions, Punt also considered one set of scenarios in which this CPUE series was eliminated. For the large coastal complex, this resulted in a generally more pessimistic outlook, with a slight decrease in N_{1998}/K from 0.21 to 0.19 in Punt's review, and a slight decrease in N_{1998}, N_{1998}/K, and RY_{1998} , and an increase in MSC, with the Prager form SPM (Table 26). For sandbar, results became much more optimistic, with N_{1998}/K almost doubling in Punt's review, and N_{1998} more than doubling, N_{1998}/K increasing by over 75%, and MSC increasing by only about 20% increase with the Prager form SPM. Consequently, projections also became more optimistic, with no need for rebuilding (Table 26). The Virginia LL series thus had opposing effects on the results for the large coastal complex and sandbar, with a slight positive effect on the former, and a larger negative impact on the latter. No Virginia LL CPUE series was available for blacktip.

E.5. Splitting all commercial and recreational CPUE series in 1993

Another concern expressed in the Industry Position Statement was that the implementation of management measures in 1993 brought about changes in the fleet in subsequent years that were not accounted for in the commercial CPUE series. To evaluate this potential effect, Punt split all commercial and recreational series that included 1993, in a pre-1993 series (up to 1992) and a post-1993 series (1993 onwards). For the large coastal complex, this meant that the LPS (recreational), charter boat (recreational), and pelagic logbook (commercial) series were split in two. The results of this change were more optimistic, with an increase in N_{1998}/K from 0.21 to 0.28 in Punt's review and from 0.14 to 0.27 with the Prager form SPM (Table 27). N_{1998} and RY_{1998} about doubled, but the MSC increased only a little with the Prager form SPM (Table 27).

Projections thus became more optimistic, with rebuilding to MSC levels taking 20 years with a no-take policy (Table 27). No CPUE series spanned 1993 for sandbar. For blacktip, the only change consisted of eliminating the first data point in the pelagic logbook series (corresponding to 1992). This change had no effect at all on output parameters or predictions in Punt's review and almost no effect with the Prager form SPM (Table 27).

E.6. Ignoring all data points past 1992 in commercial and recreational CPUE series

Another related scenario investigated by Punt was to eliminate any data points in commercial or recreational CPUE series past 1992. For the large coastal complex, this resulted in the elimination of the Shark Observer and Late Rec series and the truncation of the LPS, charter boat, and pelagic logbook series in 1992. Results also became more optimistic in this scenario, with an increase in N_{1998}/K from 0.21 to 0.31 and of RY_{1998} from 106 to 163 in Punt's review. In the Prager form SPM, N_{1998} almost doubled, N_{1998}/K increased from 0.14 to 0.26, RY_{1998} increased from 70 to 123, and MSC increased only slightly (Table 28). Projections thus became more optimistic, with rebuilding to MSC levels taking 20 years with a no-take policy (Table 28). For sandbar, this scenario resulted in the elimination of the pelagic logbook, Late Rec, and Shark Observer series. The outlook became more pessimistic, with a decrease in N_{1998}/K from 0.34 to 0.27 and of RY_{1998} from 68 to 48 in Punt's review. In the Prager form SPM, N_{1998} was significantly reduced, N_{1998}/K decreased from 0.28 to 0.16, MSC decreased from 85 to 54, and RY_{1998} from 61 to 27 (Table 28). Projections thus became more pessimistic, with rebuilding to MSC levels taking 30 years with a no-take policy (Table 28).

For blacktip, this scenario resulted in the elimination of the Gulf Reef logs, Late Rec, and Shark Observer series and the truncation of the pelagic logbook series past 1992 (so this series was also eliminated because it then consisted only of the 1992 data point). The results of fitting the model to essentially three series only (Early Rec, NMFS LL NE, and NMFS LL SE) were much more optimistic, with an increase in N_{1998}/K from 0.54 to 0.79 and of RY_{1998} from 173 to 252 in Punt's review. Results from the Prager form SPM followed a very similar trend, with N_{1998} increasing appreciably, N_{1998}/K increasing from 0.56 to 0.79, MSC, from 348 to 579, and RY_{1998}, from 181 to 253 (Table 28). Projections thus became even more optimistic than in the baseline analysis.

E.7. Using fishery-independent CPUE series only

A final scenario considered by Punt to address the effect of potential management measures introduced in 1993 was to use fishery-independent CPUE series only. For the large coastal complex, this meant using only the SC LL, Virginia LL, NMFS LL NE, and NMFS LL SE series, of which only the Virginia LL span more than four years (1974-1997). Results became only a little more optimistic in this scenario, with slight increases in N_{1998}/K from 0.21 to 0.23 and of RY_{1998} from 106 to 130 in Punt's review, and small increases in N_{1998} from 1307 to 1508, N_{1998}/K from 0.14 to 0.16, MSC from 160 to 177, and RY_{1998} from 70 to 88 with the Prager form SPM (Table 29). Projections also became a little more optimistic as a result. For sandbar, the same four series as for the large coastal complex were used. In contrast to the findings for the large coastal complex, results became a little more pessimistic, with small decreases in N_{1998}/K from 0.34 to 0.31 and of RY_{1998} from 68 to 52 in Punt's review, and larger decreases in N_{1998} from 976 to 551, N_{1998}/K from 0.28 to 0.18, MSC from 85 to 55, and RY_{1998} from 61 to 30 with the Prager form SPM (Table 29). Projections consequently became more pessimistic.

For blacktip, only two short fishery-independent CPUE series were available (NMFS LL NE and NMFS LL SSE, of 4- and 3-year duration, respectively). Results followed the same trend as those for the large coastal complex, becoming more optimistic. N_{1998}/K increased from 0.54 to 0.70 and RY_{1998} from 173 to 220 in Punt's review, and N_{1998} increased from 6942 to 7409, N_{1998}/K from 0.56 to 0.61, and RY_{1998} from 181 to 197, whereas MSC slightly decreased from 348 to 338, with the Prager form SPM (Table 29). Accordingly, projections became a little more optimistic.

E.8. Using only specific CPUE series based on ad-hoc ranking by one of the reviewers

In his review, Trumble ranked the CPUE series according to what he considered: 1, "best data"; 2, "apparent data problems that need more justification before using, but may supply supporting information"; and 3, "apparent serious data flaws that disqualify the data from quantitative use, unless justified by additional information, but may supply supporting information". Based on these considerations, a set of sensitivity trials was run incorporating only Trumble's "best" CPUE series (rank=1). For the large coastal complex, these included the Shark Observer, SC LL, Virginia LL, charter boat, and NMFS LL SE series. This change in the CPUE series used in fitting the model yielded much more optimistic results, with an increase in N_{1998} from 1307 to 3192, N_{1998}/K from 0.14 to 0.50, MSC from 160 to 397, and RY_{1998} from 70 to 364 with the Prager form SPM, with the subsequent projections indicating no need to rebuild (Table 30). Note, however, that the expected value of the posterior for r was very high (r=0.33) for the large coastal shark complex. In contrast to the results from the baseline analyses (Figs. 1 and 2), the marginal posterior distributions for N_{1998} and N_{1998}/K did not show strong central tendencies (Fig. 7). The marginal posterior distribution for K was also much less informative than in the baseline analyses (Fig. 7), indicating that there was little information in the data about K in this scenario. For sandbar, the "best" series included the same as those for the large coastal complex, except for the charter boat series, which was not available for sandbar. In contrast to the findings for the large coastal complex, results for sandbar exhibited little variation (Table 30).

For blacktip, using only the "best" series meant eliminating all but two of the seven available series. The two remaining series (Shark Observer and NMFS LL SE) span only four (1994-1997) and three (1995-1997) years, respectively. As for the large coastal complex, introducing this change resulted in considerably more optimistic results than in the baseline analysis (Table 30).

Another set of sensitivity trials was considered which incorporated the "best" CPUE series (1) and those ranked as "2". For the large coastal complex, in addition to the five series ranked as "1", these included the Crooke LL, NC#, LPS, Early Rec, and Late Rec series. Results became more optimistic than those in the baseline analysis, with an increase in N_{1998} from 1307 to 2218, N_{1998}/K from 0.14 to 0.23, MSC from 160 to 172, and RY_{1998} from 70 to 115 with the Prager form SPM, with the subsequent projections becoming a little more optimistic (Table 31). For sandbar, the additional series ranked as "2" included the two Rec series (Early and Late). As with the scenario in which only the series ranked as "1" were considered, results for sandbar exhibited little variation, becoming just slightly more pessimistic (Table 31). For blacktip, the additional series ranked as "2" also included the two Rec series (Early and Late). As with the scenario in which only the series ranked as "1" were considered, results for blacktip varied considerably, becoming even more optimistic than in the baseline analysis (Table 31).

E.9. Using only specific CPUE series for blacktip

As discussed earlier in the Stock Assessment Models section, the CPUE series for blacktip show contradictory trends. To evaluate the effect that the series indicating opposing trends can have on results, two additional trials were run: one using only the longer series that supports a strong increasing trend in abundance (Early Rec series), and another with the six remaining series. Using the Early Rec series only resulted in more optimistic results, with an increase in N_{1998} from 6942 to 10777, N_{1998}/K from 0.56 to 0.79, MSC from 348 to 592, and RY_{1998} from 181 to 255 with the Prager form SPM (Table 32). Using all the other series, except the Early Rec series, resulted in more pessimistic results, with a decrease in N_{1998} to 1886, N_{1998}/K to 0.25, MSC to 149, and RY_{1998} to 88 (Table 32).

Conclusions

The results were not very sensitive to most of the changes introduced, but there were notable exceptions. For the large coastal complex, the only change that significantly affected results and would thus modify the conclusions from the 1998 SEW report was the use of Trumble's "best" CPUE series. Those five series, however, include a series that was criticized by other reviewers and in the Industry Position Statement (Virginia LL), one commercial and one recreational series that were not standardized to account for the effect of fishing operational variables, and two very short fishery-independent series. It is thus arguable that the series ranked as "1" by this reviewer are actually the best. Fitting this model resulted in a very high, expected posterior mean value of r, especially for the aggregate of species that make up the large coastal shark complex. The marginal posterior distributions of several parameters of interest, particularly K, also indicated that there was little information in the data the model was fitted to. The results from this model fit should thus be interpreted cautiously.

For sandbar, the only modification that substantially affected results and conclusions was the elimination of the Virginia LL CPUE series, which essentially ratified that this series negatively affected results due to its decreasing trend over time. Without it, projections indicate that the status of sandbar is better than in the baseline analyses and there would be no need for rebuilding.

The analyses for blacktip were sensitive to a number of factors. The most important one is probably the importance function used, which can effectively change the conclusions from the 1998 SEW report, indicating that the resource would be a little above MSC. The form of the surplus production model (Prager vs. discrete) also had an effect on results, but not enough to affect conclusions. A substantial change in one of the priors (decreasing the upper bound of K) also changed the outcome and the ensuing conclusions, indicating that the resource would be below MSC. As also concluded by Punt, the method used to weight the CPUE indices had a very large effect. The equal weighting scenario indicated that the resource was well above MSC. This result was ratified by the use of a separate form of the stock assessment model (state space model), different weighting scheme, and use of a different method of numerical integration for the Bayesian analysis (MCMC vs. SIR). The sensitivity of the results for blacktip to computational issues (model, importance function, method to weight CPUEs) is most likely due, at least in part, to the CPUE series used, which showed contradictory trends. The Gulf Reef logs and the Early Rec series, with their strong positive trend, directly influenced the results positively. Elimination of either of these series would affect conclusions by predicting that the resource would be well below MSC. Particular emphasis should thus be placed on selecting the CPUE series for model fitting for blacktip shark.

The CPUE time series to be used in stock assessments should be chosen based on scientific criteria, not on subjective or arbitrary judgment. When multiple time series of abundance are available, it is also customary to assign relative weights to the various series. However, the assignment of weights to CPUE time series in stock assessments is still a controversial issue (McAllister et al. 2001). When the time series suggest contradictory trends, as was the case for blacktip, it has been suggested that the stock assessment model not be fitted to all series combined (Richards 1991), but rather to the two sets of series indicating opposing trends (McAllister et al. 2001), as was done in the present document. However, the issue of the relative credibility of the opposing sets of data persists. The discrepancy should then be formally addressed, for example by using statistical methods as described by Schnute and Hilborn (1993) and McAllister et al. (1999).

REFERENCES

Berger, J. O. 1985. Statistical decision theory and Bayesian analysis. 2nd ed. Springer-Verlag, New York.

Cortés, E. In press. Incorporating uncertainty into demographic modeling: application to shark populations and their conservation. Cons. Biol.

Gilks, W. R., S. Richardson, and D. J. Spiegelhalter. 1996. Markov chain Monte Carlo in practice. Chapman and Hall, London, U.K.
Hilborn, R. and M. Mangel. 1997. The ecological detective. Princeton University Press, Princeton, New Jersey. 315 pp.
McAllister, M. K. and E. A. Babcock. In preparation. Bayesian surplus production model with the Sampling Importance Resampling algorithm: a User's Guide.
McAllister, M. K. and G. P. Kirkwood. 1998. Bayesian stock assessment: a review and example application using the logistic model. ICES J. Mar. Sci. 55:1031-1060.
McAllister, M. K., E. A. Babcock, and E. K. Pikitch. 2001. Evaluating the relative merits of alternative methods to weight different time series of abundance indices in stock assessment. Col. Vol. Sci. Pap. ICCAT 52:1094-1115.
McAllister, M. K., E. A. Babcock, E. K. Pikitch, and R. Bonfil. In preparation. Importance sampling issues in the 1998 large coastal shark assessment.
McAllister, M. K., E. K. Pikitch, and E. A. Babcock. 2001. Using demographic methods to construct Bayesian priors for the intrinsic rate of increase in the Schaefer model and implications for stock rebuilding. Can. J. Fish. Aquat. Sci. 58:1871-1890.
McAllister, M. K., P. J. Starr, V. Restrepo, and G.P. Kirkwood. 1999. Formulating quantitative methods to evaluate fishery management systems: what fishery processes should be modeled and what trade-offs should be made? ICES J. Mar. Sci. 56:900-916.
Meyer, R. and R. B. Millar. 1999a. BUGS in Bayesian stock assessments. Can. J. Fish. Aquat. Sci. 56:1078-1086.
Meyer, R. and R. B. Millar. 1999b. Bayesian stock assessment using a state-space implementation of the delay difference model. Can. J. Fish. Aquat. Sci. 56:37-52.
Millar, R. B. and R. Meyer. 1999. Nonlinear state-space modeling of fisheries biomass dynamics using Metropolis-Hastings within Gibbs sampling. Tech. Rep. STAT9901. Department of Statistics, University of Auckland, Auckland, New Zealand.
NMFS (National Marine Fisheries Service). 1993. Fishery Management Plan for Sharks of the Atlantic Ocean. NOAA/NMFS, U.S. Dept. of Commerce.
NMFS (National Marine Fisheries Service). 1998. 1998 Report of the Shark Evaluation Workshop. 109pp.
Prager, M. H. 1994. A suite of extensions to a nonequilibrium surplus production model. Fish. Bull. 92:374-389.
Punt, A. E. 1988. Model selection for the dynamics of southern African hake resources. MSc thesis, Department of Applied Mathematics, University of Capetown. 395 pp.
Richards, L. J. 1991. Use of contradictory data sources in stock assessments. Fish. Res. 11:225238.
SB-IV-10. Cortés, E. and G. Scott. Rates of increase per generation for large coastal species of sharks from the U.S. Atlantic Ocean and Gulf of Mexico.
SB-IV-31. NMFS. 1996 Report of the Shark Evaluation Workshop.
Schnute, J. T. and R. Hilborn. 1993. Analysis of contradictory data sources in fish stock assessments. Can. J. Fish. Aquat. Sci. 52:2063-2077.
Smith, S. E., D. W. Au, and C. Show. 1998. Intrinsic rebound potentials of 26 species of Pacific sharks. Mar. Freshwater Res. 49:663-678.

Spiegelhalter D., A. Thomas, and N. Best. 2000. WinBUGS version 1.3. User Manual. April 2000.

Walters, C. J. and D. Ludwig. 1994. Calculation of Bayes posterior probability distributions for key population parameters: a simplified approach. Can. J. Fish. Aquat. Sci. 51:713-722.

Table 1. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex (baseline scenario)** with the Prager and discrete forms **using the original importance function** are compared to those reported in the 1998 SEW and those from two reviewers. Predictions of alternative harvesting policies from the two forms of the model are also included.

	SEW 1998		Punt's review		Haist's review		Prager form		Discrete form	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
K	9535	0.17	9690	0.23	9565	0.17	9458	0.18	9541	0.18
r	0.07	0.51	0.08	0.67	0.08	0.67	0.07	0.52	0.07	0.51
C_0	284	0.39	299	0.48	305	0.43	289	0.39	288	0.39
N_{1998}	1385	0.25	2028	0.37	1992	0.32	1314	0.27	1229	0.29
N_{1998}/K	0.15	0.24	0.21	0.31	0.21	0.28	0.14	0.25	0.13	0.27
MSC	149	0.38	168	0.43	162	0.43	156	0.37	155	0.38
RY_{1998}	---	---	106	0.52	---	---	69	0.42	78	0.40

		Prager form				Discrete form			
Horizon	**TAC[1]**	**N_{fin}/K[2]**	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**	**N_{fin}/K[2]**	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year	0	0.22	0.45	0.45	1	0.23	0.46	0.40	1
(2008)	10	0.17	0.35	0.70	0.66	0.17	0.35	0.70	0.79
	20	0.11	0.23	0.90	0.19	0.11	0.23	0.91	0.24
	30	0.06	0.11	0.98	0.02	0.06	0.11	0.98	0.03
	40	0.02	0.04	0.99	0	0.02	0.05	1	0
	50	0.01	0.02	1	0	0.01	0.03	1	0
20-year	0	0.37	0.73	0.14	1	0.37	0.74	0.13	1
(2018)	10	0.25	0.49	0.48	0.74	0.24	0.49	0.49	0.79
	20	0.10	0.20	0.83	0.22	0.10	0.20	0.84	0.24
	30	0.02	0.04	0.97	0.03	0.03	0.05	0.97	0.03
	40	0.01	0.01	1	0	0.01	0.02	1	0
	50	0.01	0.02	1	0	0.01	0.02	1	0
30-year	0	0.51	1.02	0.04	1	0.51	1.03	0.04	1
(2028)	10	0.33	0.66	0.38	0.77	0.32	0.65	0.38	0.79
	20	0.11	0.22	0.80	0.23	0.11	0.22	0.80	0.24
	30	0.02	0.03	0.97	0.03	0.03	0.05	0.97	0.03
	40	0.01	0.01	1	0	0.01	0.02	1	0
	50	0.01	0.02	1	0	0.01	0.02	1	0

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch

[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 2. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex (baseline scenario)** with the Prager and discrete forms **using a variance expansion factor of 2 for the importance function** are compared to those reported in the 1998 SEW and those from two reviewers. Predictions of alternative harvesting policies from the two forms of the model are also included.

	SEW 1998		Punt's review		Haist's review		Prager form		Discrete form	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
K	9535	0.17	9690	0.23	9565	0.17	9462	0.22	9501	0.21
r	0.07	0.51	0.08	0.67	0.08	0.67	0.08	0.68	0.07	0.68
C_0	284	0.39	299	0.48	305	0.43	300	0.42	298	0.42
N_{1998}	1385	0.25	2028	0.37	1992	0.32	1307	0.28	1216	0.30
N_{1998}/K	0.15	0.24	0.21	0.31	0.21	0.28	0.14	0.26	0.13	0.28
MSC	149	0.38	168	0.43	162	0.43	160	0.43	160	0.44
RY_{1998}	---	---	106	0.52	---	---	70	0.48	80	0.46

		Prager form				Discrete form			
Horizon	**TAC**[1]	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$
10-year	0	0.24	0.47	0.43	1	0.24	0.48	0.43	1
(2008)	10	0.18	0.37	0.68	0.66	0.18	0.36	0.69	0.77
	20	0.12	0.25	0.87	0.22	0.12	0.24	0.88	0.27
	30	0.06	0.12	0.96	0.05	0.06	0.12	0.96	0.05
	40	0.02	0.04	0.99	0.01	0.03	0.05	0.99	0.01
	50	0.01	0.02	1	0	0.01	0.03	1	0
20-year	0	0.39	0.77	0.15	1	0.39	0.78	0.14	1
(2018)	10	0.27	0.54	0.48	0.73	0.26	0.53	0.50	0.77
	20	0.12	0.25	0.79	0.26	0.12	0.24	0.81	0.27
	30	0.03	0.06	0.95	0.05	0.04	0.08	0.95	0.05
	40	0.01	0.02	0.99	0.01	0.01	0.03	0.99	0.01
	50	0.01	0.02	1	0	0.01	0.02	1	0
30-year	0	0.52	1.05	0.05	1	0.53	1.05	0.05	1
(2028)	10	0.35	0.70	0.38	0.75	0.34	0.69	0.40	0.77
	20	0.14	0.29	0.76	0.27	0.14	0.28	0.77	0.27
	30	0.03	0.07	0.95	0.06	0.04	0.08	0.95	0.05
	40	0.01	0.02	0.99	0.01	0.02	0.03	0.99	0.01
	50	0.01	0.02	1	0	0.01	0.02	1	0

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 3. Estimated expected values (EV) of the means and coefficients of variation (CV of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **sandbar shark (baseline scenario)** with the Prager and discrete forms **using the original importance function** are compared to those reported in the 1998 SEW and those from two reviewers. Predictions of alternative harvesting policies from the two forms of the model are also included.

	SEW 1998		Punt's review		Haist's review		Prager form		Discrete form	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
K	3265	0.32	3723	0.49	4031	0.49	3166	0.32	3227	0.34
r	0.10	0.70	0.11	0.71	0.11	0.69	0.10	0.74	0.10	0.74
C_0	170	0.54	190	0.62	226	0.61	166	0.54	165	0.56
N_{1998}	924	0.45	1302	1.08	1347	0.82	823	0.48	836	0.53
N_{1998}/K	0.29	0.39	0.34	0.48	0.34	0.45	0.27	0.41	0.27	0.45
MSC	71	0.55	88	0.67	96	0.56	71	0.62	70	0.55
RY_{1998}	---	---	68	0.54	---	---	53	0.75	52	0.59

		Prager form				Discrete form			
Horizon	**TAC**[1]	**N_{fin}/K**[2]	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**	**N_{fin}/K**[2]	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year	0	0.45	0.90	0.09	1	0.47	0.95	0.08	1
(2008)	10	0.42	0.85	0.13	0.96	0.43	0.87	0.13	0.98
	20	0.39	0.77	0.21	0.82	0.39	0.79	0.19	0.86
	30	0.35	0.69	0.27	0.64	0.35	0.71	0.27	0.69
	40	0.31	0.62	0.35	0.49	0.31	0.62	0.36	0.52
	50	0.27	0.54	0.44	0.37	0.27	0.55	0.44	0.39
20-year	0	0.62	1.24	0.03	1	0.64	1.27	0.02	1
(2018)	10	0.56	1.12	0.08	0.97	0.57	1.14	0.08	0.98
	20	0.49	0.98	0.17	0.84	0.50	1	0.15	0.86
	30	0.42	0.83	0.27	0.66	0.42	0.85	0.27	0.69
	40	0.34	0.69	0.39	0.50	0.35	0.69	0.39	0.52
	50	0.28	0.55	0.53	0.37	0.28	0.56	0.51	0.39
30-year	0	0.73	1.46	0.01	1	0.75	1.49	0.01	1
(2028)	10	0.66	1.31	0.06	0.98	0.67	1.33	0.05	0.98
	20	0.56	1.12	0.15	0.84	0.57	1.15	0.14	0.86
	30	0.46	0.93	0.28	0.66	0.47	0.94	0.27	0.69
	40	0.37	0.73	0.42	0.50	0.37	0.75	0.41	0.52
	50	0.28	0.56	0.56	0.37	0.29	0.57	0.55	0.39

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch

[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 4. Estimated expected values (EV) of the means and coefficients of variation (CV of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **sandbar shark (baseline scenario)** with the Prager and discrete forms **using a variance expansion factor of 2 for the importance function** are compared to those reported in the 1998 SEW and those from two reviewers. Predictions of alternative harvesting policies from the two forms of the model are also included.

	SEW 1998		Punt's review		Haist's review		Prager form		Discrete form	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
K	3265	0.32	3723	0.49	4031	0.49	3653	0.48	3679	0.54
r	0.10	0.70	0.11	0.71	0.11	0.69	0.11	0.96	0.12	1.00
C_0	170	0.54	190	0.62	226	0.61	207	0.71	200	0.71
N_{1998}	924	0.45	1302	1.08	1347	0.82	976	0.70	1031	1.20
N_{1998}/K	0.29	0.39	0.34	0.48	0.34	0.45	0.28	0.50	0.28	0.54
MSC	71	0.55	88	0.67	96	0.56	85	0.68	85	0.68
RY_{1998}	---	---	68	0.54	---	---	61	0.69	60	0.63

		Prager form				Discrete form			
Horizon	**TAC[1]**	**N_{fin}/K[2]**	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**	**N_{fin}/K[2]**	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year	0	0.48	0.95	0.09	1	0.49	0.98	0.09	1
(2008)	10	0.45	0.90	0.13	0.96	0.46	0.91	0.13	0.98
	20	0.42	0.84	0.18	0.86	0.42	0.84	0.19	0.89
	30	0.38	0.76	0.25	0.72	0.38	0.77	0.25	0.74
	40	0.35	0.69	0.32	0.59	0.35	0.69	0.33	0.59
	50	0.31	0.62	0.40	0.47	0.31	0.62	0.40	0.46
20-year	0	0.64	1.28	0.03	1	0.65	1.29	0.03	1
(2018)	10	0.59	1.18	0.07	0.97	0.59	1.18	0.07	0.98
	20	0.53	1.05	0.14	0.87	0.52	1.05	0.14	0.89
	30	0.46	0.92	0.24	0.74	0.46	0.92	0.24	0.74
	40	0.40	0.79	0.33	0.60	0.39	0.78	0.34	0.59
	50	0.33	0.66	0.44	0.48	0.33	0.66	0.45	0.46
30-year	0	0.75	1.50	0.01	1	0.75	1.51	0.01	1
(2028)	10	0.68	1.36	0.05	0.98	0.68	1.36	0.05	0.98
	20	0.60	1.20	0.12	0.87	0.60	1.20	0.13	0.89
	30	0.51	1.03	0.23	0.74	0.51	1.02	0.24	0.74
	40	0.43	0.86	0.35	0.60	0.42	0.84	0.36	0.59
	50	0.35	0.70	0.46	0.48	0.34	0.69	0.48	0.46

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 5. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **blacktip shark (baseline scenario)** with the Prager and discrete forms **using the original importance function** are compared to those reported in the 1998 SEW and those from two reviewers. Predictions of alternative harvesting policies from the two forms of the model are also included.

	SEW 1998		**Punt's review**		**Haist's review**		**Prager form**		**Discrete form**	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
K	5527	0.31	9528	0.49	8411	0.53	5438	0.29	5423	0.29
r	0.12	0.70	0.15	0.82	0.14	0.80	0.12	0.70	0.12	0.70
C_0	229	0.37	268	0.42	246	0.41	222	0.36	223	0.36
N_{1998}	1383	0.57	6083	0.83	4222	0.84	1348	0.56	1290	0.60
N_{1998}/K	0.25	0.43	0.54	0.51	0.47	0.56	0.25	0.47	0.24	0.52
MSC	137	0.43	337	1.00	226	0.63	140	0.45	142	0.46
RY_{1998}	---	---	173	0.50	---	---	95	0.59	102	0.55

		Prager form				**Discrete form**			
Horizon	**TAC[1]**	**N_{fin}/K[2]**	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**	**N_{fin}/K[2]**	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year	0	0.45	0.89	0.08	1	0.47	0.95	0.07	1
(2008)	10	0.40	0.80	0.16	0.95	0.42	0.83	0.15	0.98
	20	0.34	0.68	0.27	0.72	0.35	0.71	0.27	0.77
	30	0.28	0.56	0.41	0.47	0.29	0.58	0.41	0.52
	40	0.22	0.44	0.55	0.28	0.23	0.45	0.55	0.32
	50	0.17	0.34	0.66	0.16	0.17	0.35	0.66	0.18
20-year	0	0.64	1.29	0.02	1	0.67	1.33	0.02	1
(2018)	10	0.56	1.12	0.08	0.97	0.57	1.14	0.08	0.98
	20	0.45	0.89	0.23	0.75	0.46	0.92	0.23	0.77
	30	0.32	0.64	0.42	0.49	0.34	0.68	0.41	0.52
	40	0.22	0.43	0.61	0.29	0.23	0.46	0.59	0.32
	50	0.14	0.28	0.75	0.16	0.15	0.3	0.74	0.18
30-year	0	0.77	1.54	0.01	1	0.78	1.56	0.01	1
(2028)	10	0.66	1.33	0.05	0.97	0.67	1.35	0.06	0.98
	20	0.52	1.04	0.22	0.76	0.53	1.06	0.22	0.77
	30	0.36	0.71	0.43	0.50	0.38	0.75	0.42	0.52
	40	0.22	0.44	0.65	0.29	0.24	0.49	0.62	0.32
	50	0.14	0.27	0.81	0.16	0.15	0.29	0.80	0.18

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 6. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **blacktip shark (baseline scenario)** with the Prager and discrete forms **using a variance expansion factor of 2 for the importance function** are compared to those reported in the 1998 SEW and those from two reviewers. Predictions of alternative harvesting policies from the two forms of the model are also included.

	SEW 1998		**Punt's review**		**Haist's review**		**Prager form**		**Discrete form**	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
K	5527	0.31	9528	0.49	8411	0.53	10463	0.55	19488	0.76
r	0.12	0.70	0.15	0.82	0.14	0.80	0.15	0.89	0.13	0.86
C_0	229	0.37	268	0.42	246	0.41	272	0.40	278	0.41
N_{1998}	1383	0.57	6083	0.83	4222	0.84	6942	0.83	15939	0.93
N_{1998}/K	0.25	0.43	0.54	0.51	0.47	0.56	0.56	0.50	0.67	0.42
MSC	137	0.43	337	1.00	226	0.63	348	0.96	547	0.99
RY_{1998}	---	---	173	0.50	---	---	181	0.49	277	0.41

		Prager form				**Discrete form**			
Horizon	**TAC**[1]	**N_{fin}/K**[2]	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**	**N_{fin}/K**[2]	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year	0	0.71	1.43	0.04	1	0.79	1.59	0.02	0.99
(2008)	10	0.69	1.38	0.07	0.97	0.77	1.54	0.05	0.98
	20	0.66	1.32	0.11	0.89	0.75	1.50	0.08	0.92
	30	0.63	1.25	0.16	0.80	0.72	1.45	0.12	0.84
	40	0.59	1.19	0.21	0.71	0.70	1.40	0.15	0.78
	50	0.56	1.13	0.25	0.62	0.68	1.35	0.18	0.71
20-year	0	0.82	1.64	0.01	1	0.87	1.74	0.01	0.99
(2018)	10	0.78	1.56	0.04	0.98	0.84	1.67	0.02	0.98
	20	0.73	1.45	0.09	0.90	0.80	1.59	0.07	0.92
	30	0.67	1.34	0.16	0.81	0.75	1.51	0.12	0.84
	40	0.61	1.23	0.23	0.71	0.71	1.43	0.16	0.78
	50	0.57	1.14	0.28	0.63	0.68	1.36	0.19	0.71
30-year	0	0.88	1.77	0	1	0.92	1.83	0	0.99
(2028)	10	0.83	1.66	0.03	0.98	0.88	1.75	0.02	0.98
	20	0.77	1.53	0.09	0.91	0.83	1.65	0.06	0.92
	30	0.69	1.39	0.16	0.81	0.77	1.54	0.12	0.84
	40	0.63	1.25	0.24	0.71	0.73	1.45	0.17	0.78
	50	0.57	1.15	0.29	0.63	0.69	1.37	0.20	0.71

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 7. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex (alternative catch scenario)** with the Prager and discrete forms **using the original importance function** are compared to those reported in the 1998 SEW and those from two reviewers. Predictions of alternative harvesting policies from the two forms of the model are also included.

	SEW 1998		Prager form		Discrete form	
Parameter	**EV**	**EV**	**EV**	**CV**	**EV**	**CV**
K	11754	0.16	11804	0.16	11890	0.16
r	0.05	0.50	0.05	0.50	0.05	0.50
C_0	327	0.42	347	0.40	344	0.41
N_{1998}	2081	0.22	2009	0.23	1923	0.24
N_{1998}/K	0.18	0.23	0.17	0.24	0.16	0.25
MSC	143	0.40	145	0.40	144	0.40
RY_{1998}	---	---	78	0.45	83	0.43

		Prager form				Discrete form			
Horizon	**TAC**[1]	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$
10-year	0	0.24	0.48	0.32	1	0.25	0.49	0.29	1
(2008)	10	0.20	0.41	0.54	0.73	0.20	0.41	0.54	0.85
	20	0.16	0.32	0.76	0.29	0.16	0.32	0.76	0.35
	30	0.12	0.24	0.89	0.07	0.12	0.23	0.91	0.08
	40	0.08	0.15	0.97	0.01	0.07	0.15	0.97	0.01
	50	0.04	0.08	0.99	0	0.04	0.08	0.99	0
20-year	0	0.35	0.69	0.10	1	0.35	0.70	0.08	1
(2018)	10	0.26	0.52	0.37	0.80	0.26	0.52	0.37	0.85
	20	0.16	0.32	0.71	0.32	0.16	0.32	0.73	0.35
	30	0.07	0.13	0.91	0.08	0.07	0.13	0.92	0.08
	40	0.02	0.03	0.98	0.01	0.02	0.05	0.98	0.01
	50	0.01	0.01	1	0	0.01	0.02	1	0
30-year	0	0.46	0.92	0.04	1	0.46	0.93	0.03	1
(2028)	10	0.33	0.65	0.29	0.82	0.32	0.64	0.28	0.85
	20	0.16	0.33	0.69	0.33	0.16	0.32	0.70	0.35
	30	0.05	0.10	0.91	0.08	0.05	0.10	0.92	0.08
	40	0.01	0.02	0.98	0.01	0.02	0.03	0.98	0.01
	50	0.01	0.01	1	0	0.01	0.02	1	0

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch

[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 8. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex (alternative catch scenario)** with the Prager and discrete forms **using a variance expansion factor of 2 for the importance function** are compared to those reported in the 1998 SEW and those from two reviewers. Predictions of alternative harvesting policies from the two forms of the model are also included.

	SEW 1998		Prager form		Discrete form	
Parameter	**EV**	**EV**	**EV**	**CV**	**EV**	**CV**
K	11754	0.16	11833	0.19	11915	0.19
r	0.05	0.50	0.05	0.57	0.05	0.57
C_0	327	0.42	358	0.42	355	0.43
N_{1998}	2081	0.22	2003	0.24	1918	0.25
N_{1998}/K	0.18	0.23	0.17	0.25	0.16	0.27
MSC	143	0.40	149	0.43	147	0.43
RY_{1998}	---	---	80	0.48	85	0.46

		Prager form				Discrete form			
Horizon	**TAC**[1]	**N_{fin}/K**[2]	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**	**N_{fin}/K**[2]	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year	0	0.25	0.49	0.31	1	0.25	0.50	0.29	1
(2008)	10	0.21	0.42	0.53	0.75	0.21	0.42	0.53	0.83
	20	0.17	0.33	0.75	0.31	0.16	0.33	0.75	0.35
	30	0.12	0.25	0.89	0.09	0.12	0.24	0.89	0.10
	40	0.08	0.16	0.95	0.02	0.08	0.15	0.95	0.02
	50	0.04	0.08	0.98	0	0.04	0.08	0.98	0
20-year	0	0.36	0.72	0.10	1	0.36	0.72	0.11	1
(2018)	10	0.27	0.54	0.36	0.81	0.27	0.53	0.38	0.83
	20	0.17	0.34	0.70	0.35	0.17	0.33	0.71	0.35
	30	0.07	0.15	0.89	0.10	0.08	0.15	0.90	0.10
	40	0.02	0.04	0.97	0.02	0.03	0.06	0.97	0.02
	50	0.01	0.02	0.99	0	0.01	0.03	0.99	0
30-year	0	0.47	0.95	0.04	1	0.47	0.94	0.04	1
(2028)	10	0.34	0.68	0.28	0.82	0.33	0.66	0.30	0.83
	20	0.18	0.36	0.67	0.36	0.17	0.35	0.68	0.35
	30	0.06	0.12	0.89	0.11	0.06	0.13	0.90	0.10
	40	0.02	0.03	0.97	0.02	0.02	0.05	0.97	0.02
	50	0.01	0.02	0.99	0	0.01	0.03	0.99	0

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 9. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **sandbar shark (alternative catch scenario)** with the Prager and discrete forms **using the original importance function** are compared to those reported in the 1998 SEW. Predictions of alternative harvesting policies from the two forms of the model are also included.

	SEW 1998		**Prager form**		**Discrete form**	
Parameter	**EV**	**EV**	**EV**	**CV**	**EV**	**CV**
K	2870	0.42	3591	0.30	3434	0.42
r	0.21	0.79	0.15	0.70	0.17	0.85
C_0	126	0.56	199	0.39	184	0.53
N_{1998}	941	0.47	796	0.42	887	0.48
N_{1998}/K	0.35	0.37	0.24	0.43	0.29	0.45
MSC	109	0.41	114	0.38	109	0.48
RY_{1998}	---	---	79	0.51	85	0.59

		Prager form				**Discrete form**			
Horizon	**TAC**[1]	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$
10-year	0	0.49	0.99	0.06	1	0.57	1.15	0.06	1
(2008)	10	0.48	0.95	0.08	0.99	0.54	1.09	0.09	1
	20	0.44	0.89	0.11	0.95	0.51	1.03	0.14	0.95
	30	0.41	0.82	0.15	0.88	0.48	0.96	0.18	0.86
	40	0.38	0.75	0.17	0.78	0.45	0.90	0.23	0.74
	50	0.34	0.69	0.21	0.71	0.42	0.84	0.30	0.65
20-year	0	0.71	1.42	0.02	1	0.72	1.45	0.02	1
(2018)	10	0.67	1.34	0.04	0.99	0.68	1.35	0.05	1
	20	0.62	1.24	0.08	0.96	0.63	1.26	0.09	0.95
	30	0.56	1.13	0.12	0.88	0.58	1.15	0.16	0.86
	40	0.5	1.01	0.17	0.78	0.52	1.04	0.23	0.74
	50	0.44	0.88	0.24	0.72	0.47	0.93	0.30	0.65
30-year	0	0.83	1.66	0.01	1	0.82	1.63	0.01	1
(2028)	10	0.78	1.57	0.02	1	0.76	1.52	0.03	1
	20	0.73	1.45	0.06	0.96	0.70	1.40	0.07	0.95
	30	0.66	1.33	0.12	0.88	0.64	1.27	0.15	0.86
	40	0.59	1.19	0.18	0.78	0.57	1.13	0.23	0.74
	50	0.52	1.04	0.26	0.72	0.50	1	0.31	0.65

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 10. Estimated expected values (EV) of the means and coefficients of variation (CV of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **sandbar shark (alternative catch scenario)** with the Prager and discrete forms **using a variance expansion factor of 2 for the importance function** are compared to those reported in the 1998 SEW and those from two reviewers. Predictions of alternative harvesting policies from the two forms of the model are also included.

	SEW 1998		Prager form		Discrete form	
Parameter	EV	CV	EV	CV	EV	CV
K	2870	0.42	4063	0.48	4090	0.54
r	0.21	0.79	0.15	0.96	0.16	1.00
C_0	126	0.56	231	0.68	230	0.71
N_{1998}	941	0.47	1051	0.61	1046	0.97
N_{1998}/K	0.35	0.37	0.28	0.48	0.28	0.53
MSC	109	0.41	116	0.52	117	0.55
RY_{1998}	---	---	86	0.60	85	0.59

		Prager form				Discrete form			
Horizon	TAC[1]	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$
10-year	0	0.52	1.07	0.03	1	0.54	1.08	0.08	1
(2008)	10	0.49	1.01	0.05	0.99	0.51	1.03	0.11	0.99
	20	0.46	0.95	0.09	0.94	0.48	0.97	0.15	0.94
	30	0.42	0.88	0.13	0.85	0.46	0.91	0.20	0.86
	40	0.39	0.82	0.19	0.74	0.43	0.85	0.25	0.77
	50	0.36	0.75	0.24	0.64	0.39	0.79	0.30	0.67
20-year	0	0.69	1.39	0.01	1	0.70	1.40	0.03	1
(2018)	10	0.64	1.30	0.03	0.99	0.66	1.31	0.06	0.99
	20	0.59	1.20	0.06	0.94	0.61	1.22	0.10	0.94
	30	0.53	1.09	0.12	0.85	0.56	1.12	0.16	0.86
	40	0.47	0.98	0.19	0.74	0.51	1.02	0.22	0.77
	50	0.41	0.87	0.27	0.64	0.46	0.91	0.30	0.67
30-year	0	0.81	1.58	0	1	0.80	1.59	0.01	1
(2028)	10	0.75	1.48	0.02	0.99	0.75	1.49	0.04	0.99
	20	0.68	1.36	0.05	0.94	0.69	1.38	0.08	0.94
	30	0.60	1.22	0.12	0.85	0.63	1.25	0.15	0.86
	40	0.52	1.08	0.20	0.74	0.56	1.12	0.22	0.77
	50	0.45	0.94	0.30	0.64	0.50	0.99	0.30	0.67

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 11. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **blacktip shark (alternative catch scenario)** with the Prager and discrete forms **using the original importance function** are compared to those reported in the 1998 SEW. Predictions of alternative harvesting policies from the two forms of the model are also included.

	SEW 1998		Prager form		Discrete form	
Parameter	**EV**	**EV**	**EV**	**CV**	**EV**	**CV**
K	6532	0.29	6990	0.29	6986	0.29
r	0.11	0.70	0.11	0.68	0.11	0.68
C_0	235	0.38	278	0.35	278	0.35
N_{1998}	1441	0.56	1450	0.62	1386	0.65
N_{1998}/K	0.22	0.40	0.20	0.48	0.19	0.52
MSC	157	0.45	159	0.45	160	0.46
RY_{1998}	---	---	93	0.58	99	0.55

		Prager form				Discrete form			
Horizon	**TAC[1]**	**N_{fin}/K[2]**	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**	**N_{fin}/K[2]**	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year	0	0.37	0.74	0.15	1	0.38	0.77	0.13	1
(2008)	10	0.33	0.66	0.24	0.94	0.33	0.67	0.23	0.98
	20	0.28	0.57	0.36	0.71	0.28	0.56	0.38	0.80
	30	0.23	0.46	0.49	0.46	0.23	0.46	0.51	0.50
	40	0.18	0.36	0.62	0.26	0.18	0.35	0.63	0.28
	50	0.13	0.27	0.73	0.14	0.13	0.27	0.74	0.15
20-year	0	0.57	1.13	0.03	1	0.58	1.16	0.03	1
(2018)	10	0.49	0.98	0.12	0.97	0.49	0.98	0.12	0.98
	20	0.39	0.78	0.27	0.75	0.39	0.78	0.27	0.80
	30	0.28	0.56	0.46	0.49	0.28	0.56	0.47	0.50
	40	0.19	0.37	0.64	0.27	0.19	0.37	0.66	0.28
	50	0.11	0.23	0.78	0.14	0.12	0.24	0.78	0.15
30-year	0	0.70	1.41	0.01	1	0.72	1.43	0.01	1
(2028)	10	0.61	1.21	0.08	0.98	0.61	1.22	0.08	0.98
	20	0.47	0.95	0.24	0.78	0.48	0.95	0.23	0.80
	30	0.33	0.65	0.45	0.50	0.32	0.65	0.45	0.50
	40	0.20	0.40	0.65	0.28	0.20	0.40	0.67	0.28
	50	0.11	0.23	0.83	0.14	0.12	0.23	0.83	0.15

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 12. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **blacktip shark (alternative catch scenario)** with the Prager and discrete forms **using a variance expansion factor of 2 for the importance function** are compared to those reported in the 1998 SEW and those from two reviewers. Predictions of alternative harvesting policies from the two forms of the model are also included.

	SEW 1998		Prager form		Discrete form	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
K	6532	0.29	12876	0.48	25467	0.66
r	0.11	0.70	0.15	1.26	0.13	0.86
C_0	235	0.38	343	0.40	358	0.40
N_{1998}	1441	0.56	8439	0.75	21058	0.80
N_{1998}/K	0.22	0.40	0.57	0.51	0.71	0.39
MSC	157	0.45	425	0.95	706	0.92
RY_{1998}	---	---	215	0.50	254	0.46

		Prager form				Discrete form			
Horizon	**TAC[1]**	**N_{fin}/K[2]**	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**	**N_{fin}/K[2]**	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year	0	0.71	1.42	0.05	1	0.81	1.62	0.03	0.99
(2008)	10	0.69	1.39	0.08	0.98	0.80	1.59	0.05	0.99
	20	0.67	1.34	0.12	0.91	0.78	1.56	0.07	0.94
	30	0.64	1.29	0.16	0.83	0.76	1.53	0.10	0.88
	40	0.62	1.24	0.20	0.76	0.75	1.49	0.13	0.82
	50	0.60	1.19	0.23	0.70	0.73	1.46	0.14	0.78
20-year	0	0.81	1.62	0.01	1	0.88	1.76	0.01	0.99
(2018)	10	0.78	1.55	0.04	0.99	0.85	1.70	0.02	0.99
	20	0.73	1.47	0.10	0.92	0.82	1.65	0.06	0.94
	30	0.69	1.38	0.15	0.84	0.79	1.58	0.09	0.88
	40	0.65	1.30	0.20	0.77	0.76	1.53	0.13	0.82
	50	0.61	1.22	0.24	0.7	0.74	1.49	0.15	0.78
30-year	0	0.87	1.74	0	1	0.92	1.84	0	0.99
(2028)	10	0.83	1.66	0.03	0.99	0.89	1.78	0.02	0.99
	20	0.78	1.55	0.08	0.92	0.85	1.70	0.05	0.94
	30	0.72	1.44	0.14	0.84	0.81	1.62	0.09	0.88
	40	0.67	1.33	0.20	0.77	0.78	1.55	0.13	0.82
	50	0.62	1.25	0.25	0.70	0.75	1.50	0.16	0.78

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 13. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex (alternative catch scenario proposed by Haist)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		Haist's review	
Parameter	**EV**	**CV**	**EV**	**CV**
K	15899	0.17	15092	0.14
R	0.05	0.55	0.06	0.55
C_0	374	0.42	361	0.44
N_{1998}	2952	0.25	3986	0.29
N_{1998}/K	0.19	0.25	0.27	0.26
MSC	187	0.43	217	0.42
RY_{1998}	109	0.49	---	---

		Prager form			
Horizon	**TAC**[1]	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$
10-year	0	0.26	0.52	0.24	1
(2008)	10	0.23	0.45	0.43	0.76
	20	0.19	0.37	0.64	0.36
	30	0.15	0.30	0.81	0.12
	40	0.11	0.22	0.90	0.04
	50	0.07	0.14	0.96	0.01
20-year	0	0.36	0.72	0.07	1
(2018)	10	0.29	0.57	0.29	0.83
	20	0.20	0.40	0.60	0.40
	30	0.11	0.22	0.84	0.14
	40	0.04	0.08	0.94	0.04
	50	0.01	0.03	0.98	0.01
30-year	0	0.47	0.94	0.03	1
(2028)	10	0.35	0.70	0.23	0.85
	20	0.21	0.42	0.59	0.42
	30	0.09	0.18	0.84	0.14
	40	0.03	0.06	0.95	0.04
	50	0.01	0.02	0.99	0.01

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 14. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex (with the upper bound for K=20x10^6 individuals)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		Haist's review	
Parameter	**EV**	**CV**	**EV**	**CV**
K	9460	0.22	9565	0.22
r	0.08	0.67	0.08	0.67
C_0	300	0.42	305	0.43
N_{1998}	1307	0.28	1992	0.32
N_{1998}/K	0.14	0.26	0.21	0.28
MSC	160	0.43	162	0.43
RY_{1998}	70	0.48	---	---

		Prager form			
Horizon	**TAC[1]**	**N_{fin}/K[2]**	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year (2008)	0	0.23	0.46	0.45	1
	10	0.18	0.36	0.69	0.65
	20	0.12	0.24	0.88	0.22
	30	0.06	0.12	0.96	0.05
	40	0.02	0.04	0.99	0.01
	50	0.01	0.02	1	0
20-year (2018)	0	0.38	0.76	0.15	1
	10	0.26	0.53	0.49	0.72
	20	0.12	0.24	0.80	0.25
	30	0.03	0.06	0.95	0.05
	40	0.01	0.02	0.99	0.01
	50	0.01	0.02	1	0
30-year (2028)	0	0.52	1.04	0.06	1
	10	0.35	0.69	0.39	0.74
	20	0.14	0.28	0.77	0.26
	30	0.03	0.06	0.95	0.05
	40	0.01	0.02	0.99	0.01
	50	0.01	0.02	1	0

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 15. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **sandbar shark (with the upper bound for K=20x10^6 and 12x10^6 individuals, respectively)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		Haist's review		Prager form		Haist's review	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
	K=20x10^6				*K=12x10^6*			
K	3649	0.48	4031	0.49	3560	0.43	3936	0.44
r	0.11	0.92	0.11	0.69	0.11	0.89	0.12	0.69
C_0	207	0.70	226	0.61	197	0.68	227	0.60
N_{1998}	974	0.70	1347	0.82	977	0.68	1299	0.72
N_{1998}/K	0.28	0.50	0.34	0.45	0.29	0.50	0.34	0.43
MSC	85	0.67	96	0.56	81	0.64	97	0.56
RY_{1998}	61	0.69	---	---	59	0.68	---	---

		Prager form (*K=20x10^6*)				Prager form (*K=12x10^6*)			
Horizon	**TAC**[1]	**N_{fin}/K**[2]	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**	**N_{fin}/K**[2]	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year	0	0.48	0.96	0.09	1	0.48	0.95	0.09	1
(2008)	10	0.45	0.91	0.13	0.96	0.45	0.90	0.13	0.96
	20	0.42	0.84	0.18	0.85	0.42	0.84	0.18	0.85
	30	0.38	0.77	0.25	0.72	0.38	0.76	0.25	0.71
	40	0.35	0.70	0.32	0.58	0.35	0.69	0.31	0.58
	50	0.31	0.62	0.40	0.46	0.31	0.62	0.39	0.46
20-year	0	0.64	1.28	0.03	1	0.64	1.28	0.03	1
(2018)	10	0.59	1.18	0.07	0.97	0.59	1.18	0.08	0.97
	20	0.53	1.06	0.15	0.87	0.53	1.05	0.15	0.87
	30	0.46	0.92	0.23	0.73	0.46	0.92	0.24	0.73
	40	0.39	0.79	0.33	0.59	0.39	0.79	0.34	0.59
	50	0.33	0.66	0.44	0.46	0.33	0.66	0.44	0.46
30-year	0	0.75	1.50	0.01	1	0.75	1.50	0.02	1
(2028)	10	0.68	1.36	0.05	0.98	0.68	1.37	0.05	0.97
	20	0.60	1.20	0.13	0.87	0.60	1.20	0.13	0.88
	30	0.51	1.03	0.23	0.74	0.51	1.02	0.24	0.73
	40	0.43	0.85	0.35	0.59	0.43	0.85	0.35	0.59
	50	0.35	0.70	0.47	0.46	0.35	0.70	0.46	0.46

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 16. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **blacktip shark (with the upper bound for K=20x10^6 and 12x10^6 individuals, respectively)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		**Haist's review**		**Prager form**		**Haist's review**	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
	K=20x10^6				*K=12x10^6*			
K	9292	0.49	8411	0.53	6692	0.35	6445	0.35
r	0.15	0.88	0.14	0.80	0.16	0.90	0.14	0.81
C_0	266	0.40	246	0.41	251	0.41	235	0.39
N_{1998}	5862	0.83	4222	0.84	3173	0.83	2766	0.85
N_{1998}/K	0.54	0.52	0.47	0.56	0.43	0.61	0.39	0.57
MSC	330	0.99	226	0.63	243	0.92	186	0.61
RY_{1998}	175	0.50	---	---	148	0.57	---	---

		Prager form (*K=20x10^6*)				**Prager form (*K=12x10^6*)**			
Horizon	**TAC**[1]	**N_{fin}/K**[2]	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**	**N_{fin}/K**[2]	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year	0	0.69	1.38	0.04	1	0.61	1.23	0.05	1
(2008)	10	0.67	1.33	0.07	0.97	0.58	1.17	0.10	0.95
	20	0.63	1.27	0.13	0.88	0.54	1.08	0.17	0.83
	30	0.60	1.20	0.18	0.77	0.49	0.99	0.26	0.70
	40	0.56	1.13	0.23	0.67	0.45	0.90	0.33	0.56
	50	0.53	1.07	0.28	0.60	0.41	0.82	0.40	0.46
20-year	0	0.81	1.61	0.01	1	0.76	1.52	0.01	1
(2018)	10	0.76	1.52	0.04	0.98	0.70	1.40	0.06	0.97
	20	0.70	1.40	0.10	0.89	0.62	1.25	0.14	0.85
	30	0.64	1.28	0.19	0.78	0.54	1.08	0.25	0.71
	40	0.58	1.17	0.26	0.68	0.47	0.93	0.36	0.57
	50	0.54	1.08	0.31	0.6	0.41	0.81	0.44	0.47
30-year	0	0.87	1.75	0	1	0.84	1.69	0	1
(2028)	10	0.82	1.63	0.03	0.98	0.77	1.54	0.04	0.97
	20	0.74	1.49	0.10	0.90	0.68	1.35	0.13	0.86
	30	0.66	1.32	0.19	0.79	0.57	1.15	0.26	0.72
	40	0.59	1.19	0.27	0.68	0.48	0.96	0.37	0.58
	50	0.54	1.08	0.33	0.60	0.41	0.82	0.47	0.47

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 17. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex, sandbar, and blacktip (with the CV for r divided by two)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		**Punt's review**		**Prager form**		**Punt's review**	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
	Large coastal				*Sandbar*			
K	8491	0.16	---	---	3574	0.46	---	---
r	0.10	0.35	0.10	---	0.11	0.37	0.12	---
C_0	293	0.41	---	---	222	0.72	---	---
N_{1998}	1163	0.26	---	---	952	0.67	---	---
N_{1998}/K	0.14	0.25	0.21	---	0.28	0.49	0.35	---
MSC	203	0.23	---	---	98	0.53	---	---
RY_{1998}	89	0.30	134	---	69	0.51	74	---

		Prager form *(Large coastal)*				**Prager form *(Sandbar)***			
Horizon	**TAC**[1]	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$
10-year	0	0.27	0.53	0.23	1	0.49	0.99	0.04	1
(2008)	10	0.21	0.42	0.53	0.95	0.47	0.94	0.06	1
	20	0.14	0.28	0.82	0.39	0.43	0.87	0.11	0.97
	30	0.07	0.14	0.95	0.06	0.40	0.79	0.16	0.89
	40	0.03	0.05	0.99	0.01	0.36	0.71	0.23	0.76
	50	0.01	0.03	1	0	0.32	0.63	0.31	0.62
20-year	0	0.48	0.96	0.01	1	0.71	1.42	0	1
(2018)	10	0.35	0.69	0.20	0.98	0.66	1.32	0.01	1
	20	0.16	0.33	0.67	0.45	0.59	1.18	0.05	0.98
	30	0.04	0.07	0.94	0.07	0.52	1.04	0.12	0.90
	40	0.01	0.02	0.99	0.01	0.44	0.89	0.21	0.77
	50	0.01	0.02	1	0	0.37	0.73	0.33	0.63
30-year	0	0.68	1.36	0	1	0.84	1.69	0	1
(2028)	10	0.50	1	0.09	0.99	0.79	1.57	0.01	1
	20	0.21	0.42	0.60	0.46	0.71	1.42	0.03	0.98
	30	0.04	0.07	0.93	0.07	0.61	1.23	0.11	0.90
	40	0.01	0.02	0.99	0.01	0.51	1.03	0.21	0.77
	50	0.01	0.02	1	0	0.41	0.83	0.34	0.63

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 17 (continued). Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex, sandbar, and blacktip (with the CV for r divided by two)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		Punt's review	
Parameter	**EV**	**CV**	**EV**	**CV**
	Blacktip			
K	9293	0.52	---	---
r	0.13	0.37	0.14	---
C_0	271	0.39	---	---
N_{1998}	5931	0.85	---	---
N_{1998}/K	0.53	0.50	0.55	---
MSC	291	0.58	---	---
RY_{1998}	192	0.44	196	---

		Prager form *(Blacktip)*			
Horizon	**TAC**[1]	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$
10-year	0	0.72	1.43	0.01	1
(2008)	10	0.69	1.38	0.04	1
	20	0.65	1.31	0.08	0.96
	30	0.62	1.23	0.14	0.85
	40	0.58	1.16	0.21	0.76
	50	0.55	1.09	0.26	0.68
20-year	0	0.86	1.72	0	1
(2018)	10	0.81	1.63	0.01	1
	20	0.75	1.50	0.05	0.96
	30	0.68	1.36	0.13	0.87
	40	0.61	1.23	0.22	0.77
	50	0.56	1.13	0.28	0.69
30-year	0	0.94	1.87	0	1
(2028)	10	0.89	1.77	0	1
	20	0.81	1.63	0.04	0.97
	30	0.72	1.44	0.13	0.87
	40	0.64	1.28	0.22	0.77
	50	0.58	1.15	0.29	0.69

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 18. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **sandbar shark (mean r=0.07 and K=12x10^6 individuals)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		Haist's review	
Parameter	**EV**	**CV**	**EV**	**CV**
K	4124	0.42	4516	0.40
r	0.06	0.85	0.07	0.76
C_0	201	0.64	223	0.58
N_{1998}	1060	0.68	1466	0.69
N_{1998}/K	0.27	0.51	0.33	0.44
MSC	59	0.69	70	0.60
RY_{1998}	41	0.73	---	---

		Prager form			
Horizon	**TAC[1]**	**N_{fin}/K[2]**	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year	0	0.38	0.75	0.17	1
(2008)	10	0.35	0.70	0.23	0.89
	20	0.32	0.64	0.31	0.68
	30	0.29	0.58	0.39	0.49
	40	0.26	0.51	0.46	0.35
	50	0.23	0.45	0.54	0.24
20-year	0	0.50	0.99	0.07	1
(2018)	10	0.44	0.88	0.17	0.91
	20	0.38	0.76	0.28	0.70
	30	0.31	0.63	0.40	0.51
	40	0.25	0.51	0.51	0.37
	50	0.20	0.40	0.61	0.24
30-year	0	0.60	1.20	0.04	1
(2028)	10	0.52	1.04	0.13	0.92
	20	0.43	0.85	0.26	0.71
	30	0.34	0.67	0.42	0.51
	40	0.26	0.52	0.55	0.37
	50	0.19	0.39	0.65	0.25

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 19. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex (equal weights)** with and without the Prager form are compared to those reported by one of the reviewers and those obtained using two weighting schemes in **WINBUGS** (see text for details). Predictions of alternative harvesting policies are also included.

	Punt's review		Prager form		Discrete form		Winbugs[1]		Winbugs[2]	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
K	8612	0.27	9474	0.20	10127	0.18	9734	0.25	10710	0.27
r	0.11	0.90	0.07	0.72	0.07	0.72	0.08	0.48	0.08	0.49
C_0	355	0.51	373	0.41	421	0.45	363	0.43	442	0.46
N_{1998}	1794	0.31	2112	0.47	1948	0.50	1928	0.37	2137	0.40
N_{1998}/K	0.21	0.26	0.22	0.37	0.19	0.44	0.20	0.29	0.20	0.31
MSC	197	0.44	160	0.50	170	0.50	191	0.37	208	0.38
RY_{1998}	130	0.56	104	0.62	108	0.57	---	---	---	---

		Prager form				Discrete form			
Horizon	**TAC[3]**	**N_{fin}/K[4]**	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**	**N_{fin}/K[2]**	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year	0	0.34	0.68	0.12	1	0.33	0.66	0.26	1
(2008)	10	0.30	0.60	0.36	0.74	0.28	0.55	0.39	0.92
	20	0.24	0.49	0.49	0.43	0.22	0.45	0.46	0.47
	30	0.19	0.38	0.60	0.26	0.17	0.34	0.66	0.30
	40	0.14	0.28	0.72	0.15	0.13	0.25	0.82	0.14
	50	0.10	0.21	0.8	0.09	0.09	0.18	0.86	0.08
20-year	0	0.49	0.98	0.05	1	0.48	0.96	0.05	1
(2018)	10	0.39	0.78	0.29	0.76	0.38	0.75	0.34	0.92
	20	0.28	0.56	0.48	0.45	0.27	0.53	0.47	0.47
	30	0.18	0.36	0.67	0.27	0.17	0.34	0.68	0.30
	40	0.11	0.23	0.77	0.16	0.10	0.20	0.85	0.14
	50	0.07	0.13	0.86	0.09	0.06	0.12	0.89	0.08
30-year	0	0.61	1.22	0.01	1	0.6	1.19	0.02	1
(2028)	10	0.47	0.94	0.26	0.76	0.46	0.92	0.31	0.92
	20	0.31	0.62	0.47	0.45	0.31	0.63	0.47	0.47
	30	0.19	0.38	0.68	0.27	0.19	0.38	0.69	0.30
	40	0.11	0.22	0.80	0.17	0.10	0.19	0.84	0.14
	50	0.06	0.12	0.89	0.09	0.06	0.12	0.90	0.08

[1] Using one MLE for q for each series, 1 σ^2, 1 τ^2 for each series; [2] Using one MLE for q for each series, 1 σ^2, 1 τ^2 for all series; [3] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch; [4] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 20. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **sandbar shark (equal weights)** with and without the Prager form are compared to those reported by one of the reviewers and those obtained using two weighting schemes in **WINBUGS** (see text for details). Predictions of alternative harvesting policies are also included.

	Punt's review		**Prager form**		**Discrete form**		**Winbugs[1]**		**Winbugs[2]**	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
K	3526	0.41	3296	0.42	3383	0.48	8904	0.54	4590	0.57
r	0.11	0.70	0.10	0.82	0.10	0.81	0.10	0.45	0.09	0.47
C_0	200	0.54	161	0.57	161	0.59	156	0.56	193	0.56
N_{1998}	991	0.62	1011	0.69	1060	1.09	3609	0.79	1593	1.02
N_{1998}/K	0.29	0.41	0.31	0.45	0.31	0.49	0.41	0.49	0.33	0.46
MSC	82	0.48	71	0.48	72	0.51	210	0.70	96	0.62
RY_{1998}	62	0.49	55	0.54	56	0.52	---	---	---	---

		Prager form				**Discrete form**			
Horizon	**TAC[3]**	N_{fin}/K[4]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$
10-year	0	0.49	0.99	0.06	1	0.51	1.02	0.06	1
(2008)	10	0.47	0.93	0.09	0.96	0.47	0.94	0.10	0.98
	20	0.43	0.86	0.15	0.86	0.43	0.87	0.15	0.88
	30	0.39	0.79	0.21	0.71	0.39	0.79	0.22	0.74
	40	0.35	0.71	0.29	0.56	0.36	0.71	0.29	0.58
	50	0.32	0.63	0.36	0.43	0.32	0.63	0.37	0.44
20-year	0	0.65	1.30	0.02	1	0.66	1.33	0.02	1
(2018)	10	0.60	1.20	0.05	0.98	0.60	1.20	0.06	0.98
	20	0.53	1.06	0.12	0.88	0.54	1.07	0.12	0.88
	30	0.46	0.92	0.22	0.72	0.46	0.93	0.22	0.74
	40	0.39	0.78	0.33	0.57	0.39	0.78	0.33	0.58
	50	0.32	0.64	0.44	0.43	0.32	0.65	0.43	0.44
30-year	0	0.76	1.51	0.01	1	0.77	1.53	0.01	1
(2028)	10	0.69	1.38	0.04	0.98	0.69	1.38	0.04	0.98
	20	0.60	1.21	0.11	0.89	0.61	1.21	0.11	0.88
	30	0.51	1.02	0.22	0.73	0.51	1.03	0.22	0.74
	40	0.41	0.83	0.35	0.57	0.42	0.84	0.35	0.58
	50	0.33	0.65	0.47	0.44	0.33	0.67	0.47	0.44

[1] Using one MLE for q for each series, 1 σ^2, 1 τ^2 for each series; [2] Using one MLE for q for each series, 1 σ^2, 1 τ^2 for all series; [3] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch; [4] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 21. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **blacktip shark (equal weights)** with and without the Prager form are compared to those reported by one of the reviewers and those obtained using two weighting schemes in **WINBUGS** (see text for details). Predictions of alternative harvesting policies are also included.

	Punt's review		**Prager form**		**Winbugs**[1]		**Winbugs**[2]	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
K	11970	0.35	12631	0.44	11700	0.38	12740	0.32
r	0.20	0.76	0.18	0.81	0.11	0.41	0.12	0.36
C_0	300	0.43	308	0.41	278	0.40	300	0.41
N_{1998}	9557	0.46	9746	0.53	8944	0.57	10120	0.45
N_{1998}/K	0.78	0.17	0.74	0.22	0.73	0.34	0.77	0.23
MSC	540	0.75	493	0.81	323	0.56	383	0.48
RY_{1998}	248	0.21	237	0.26	---	---	---	---

		Prager form			
Horizon	**TAC**[3]	N_{fin}/K[4]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$
10-year (2008)	0	0.88	1.75	0	1
	10	0.87	1.73	0	1
	20	0.85	1.70	0	0.99
	30	0.83	1.67	0	0.97
	40	0.82	1.64	0.01	0.95
	50	0.80	1.60	0.01	0.91
20-year (2018)	0	0.93	1.87	0	1
	10	0.92	1.83	0	1
	20	0.89	1.79	0	0.99
	30	0.87	1.74	0.01	0.98
	40	0.85	1.69	0.01	0.95
	50	0.82	1.65	0.02	0.91
30-year (2028)	0	0.96	1.92	0	1
	10	0.94	1.88	0	1
	20	0.91	1.83	0	0.99
	30	0.89	1.78	0.01	0.98
	40	0.86	1.72	0.01	0.95
	50	0.83	1.66	0.02	0.91

[1] Using one MLE for q for each series, 1 σ^2, 1 τ^2 for each series; [2] Using one MLE for q for each series, 1 σ^2, 1 τ^2 for all series; [3] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch; [4] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 22. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex, sandbar, and blacktip (with the beginning of the fishery in 1969)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		Punt's review		Prager form		Punt's review	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
	Large coastal				*Sandbar*			
K	9922	0.24	---	---	4223	0.51	---	---
r	0.08	0.66	0.08	---	0.12	0.91	0.11	---
C_0	296	0.41	---	---	218	0.74	---	---
N_{1998}	1253	0.29	---	---	964	0.69	---	---
N_{1998}/K	0.13	0.26	0.19	---	0.25	0.55	0.31	---
MSC	173	0.41	---	---	101	0.78	---	---
RY_{1998}	71	0.47	107	---	66	0.79	71	---

		Prager form *(Large coastal)*				Prager form *(Sandbar)*			
Horizon	**TAC[1]**	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$
10-year	0	0.22	0.45	0.51	1	0.44	0.89	0.15	1
(2008)	10	0.17	0.35	0.72	0.67	0.42	0.85	0.20	0.96
	20	0.11	0.23	0.89	0.22	0.39	0.78	0.26	0.85
	30	0.06	0.11	0.96	0.05	0.36	0.72	0.31	0.71
	40	0.02	0.04	0.99	0.01	0.33	0.66	0.37	0.59
	50	0.01	0.02	1	0	0.30	0.59	0.43	0.47
20-year	0	0.38	0.76	0.19	1	0.61	1.21	0.05	1
(2018)	10	0.26	0.52	0.51	0.74	0.56	1.12	0.10	0.97
	20	0.12	0.24	0.81	0.25	0.50	1	0.19	0.86
	30	0.03	0.06	0.95	0.06	0.44	0.88	0.28	0.72
	40	0.01	0.02	0.99	0.01	0.38	0.77	0.37	0.59
	50	0.01	0.02	1	0	0.33	0.66	0.46	0.48
30-year	0	0.52	1.03	0.08	1	0.71	1.43	0.03	1
(2028)	10	0.35	0.70	0.40	0.76	0.65	1.31	0.07	0.97
	20	0.14	0.28	0.77	0.26	0.58	1.15	0.16	0.87
	30	0.04	0.07	0.94	0.06	0.50	0.99	0.27	0.72
	40	0.01	0.02	0.99	0.01	0.42	0.84	0.37	0.60
	50	0.01	0.02	1	0	0.35	0.70	0.48	0.48

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 22 (continued). Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex, sandbar, and blacktip (with the beginning of the fishery in 1969)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		Punt's review	
Parameter	**EV**	**CV**	**EV**	**CV**
	Blacktip			
K	10871	0.54	---	---
r	0.15	0.84	0.16	---
C_0	275	0.41	---	---
N_{1998}	7190	0.82	---	---
N_{1998}/K	0.56	0.50	0.54	---
MSC	368	0.94	---	---
RY_{1998}	189	0.47	180	---

		Prager form *(Blacktip)*			
Horizon	**TAC[1]**	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$
10-year	0	0.72	1.44	0.03	1
(2008)	10	0.70	1.40	0.06	0.98
	20	0.67	1.34	0.11	0.91
	30	0.64	1.28	0.15	0.82
	40	0.61	1.22	0.20	0.73
	50	0.58	1.16	0.24	0.66
20-year	0	0.83	1.66	0.01	1
(2018)	10	0.79	1.58	0.03	0.98
	20	0.74	1.48	0.08	0.92
	30	0.68	1.37	0.15	0.83
	40	0.63	1.27	0.21	0.74
	50	0.59	1.18	0.26	0.67
30-year	0	0.89	1.78	0	1
(2028)	10	0.84	1.68	0.02	0.98
	20	0.78	1.56	0.08	0.92
	30	0.71	1.42	0.15	0.83
	40	0.65	1.30	0.22	0.74
	50	0.60	1.20	0.27	0.67

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 23. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex ($K=20x10^6$ individuals, only 8 CPUE series, and 1983 Early Rec data point removed), sandbar ($K=12x10^6$ individuals and 1983 "early Rec" CPUE point removed), and blacktip ($K=12x10^6$ individuals and Gulf Reef logs CPUE series removed)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		Haist's review		Prager form		Haist's review	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
	Large coastal				*Sandbar*			
K	10091	0.23	10573	0.25	3363	0.39	3719	0.43
r	0.08	0.65	0.08	0.61	0.10	0.83	0.11	0.70
C_0	438	0.43	590	0.51	173	0.59	196	0.58
N_{1998}	1603	0.37	1636	0.30	987	0.66	1319	0.72
N_{1998}/K	0.16	0.33	0.16	0.30	0.30	0.45	0.36	0.41
MSC	172	0.43	179	0.42	74	0.51	87	0.52
RY_{1998}	85	0.49	---	---	56	0.56	---	---

		Prager form *(Large coastal)*				Prager form *(Sandbar)*			
Horizon	**TAC**[1]	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$
10-year	0	0.27	0.53	0.32	1	0.48	0.97	0.05	1
(2008)	10	0.22	0.44	0.52	0.76	0.46	0.92	0.09	0.97
	20	0.17	0.33	0.72	0.36	0.42	0.84	0.15	0.83
	30	0.11	0.22	0.86	0.13	0.39	0.77	0.23	0.71
	40	0.06	0.12	0.94	0.03	0.35	0.70	0.31	0.59
	50	0.03	0.07	0.97	0.01	0.31	0.62	0.36	0.49
20-year	0	0.42	0.84	0.11	1	0.65	1.29	0.02	1
(2018)	10	0.32	0.64	0.35	0.81	0.59	1.19	0.04	0.98
	20	0.19	0.38	0.65	0.40	0.53	1.06	0.12	0.85
	30	0.08	0.16	0.86	0.14	0.46	0.92	0.22	0.72
	40	0.03	0.06	0.95	0.04	0.39	0.78	0.31	0.59
	50	0.02	0.03	0.98	0.01	0.33	0.66	0.40	0.49
30-year	0	0.56	1.12	0.04	1	0.76	1.51	0.01	1
(2028)	10	0.41	0.82	0.27	0.83	0.69	1.37	0.03	0.98
	20	0.22	0.44	0.61	0.41	0.60	1.20	0.11	0.85
	30	0.08	0.17	0.85	0.14	0.51	1.02	0.23	0.72
	40	0.03	0.06	0.96	0.04	0.43	0.85	0.33	0.59
	50	0.01	0.03	0.99	0.01	0.35	0.69	0.44	0.49

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 23 (continued). Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex ($K=20x10^6$ individuals, only 8 CPUE series, and 1983 Early Rec data point removed), sandbar ($K=12x10^6$ individuals and 1983 "early Rec" CPUE point removed), and blacktip ($K=12x10^6$ individuals and Gulf logs CPUE series removed)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		**Haist's review**	
Parameter	**EV**	**CV**	**EV**	**CV**
	Blacktip			
K	7504	0.62	5984	0.35
r	0.13	0.83	0.13	0.80
C_0	248	0.40	230	0.38
N_{1998}	3471	1.34	2074	0.94
N_{1998}/K	0.34	0.76	0.31	0.60
MSC	216	1.08	161	0.58
RY_{1998}	117	0.70	---	---

		Prager form *(Blacktip)*			
Horizon	**TAC**[1]	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$
10-year	0	0.52	1.04	0.11	1
(2008)	10	0.48	0.96	0.21	0.91
	20	0.43	0.85	0.33	0.71
	30	0.37	0.74	0.44	0.52
	40	0.32	0.64	0.53	0.39
	50	0.28	0.57	0.60	0.30
20-year	0	0.68	1.37	0.03	1
(2018)	10	0.61	1.21	0.12	0.94
	20	0.51	1.01	0.28	0.74
	30	0.40	0.81	0.43	0.54
	40	0.33	0.66	0.55	0.40
	50	0.28	0.56	0.63	0.31
30-year	0	0.79	1.58	0.01	1
(2028)	10	0.69	1.38	0.09	0.95
	20	0.56	1.12	0.26	0.75
	30	0.43	0.86	0.43	0.54
	40	0.34	0.68	0.56	0.40
	50	0.28	0.56	0.64	0.31

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 24. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex, sandbar, and blacktip (all CPUE series with less than 5 data points removed)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		Punt's review		Prager form		Punt's review	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
	Large coastal				*Sandbar*			
K	9687	0.22	---	---	3707	0.40	---	---
r	0.07	0.67	0.08	---	0.10	0.79	0.11	---
C_0	305	0.42	---	---	190	0.68	---	---
N_{1998}	1547	0.35	---	---	1271	0.68	---	---
N_{1998}/K	0.16	0.30	0.23	---	0.34	0.47	0.35	---
MSC	161	0.43	---	---	82	0.65	---	---
RY_{1998}	80	0.50	118	---	64	0.69	64	---

		Prager form *(Large coastal)*				Prager form *(Sandbar)*			
Horizon	**TAC**[1]	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$
10-year	0	0.26	0.52	0.32	1	0.52	1.05	0.06	1
(2008)	10	0.21	0.43	0.54	0.73	0.50	1	0.09	0.98
	20	0.16	0.31	0.75	0.31	0.47	0.94	0.12	0.90
	30	0.10	0.20	0.88	0.09	0.44	0.87	0.16	0.74
	40	0.05	0.11	0.95	0.02	0.40	0.81	0.22	0.62
	50	0.03	0.06	0.98	0.01	0.37	0.74	0.28	0.50
20-year	0	0.41	0.82	0.10	1	0.67	1.35	0.01	1
(2018)	10	0.30	0.60	0.37	0.79	0.63	1.25	0.05	0.98
	20	0.17	0.34	0.69	0.34	0.57	1.14	0.10	0.90
	30	0.07	0.13	0.89	0.11	0.51	1.02	0.16	0.76
	40	0.02	0.04	0.97	0.02	0.45	0.90	0.24	0.63
	50	0.01	0.02	0.99	0.01	0.39	0.78	0.33	0.51
30-year	0	0.54	1.09	0.04	1	0.78	1.56	0.01	1
(2028)	10	0.39	0.77	0.29	0.80	0.71	1.43	0.02	0.99
	20	0.19	0.39	0.67	0.35	0.64	1.27	0.09	0.91
	30	0.07	0.13	0.89	0.11	0.56	1.11	0.16	0.76
	40	0.02	0.04	0.97	0.02	0.48	0.95	0.26	0.64
	50	0.01	0.02	0.99	0.01	0.40	0.80	0.38	0.51

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 24 (continued). Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex, sandbar, and blacktip (all CPUE series with less than 5 data points removed)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		Punt's review	
Parameter	**EV**	**CV**	**EV**	**CV**
	Blacktip			
K	11147	0.51	---	---
r	0.15	0.87	0.14	---
C_0	279	0.40	---	---
N_{1998}	7739	0.73	---	---
N_{1998}/K	0.61	0.43	0.46	---
MSC	381	0.92	---	---
RY_{1998}	194	0.44	147	---

		Prager form *(Blacktip)*			
Horizon	**TAC**[1]	**N_{fin}/K**[2]	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year	0	0.75	1.51	0.02	1
(2008)	10	0.73	1.47	0.05	0.98
	20	0.71	1.42	0.08	0.92
	30	0.68	1.36	0.11	0.84
	40	0.65	1.30	0.15	0.77
	50	0.63	1.25	0.17	0.70
20-year	0	0.85	1.69	0	1
(2018)	10	0.81	1.62	0.03	0.99
	20	0.77	1.53	0.07	0.93
	30	0.72	1.44	0.12	0.85
	40	0.67	1.35	0.16	0.77
	50	0.64	1.27	0.20	0.70
30-year	0	0.90	1.80	0	1
(2028)	10	0.86	1.71	0.02	0.99
	20	0.80	1.60	0.06	0.93
	30	0.74	1.48	0.12	0.85
	40	0.69	1.37	0.17	0.77
	50	0.64	1.28	0.22	0.70

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 25. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex, sandbar, and blacktip (two MRFSS CPUE series removed)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		Punt's review		Prager form		Punt's review	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
	Large coastal				*Sandbar*			
K	9124	0.23	---	---	3342	0.44	---	---
r	0.08	0.70	0.09	---	0.09	0.80	0.11	---
C_0	298	0.42	---	---	162	0.66	---	---
N_{1998}	1076	0.30	---	---	857	0.85	---	---
N_{1998}/K	0.12	0.27	0.20	---	0.26	0.56	0.39	---
MSC	170	0.44	---	---	66	0.59	---	---
RY_{1998}	64	0.48	109	---	45	0.67	67	---

		Prager form *(Large coastal)*				Prager form *(Sandbar)*			
Horizon	**TAC**[1]	**N_{fin}/K**[2]	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**	**N_{fin}/K**[2]	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year	0	0.21	0.43	0.57	0.99	0.41	0.82	0.16	1
(2008)	10	0.16	0.32	0.80	0.59	0.38	0.76	0.22	0.91
	20	0.09	0.18	0.93	0.15	0.34	0.68	0.31	0.74
	30	0.03	0.06	0.98	0.03	0.30	0.60	0.40	0.56
	40	0.01	0.02	1	0	0.26	0.52	0.49	0.41
	50	0.01	0.02	1	0	0.22	0.45	0.56	0.30
20-year	0	0.37	0.75	0.21	1	0.57	1.13	0.06	1
(2018)	10	0.24	0.48	0.58	0.67	0.50	1	0.15	0.93
	20	0.09	0.17	0.87	0.18	0.43	0.85	0.26	0.76
	30	0.02	0.04	0.97	0.03	0.35	0.70	0.39	0.58
	40	0.01	0.01	1	0	0.28	0.56	0.51	0.42
	50	0.01	0.02	1	0	0.22	0.44	0.61	0.30
30-year	0	0.52	1.03	0.08	1	0.68	1.37	0.03	1
(2028)	10	0.32	0.65	0.46	0.70	0.60	1.19	0.11	0.93
	20	0.11	0.21	0.84	0.19	0.49	0.98	0.24	0.77
	30	0.02	0.04	0.97	0.03	0.39	0.77	0.39	0.58
	40	0.01	0.01	1	0	0.30	0.59	0.53	0.42
	50	0.01	0.02	1	0	0.22	0.45	0.63	0.30

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 25 (continued). Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex, sandbar, and blacktip (two MRFSS CPUE series removed)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		**Punt's review**	
Parameter	**EV**	**CV**	**EV**	**CV**
	Blacktip			
K	8008	0.58	---	---
r	0.12	0.82	0.12	---
C_0	276	0.42	---	---
N_{1998}	3737	1.24	---	---
N_{1998}/K	0.36	0.74	0.37	---
MSC	211	0.99	---	---
RY_{1998}	121	0.72	122	---

		Prager form *(Blacktip)*			
Horizon	**TAC[1]**	**N_{fin}/K[2]**	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year	0	0.51	1.03	0.17	1
(2008)	10	0.48	0.96	0.26	0.87
	20	0.43	0.86	0.35	0.67
	30	0.39	0.77	0.43	0.53
	40	0.35	0.70	0.49	0.43
	50	0.32	0.64	0.53	0.36
20-year	0	0.66	1.32	0.06	1
(2018)	10	0.59	1.17	0.17	0.90
	20	0.49	0.99	0.32	0.69
	30	0.42	0.83	0.43	0.54
	40	0.36	0.72	0.51	0.43
	50	0.32	0.64	0.56	0.36
30-year	0	0.76	1.52	0.02	1
(2028)	10	0.66	1.32	0.13	0.91
	20	0.54	1.08	0.30	0.70
	30	0.44	0.88	0.43	0.54
	40	0.37	0.74	0.52	0.44
	50	0.32	0.65	0.57	0.36

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 26. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex and sandbar (VIMS CPUE series removed)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		Punt's review		Prager form		Punt's review	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
	Large coastal				*Sandbar*			
K	9410	0.22	---	---	3999	0.48	---	---
r	0.08	0.66	0.08	---	0.12	0.85	0.13	---
C_0	308	0.42	---	---	133	0.56	---	---
N_{1998}	1123	0.29	---	---	2197	0.79	---	---
N_{1998}/K	0.12	0.26	0.19	---	0.50	0.45	0.64	---
MSC	169	0.43	---	---	104	0.74	---	---
RY_{1998}	64	0.46	96	---	75	0.48	85	---

		Prager form *(Large coastal)*				Prager form *(Sandbar)*			
Horizon	**TAC**[1]	**N_{fin}/K**[2]	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**	**N_{fin}/K**[2]	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year	0	0.21	0.42	0.56	1	0.67	1.35	0.05	1
(2008)	10	0.16	0.31	0.79	0.62	0.65	1.31	0.06	0.97
	20	0.09	0.18	0.93	0.16	0.63	1.25	0.09	0.91
	30	0.03	0.07	0.99	0.03	0.60	1.20	0.11	0.84
	40	0.01	0.02	1	0	0.57	1.14	0.14	0.75
	50	0.01	0.02	1	0	0.54	1.09	0.17	0.67
20-year	0	0.37	0.73	0.20	1	0.79	1.57	0.02	1
(2018)	10	0.24	0.47	0.57	0.69	0.75	1.49	0.04	0.97
	20	0.09	0.17	0.87	0.19	0.70	1.40	0.08	0.92
	30	0.02	0.03	0.97	0.03	0.66	1.31	0.11	0.85
	40	0.01	0.01	1	0	0.61	1.22	0.16	0.76
	50	0.01	0.02	1	0	0.56	1.13	0.20	0.68
30-year	0	0.51	1.02	0.08	1	0.85	1.71	0.01	1
(2028)	10	0.32	0.64	0.45	0.71	0.80	1.61	0.03	0.98
	20	0.10	0.21	0.83	0.20	0.75	1.50	0.07	0.93
	30	0.02	0.04	0.97	0.03	0.69	1.38	0.12	0.85
	40	0.01	0.01	1	0	0.63	1.26	0.17	0.76
	50	0.01	0.02	1	0	0.58	1.15	0.22	0.68

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 27. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex and blacktip (split all commercial and recreational CPUE series including 1993 in 1993)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		**Punt's review**		**Prager form**		**Punt's review**	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
	Large coastal				*Blacktip*			
K	10309	0.23	---	---	10639	0.55	---	---
r	0.07	0.68	0.08	---	0.15	0.87	0.15	---
C_0	306	0.43	---	---	275	0.40	---	---
N_{1998}	2770	0.37	---	---	7170	0.81	---	---
N_{1998}/K	0.27	0.30	0.28	---	0.57	0.49	0.54	---
MSC	168	0.43	---	---	360	0.95	---	---
RY_{1998}	128	0.51	143	---	184	0.49	173	---

		Prager form *(Large coastal)*				**Prager form *(Blacktip)***			
Horizon	**TAC**[1]	**N_{fin}/K**[2]	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**	**N_{fin}/K**[2]	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year	0	0.41	0.82	0.04	1	0.72	1.43	0.04	1
(2008)	10	0.37	0.74	0.09	0.92	0.69	1.39	0.07	0.97
	20	0.33	0.65	0.20	0.65	0.66	1.33	0.12	0.88
	30	0.28	0.55	0.34	0.39	0.63	1.26	0.17	0.79
	40	0.23	0.45	0.50	0.21	0.60	1.20	0.21	0.71
	50	0.18	0.36	0.63	0.10	0.57	1.14	0.25	0.64
20-year	0	0.56	1.12	0.01	1	0.82	1.64	0.01	1
(2018)	10	0.48	0.96	0.06	0.94	0.78	1.56	0.04	0.98
	20	0.39	0.77	0.21	0.68	0.73	1.45	0.10	0.90
	30	0.28	0.57	0.43	0.41	0.67	1.34	0.17	0.80
	40	0.19	0.37	0.64	0.21	0.62	1.24	0.23	0.71
	50	0.11	0.22	0.79	0.10	0.58	1.16	0.27	0.64
30-year	0	0.68	1.35	0	1	0.88	1.77	0	1
(2028)	10	0.57	1.14	0.05	0.95	0.83	1.66	0.03	0.98
	20	0.43	0.87	0.22	0.69	0.76	1.53	0.09	0.90
	30	0.29	0.58	0.48	0.41	0.69	1.39	0.17	0.80
	40	0.17	0.33	0.70	0.21	0.63	1.26	0.24	0.72
	50	0.09	0.18	0.84	0.11	0.58	1.17	0.29	0.64

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch

[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 28. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex, sandbar, and blacktip (all data points in commercial and recreational CPUE series extending beyond 1992 removed)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		**Punt's review**		**Prager form**		**Punt's review**	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
	Large coastal				*Sandbar*			
K	10179	0.23	---	---	3072	0.40	---	---
r	0.07	0.68	0.09	---	0.08	0.72	0.09	---
C_0	305	0.43	---	---	153	0.60	---	---
N_{1998}	2588	0.40	---	---	483	0.76	---	---
N_{1998}/K	0.26	0.33	0.31	---	0.16	0.59	0.27	---
MSC	169	0.43	---	---	54	0.53	---	---
RY_{1998}	123	0.53	163	---	27	0.76	48	---

		Prager form *(Large coastal)*				**Prager form *(Sandbar)***			
Horizon	**TAC[1]**	**N_{fin}/K[2]**	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**	**N_{fin}/K[2]**	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year	0	0.39	0.78	0.07	1	0.27	0.54	0.43	0.99
(2008)	10	0.35	0.70	0.15	0.89	0.23	0.46	0.53	0.71
	20	0.30	0.60	0.28	0.60	0.18	0.37	0.64	0.45
	30	0.25	0.50	0.42	0.34	0.14	0.29	0.73	0.27
	40	0.20	0.41	0.56	0.18	0.11	0.22	0.80	0.17
	50	0.16	0.31	0.68	0.09	0.09	0.17	0.85	0.10
20-year	0	0.54	1.07	0.02	1	0.42	0.83	0.22	1
(2018)	10	0.45	0.91	0.10	0.92	0.32	0.65	0.40	0.76
	20	0.36	0.71	0.28	0.63	0.23	0.46	0.57	0.48
	30	0.25	0.50	0.50	0.36	0.16	0.32	0.71	0.29
	40	0.16	0.32	0.68	0.18	0.11	0.21	0.81	0.17
	50	0.10	0.20	0.82	0.09	0.07	0.14	0.87	0.10
30-year	0	0.65	1.31	0.01	1	0.54	1.09	0.12	1
(2028)	10	0.54	1.08	0.08	0.93	0.41	0.82	0.33	0.77
	20	0.40	0.80	0.29	0.65	0.28	0.56	0.54	0.48
	30	0.26	0.51	0.54	0.36	0.18	0.36	0.70	0.29
	40	0.15	0.29	0.74	0.19	0.11	0.23	0.81	0.17
	50	0.08	0.16	0.86	0.09	0.07	0.14	0.89	0.10

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 28 (continued). Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex, sandbar, and blacktip (all data points in commercial and recreational CPUE series extending beyond 1992 removed)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		**Punt's review**	
Parameter	**EV**	**CV**	**EV**	**CV**
	Blacktip			
K	13197	0.42	---	---
r	0.20	0.78	0.22	---
C_0	326	0.43	---	---
N_{1998}	10599	0.48	---	---
N_{1998}/K	0.79	0.18	0.79	---
MSC	579	0.74	---	---
RY_{1998}	253	0.22	252	---

		Prager form *(Blacktip)*			
Horizon	**TAC[1]**	**N_{fin}/K[2]**	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year	0	0.91	1.82	0	1
(2008)	10	0.90	1.80	0	1
	20	0.89	1.77	0	0.99
	30	0.87	1.75	0	0.99
	40	0.86	1.72	0	0.97
	50	0.85	1.69	0.01	0.95
20-year	0	0.95	1.91	0	1
(2018)	10	0.94	1.88	0	1
	20	0.92	1.84	0	0.99
	30	0.90	1.81	0	0.99
	40	0.88	1.77	0.01	0.97
	50	0.87	1.73	0.01	0.95
30-year	0	0.97	1.95	0	1
(2028)	10	0.96	1.91	0	1
	20	0.94	1.87	0	1
	30	0.92	1.83	0	0.99
	40	0.90	1.79	0.01	0.97
	50	0.87	1.75	0.01	0.95

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 29. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex, sandbar, and blacktip (only fishery-independent CPUE series used)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		Punt's review		Prager form		Punt's review	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
	Large coastal				*Sandbar*			
K	9347	0.25	---	---	3023	0.41	---	---
r	0.09	0.72	0.09	---	0.08	0.74	0.10	---
C_0	394	0.45	---	---	143	0.61	---	---
N_{1998}	1508	0.54	---	---	551	0.89	---	---
N_{1998}/K	0.16	0.44	0.23	---	0.18	0.62	0.31	---
MSC	177	0.43	---	---	55	0.53	---	---
RY_{1998}	88	0.60	130	---	30	0.76	52	---

		Prager form *(Large coastal)*				Prager form *(Sandbar)*			
Horizon	**TAC**[1]	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$
10-year	0	0.28	0.56	0.35	1	0.30	0.61	0.36	0.99
(2008)	10	0.23	0.46	0.53	0.73	0.26	0.53	0.46	0.76
	20	0.17	0.34	0.70	0.35	0.22	0.44	0.57	0.50
	30	0.11	0.22	0.82	0.15	0.18	0.36	0.65	0.33
	40	0.07	0.14	0.90	0.07	0.14	0.29	0.73	0.21
	50	0.04	0.09	0.94	0.03	0.11	0.23	0.79	0.13
20-year	0	0.44	0.89	0.12	1	0.45	0.91	0.18	1
(2018)	10	0.33	0.66	0.37	0.79	0.37	0.73	0.34	0.80
	20	0.20	0.39	0.65	0.38	0.27	0.55	0.51	0.53
	30	0.10	0.20	0.82	0.16	0.20	0.40	0.64	0.34
	40	0.05	0.10	0.91	0.07	0.14	0.28	0.75	0.21
	50	0.03	0.06	0.96	0.03	0.10	0.20	0.82	0.13
30-year	0	0.58	1.17	0.05	1	0.58	1.16	0.10	1
(2028)	10	0.42	0.84	0.29	0.81	0.45	0.91	0.28	0.81
	20	0.23	0.46	0.63	0.39	0.32	0.64	0.48	0.54
	30	0.11	0.21	0.83	0.16	0.22	0.44	0.64	0.34
	40	0.05	0.11	0.92	0.07	0.15	0.30	0.76	0.22
	50	0.03	0.06	0.97	0.03	0.10	0.20	0.84	0.13

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 29 (continued). Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex, sandbar, and blacktip (only fishery-independent CPUE series used)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		Punt's review	
Parameter	**EV**	**CV**	**EV**	**CV**
	Blacktip			
K	10994	0.51	---	---
r	0.14	0.86	0.17	---
C_0	296	0.41	---	---
N_{1998}	7409	0.72	---	---
N_{1998}/K	0.61	0.40	0.70	---
MSC	338	0.87	---	---
RY_{1998}	197	0.42	220	---

		Prager form *(Blacktip)*			
Horizon	**TAC**[1]	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$
10-year	0	0.75	1.51	0.04	1
(2008)	10	0.73	1.47	0.06	0.96
	20	0.71	1.42	0.08	0.91
	30	0.69	1.37	0.10	0.87
	40	0.66	1.33	0.11	0.81
	50	0.64	1.28	0.13	0.74
20-year	0	0.84	1.69	0.02	1
(2018)	10	0.81	1.61	0.04	0.96
	20	0.77	1.54	0.07	0.92
	30	0.73	1.46	0.10	0.87
	40	0.69	1.39	0.12	0.82
	50	0.66	1.32	0.15	0.74
30-year	0	0.90	1.79	0.01	1
(2028)	10	0.85	1.70	0.04	0.97
	20	0.80	1.60	0.07	0.92
	30	0.75	1.51	0.10	0.87
	40	0.71	1.42	0.13	0.82
	50	0.67	1.33	0.16	0.74

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 30. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex, sandbar, and blacktip (only "best" CPUE series [according to one reviewer] used)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		Trumble's review		Prager form		Trumble's review	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
	Large coastal				*Sandbar*			
K	6290	0.48	---	---	3540	0.45	---	---
r	0.33	0.68	---	---	0.09	0.59	---	---
C_0	285	0.35	---	---	171	0.66	---	---
N_{1998}	3192	0.76	---	---	1037	0.84	---	---
N_{1998}/K	0.50	0.24	---	---	0.29	0.54	---	---
MSC	397	0.32	---	---	71	0.59	---	---
RY_{1998}	364	0.24	---	---	51	0.62	---	---

		Prager form *(Large coastal)*				Prager form *(Sandbar)*			
Horizon	**TAC**[1]	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$
10-year	0	0.87	1.73	0	1	0.45	0.91	0.11	1
(2008)	10	0.84	1.68	0	1	0.43	0.85	0.15	0.94
	20	0.81	1.61	0	1	0.39	0.78	0.21	0.81
	30	0.77	1.54	0	1	0.35	0.70	0.29	0.65
	40	0.73	1.46	0	0.90	0.31	0.63	0.36	0.49
	50	0.69	1.37	0	0.89	0.28	0.56	0.44	0.36
20-year	0	0.95	1.91	0	1	0.61	1.22	0.04	1
(2018)	10	0.92	1.84	0	1	0.55	1.10	0.09	0.96
	20	0.88	1.76	0	1	0.48	0.97	0.18	0.82
	30	0.83	1.67	0	1	0.41	0.82	0.29	0.66
	40	0.78	1.57	0	0.90	0.34	0.68	0.40	0.50
	50	0.73	1.45	0.10	0.89	0.28	0.55	0.51	0.37
30-year	0	0.98	1.96	0	1	0.72	1.44	0.02	1
(2028)	10	0.95	1.89	0	1	0.64	1.29	0.07	0.96
	20	0.90	1.81	0	1	0.55	1.10	0.16	0.83
	30	0.86	1.72	0	1	0.46	0.91	0.28	0.67
	40	0.80	1.60	0	0.90	0.36	0.72	0.42	0.51
	50	0.73	1.46	0.11	0.89	0.28	0.56	0.54	0.37

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 30 (continued). Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex, sandbar, and blacktip (only "best" CPUE series [according to one reviewer] used)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		**Trumble's review**	
Parameter	**EV**	**CV**	**EV**	**CV**
	Blacktip			
K	11838	0.47	---	---
r	0.16	0.83	---	---
C_0	302	0.42	---	---
N_{1998}	8625	0.62	---	---
N_{1998}/K	0.68	0.30	---	---
MSC	411	0.85	---	---
RY_{1998}	218	0.33	---	---

		Prager form *(Blacktip)*			
Horizon	**TAC**[1]	**N_{fin}/K**[2]	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year	0	0.82	1.64	0.01	1
(2008)	10	0.81	1.61	0.02	0.99
	20	0.79	1.58	0.02	0.97
	30	0.77	1.53	0.03	0.94
	40	0.75	1.49	0.04	0.89
	50	0.73	1.45	0.05	0.83
20-year	0	0.90	1.79	0	1
(2018)	10	0.87	1.74	0.01	0.99
	20	0.84	1.68	0.02	0.97
	30	0.81	1.62	0.03	0.94
	40	0.78	1.56	0.05	0.89
	50	0.75	1.49	0.07	0.84
30-year	0	0.94	1.87	0	1
(2028)	10	0.90	1.81	0.01	0.99
	20	0.87	1.74	0.02	0.97
	30	0.83	1.66	0.04	0.94
	40	0.79	1.59	0.05	0.89
	50	0.76	1.51	0.08	0.84

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 31. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex, sandbar, and blacktip (only "best" CPUE series and those with "data problems" [according to one reviewer] used)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		Trumble's review		Prager form		Trumble's review	
Parameter	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**	**EV**	**CV**
	Large coastal				*Sandbar*			
K	9809	0.23	---	---	3558	0.26	---	---
r	0.08	0.70	---	---	0.12	0.38	---	---
C_0	297	0.42	---	---	218	0.50	---	---
N_{1998}	2218	0.43	---	---	846	0.46	---	---
N_{1998}/K	0.23	0.34	---	---	0.24	0.34	---	---
MSC	172	0.43	---	---	105	0.48	---	---
RY_{1998}	115	0.54	---	---	72	0.43	---	---

		Prager form *(Large coastal)*				Prager form *(Sandbar)*			
Horizon	**TAC**[1]	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$
10-year	0	0.37	0.73	0.10	1	0.47	0.94	0.01	1
(2008)	10	0.32	0.65	0.21	0.87	0.45	0.90	0.01	0.99
	20	0.27	0.55	0.38	0.57	0.41	0.82	0.03	0.97
	30	0.22	0.44	0.54	0.32	0.38	0.75	0.05	0.93
	40	0.16	0.33	0.69	0.15	0.34	0.68	0.06	0.89
	50	0.12	0.23	0.80	0.07	0.30	0.60	0.08	0.86
20-year	0	0.53	1.05	0.03	1	0.72	1.45	0	1
(2018)	10	0.44	0.88	0.13	0.90	0.68	1.36	0.01	1
	20	0.33	0.66	0.35	0.60	0.62	1.24	0.03	0.97
	30	0.22	0.43	0.59	0.33	0.55	1.11	0.04	0.93
	40	0.12	0.25	0.77	0.16	0.48	0.96	0.06	0.90
	50	0.07	0.14	0.88	0.07	0.40	0.80	0.10	0.86
30-year	0	0.65	1.30	0.01	1	0.87	1.74	0	1
(2028)	10	0.53	1.06	0.11	0.91	0.82	1.65	0.01	1
	20	0.38	0.75	0.35	0.61	0.77	1.53	0.03	0.97
	30	0.22	0.45	0.62	0.34	0.70	1.39	0.05	0.93
	40	0.12	0.24	0.80	0.16	0.61	1.22	0.09	0.90
	50	0.06	0.12	0.90	0.07	0.51	1.01	0.11	0.86

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch

[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 31 (continued). Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **large coastal shark complex, sandbar, and blacktip (only "best" CPUE series and those with "data problems" [according to one reviewer] used)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		Trumble's review	
Parameter	**EV**	**CV**	**EV**	**CV**
	Blacktip			
K	13020	0.43	---	---
r	0.19	0.82	---	---
C_0	312	0.42	---	---
N_{1998}	10212	0.51	---	---
N_{1998}/K	0.76	0.23	---	---
MSC	537	0.80	---	---
RY_{1998}	240	0.27	---	---

		Prager form *(Blacktip)*			
Horizon	**TAC**[1]	N_{fin}/K[2]	N_{fin}/N_{msy}	$P(N_{fin}<0.2K)$	$P(N_{fin}>N_{98})$
10-year	0	0.88	1.76	0	1
(2008)	10	0.87	1.74	0	1
	20	0.86	1.71	0	0.99
	30	0.84	1.68	0.01	0.97
	40	0.83	1.65	0.01	0.95
	50	0.81	1.62	0.02	0.91
20-year	0	0.94	1.87	0	1
(2018)	10	0.92	1.83	0	1
	20	0.90	1.79	0	0.99
	30	0.87	1.75	0.01	0.97
	40	0.85	1.70	0.01	0.95
	50	0.83	1.66	0.02	0.91
30-year	0	0.96	1.92	0	1
(2028)	10	0.94	1.88	0	1
	20	0.92	1.83	0	0.99
	30	0.89	1.78	0.01	0.97
	40	0.86	1.73	0.02	0.95
	50	0.84	1.67	0.03	0.91

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Table 32. Estimated expected values (EV) of the means and coefficients of variation (CV) of marginal posterior distributions for output parameters from the Bayesian surplus production model analysis. Results for the **blacktip shark (with the Early Rec CPUE series only, and with all the other CPUE series except Early Rec)** with the Prager form are compared to those reported by one of the reviewers. Predictions of alternative harvesting policies are also included.

	Prager form		**Prager form**	
Parameter	**EV**	**CV**	**EV**	**CV**
	Early Rec only		*Other series only*	
K	13342	0.42	6441	0.48
r	0.21	0.78	0.11	0.78
C_0	329	0.43	265	0.43
N_{1998}	10777	0.47	1886	1.44
N_{1998}/K	0.79	0.17	0.25	0.70
MSC	592	0.73	149	0.79
RY_{1998}	255	0.22	88	0.67

		Prager form *(Early Rec only)*				**Prager form *(Other series only)***			
Horizon	**TAC**[1]	**N_{fin}/K**[2]	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**	**N_{fin}/K**[2]	**N_{fin}/N_{msy}**	**$P(N_{fin}<0.2K)$**	**$P(N_{fin}>N_{98})$**
10-year	0	0.91	1.82	0	1	0.41	0.82	0.17	1
(2008)	10	0.90	1.80	0	1	0.37	0.74	0.28	0.88
	20	0.89	1.78	0	1	0.31	0.62	0.42	0.62
	30	0.88	1.75	0	0.99	0.25	0.51	0.56	0.40
	40	0.86	1.73	0	0.97	0.20	0.40	0.67	0.24
	50	0.85	1.70	0	0.95	0.16	0.32	0.74	0.16
20-year	0	0.96	1.91	0	1	0.59	1.18	0.05	1
(2018)	10	0.94	1.88	0	1	0.50	1	0.17	0.91
	20	0.92	1.85	0	1	0.39	0.77	0.36	0.66
	30	0.91	1.81	0	0.99	0.28	0.55	0.55	0.42
	40	0.89	1.77	0	0.98	0.19	0.39	0.70	0.25
	50	0.87	1.74	0.01	0.95	0.15	0.30	0.78	0.17
30-year	0	0.98	1.95	0	1	0.72	1.43	0.02	1
(2028)	10	0.96	1.92	0	1	0.60	1.20	0.12	0.92
	20	0.94	1.88	0	1	0.45	0.89	0.34	0.67
	30	0.92	1.84	0	0.99	0.30	0.60	0.55	0.43
	40	0.90	1.80	0.01	0.98	0.20	0.40	0.71	0.25
	50	0.88	1.75	0.01	0.95	0.15	0.30	0.79	0.17

[1] Total Allowable Catch policy option expressed as a percentage of the reported 1995 catch
[2] N_{fin}/K is the stock abundance in the final year of management (2008, 2018, or 2028) as a percentage of K

Figure 1. Marginal posterior distributions of baseline parameters (original importance function with the Prager form SPM) for the **large coastal complex**

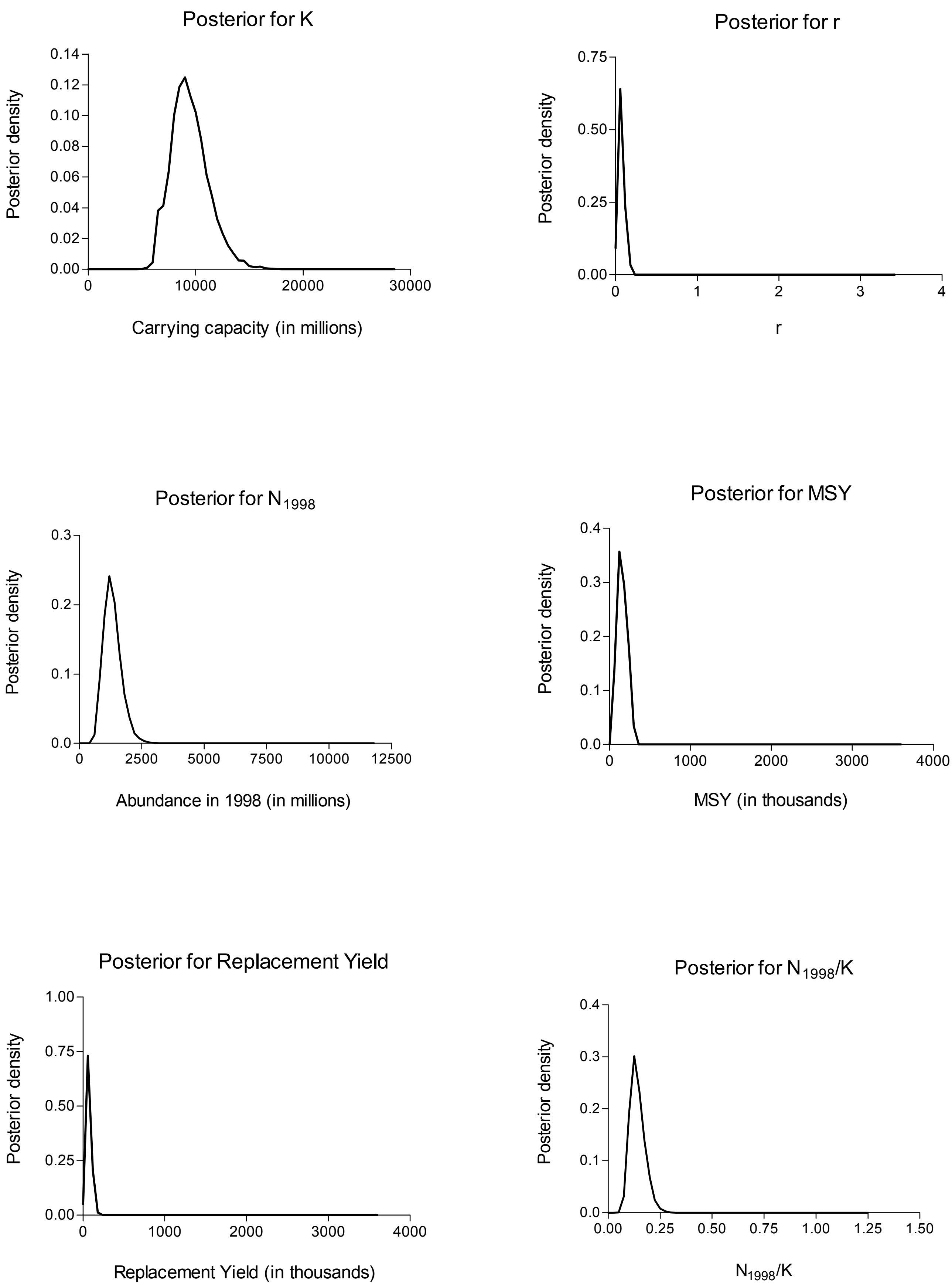


Figure 2. Marginal posterior distributions of baseline parameters (importance function with a variance expansion factor of two, and the Prager form SPM) for the **large coastal complex**

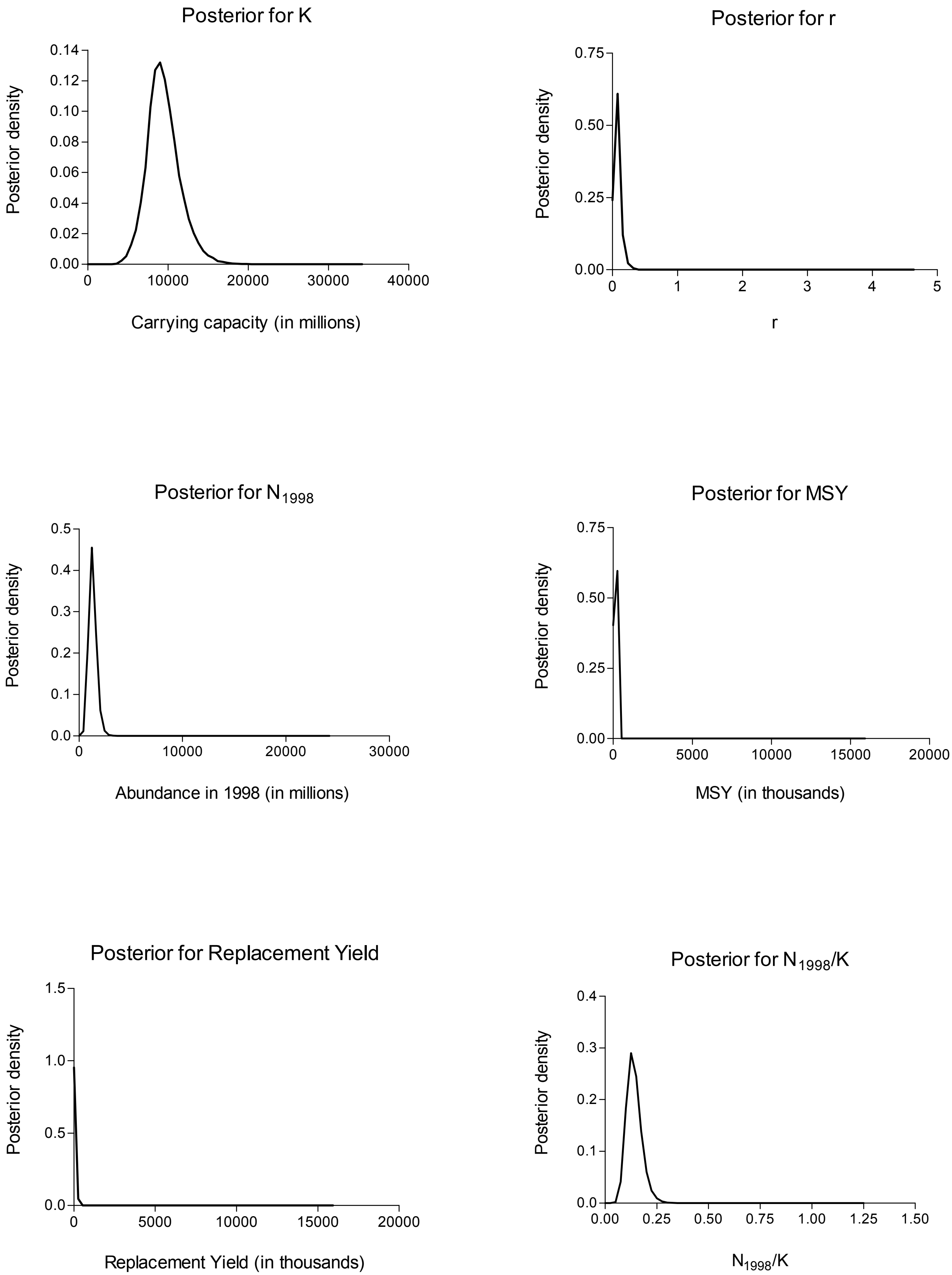


Figure 3. Marginal posterior distributions of baseline parameters (original importance function with the Prager form SPM) for **sandbar shark**

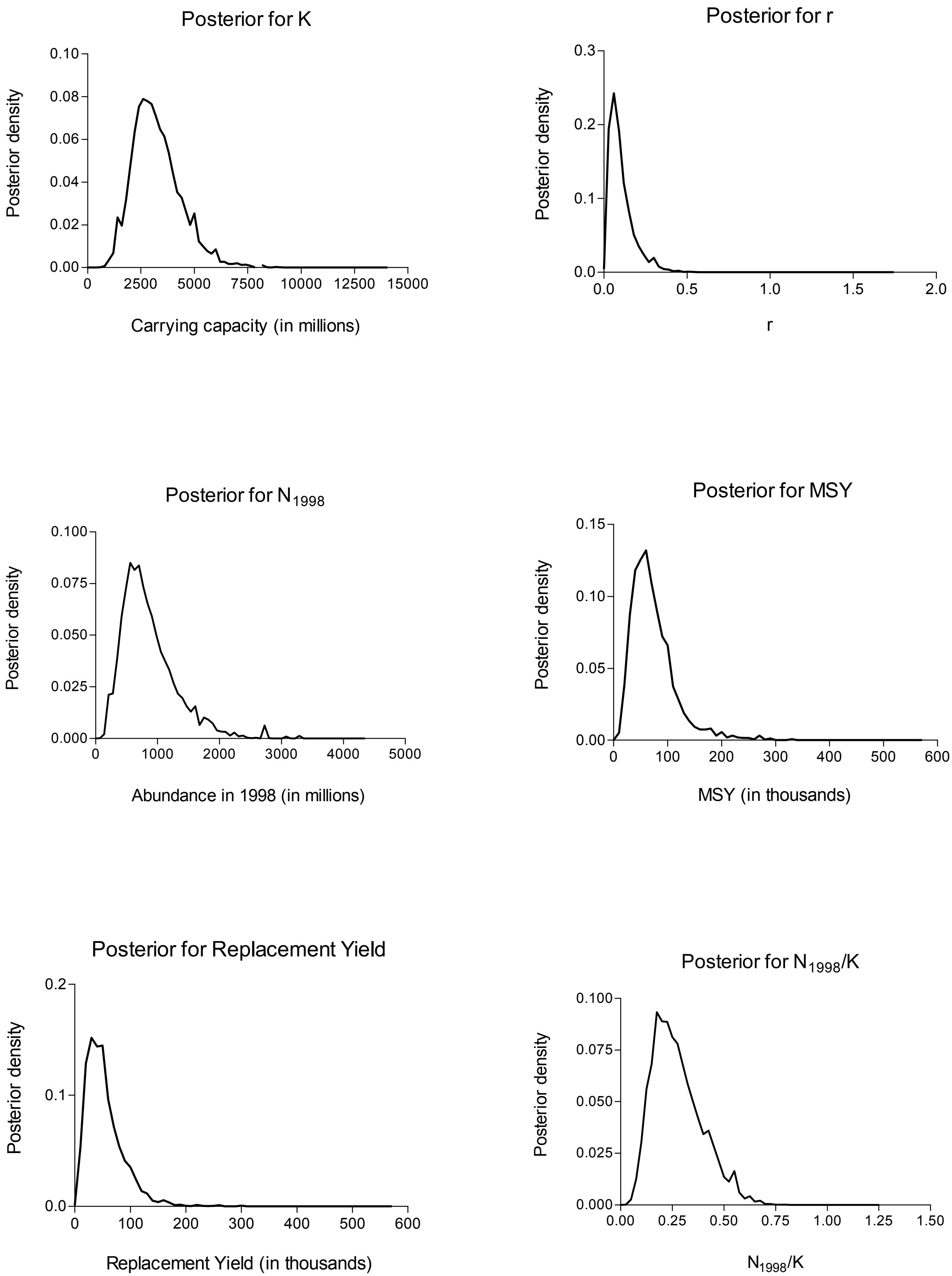


Figure 4. Marginal posterior distributions of baseline parameters (importance function with a variance expansion factor of two, and the Prager form SPM) for **sandbar shark**

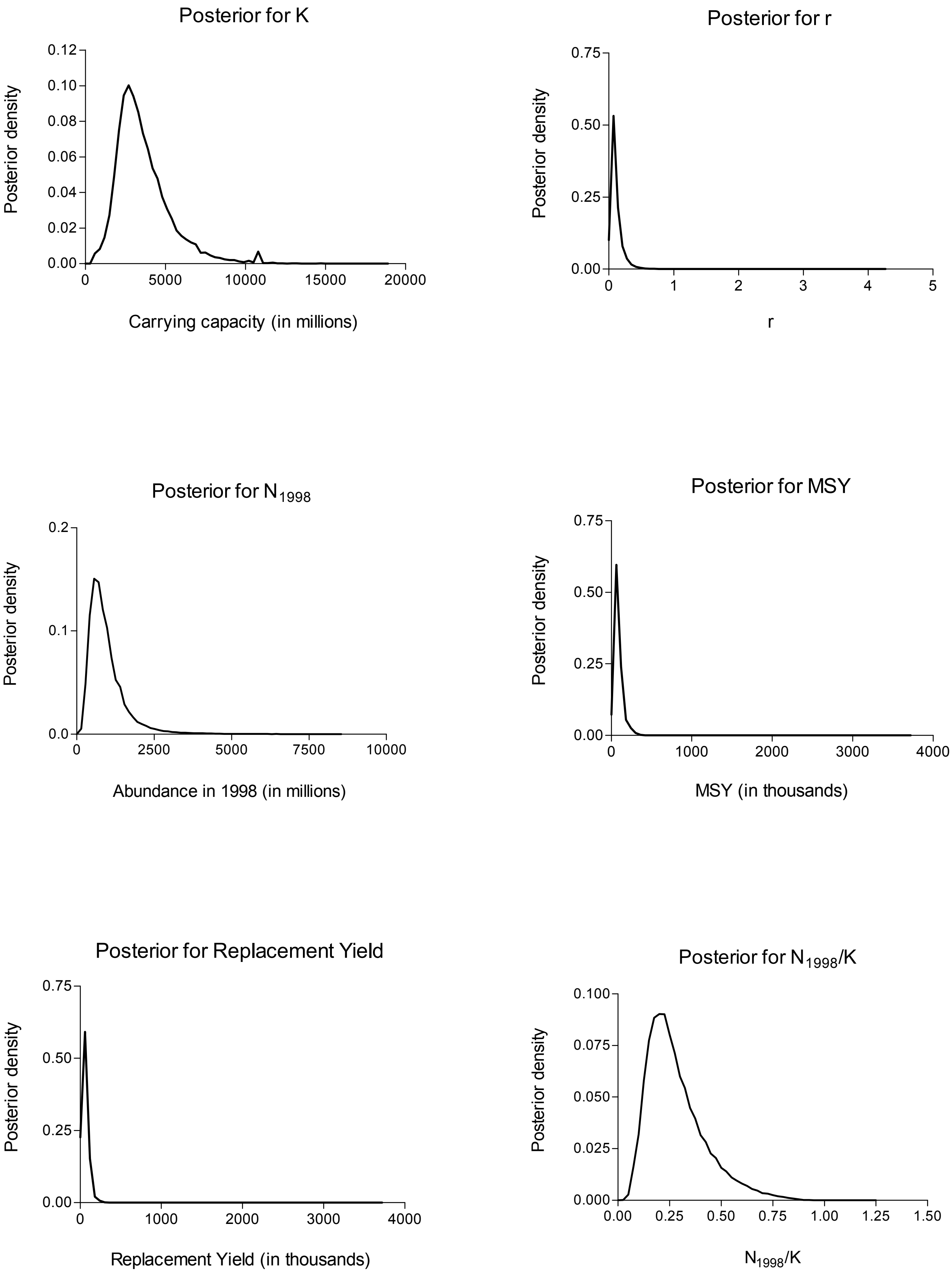


Figure 5. Marginal posterior distributions of baseline parameters (original importance function with the Prager form SPM) for **blacktip shark**

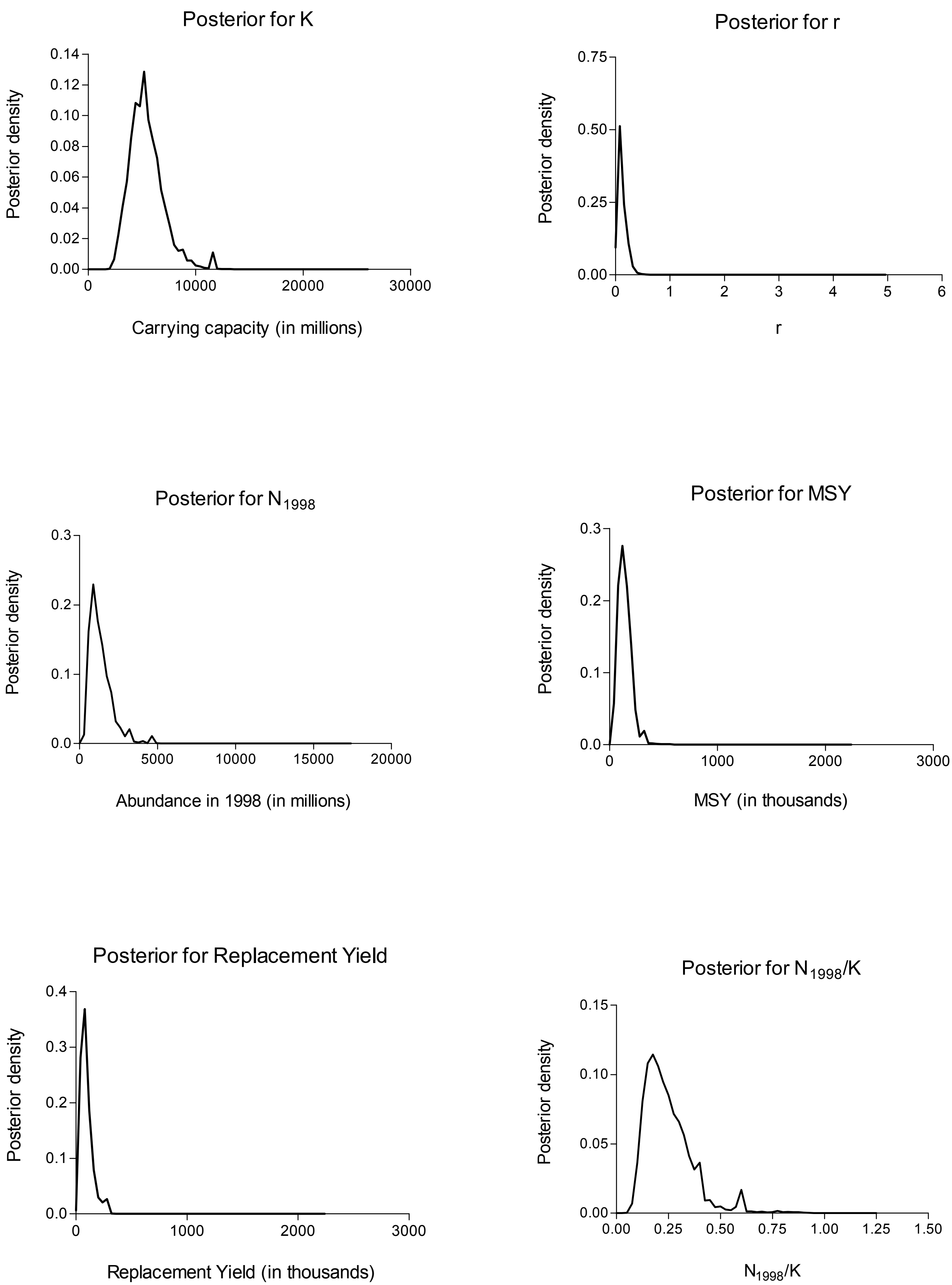


Figure 6. Marginal posterior distributions of baseline parameters (importance function with a variance expansion factor of two, and the Prager form SPM) for **blacktip shark**

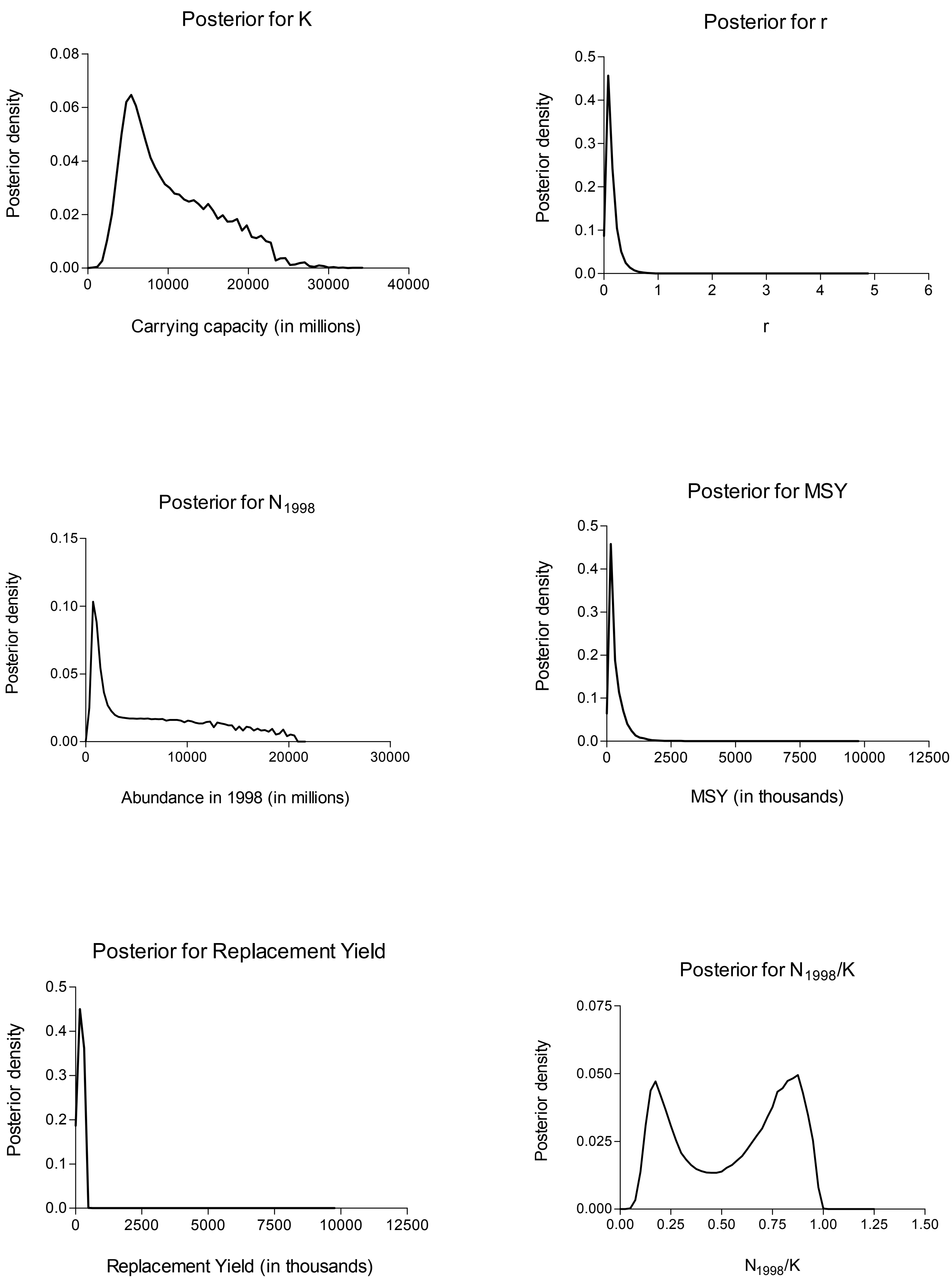
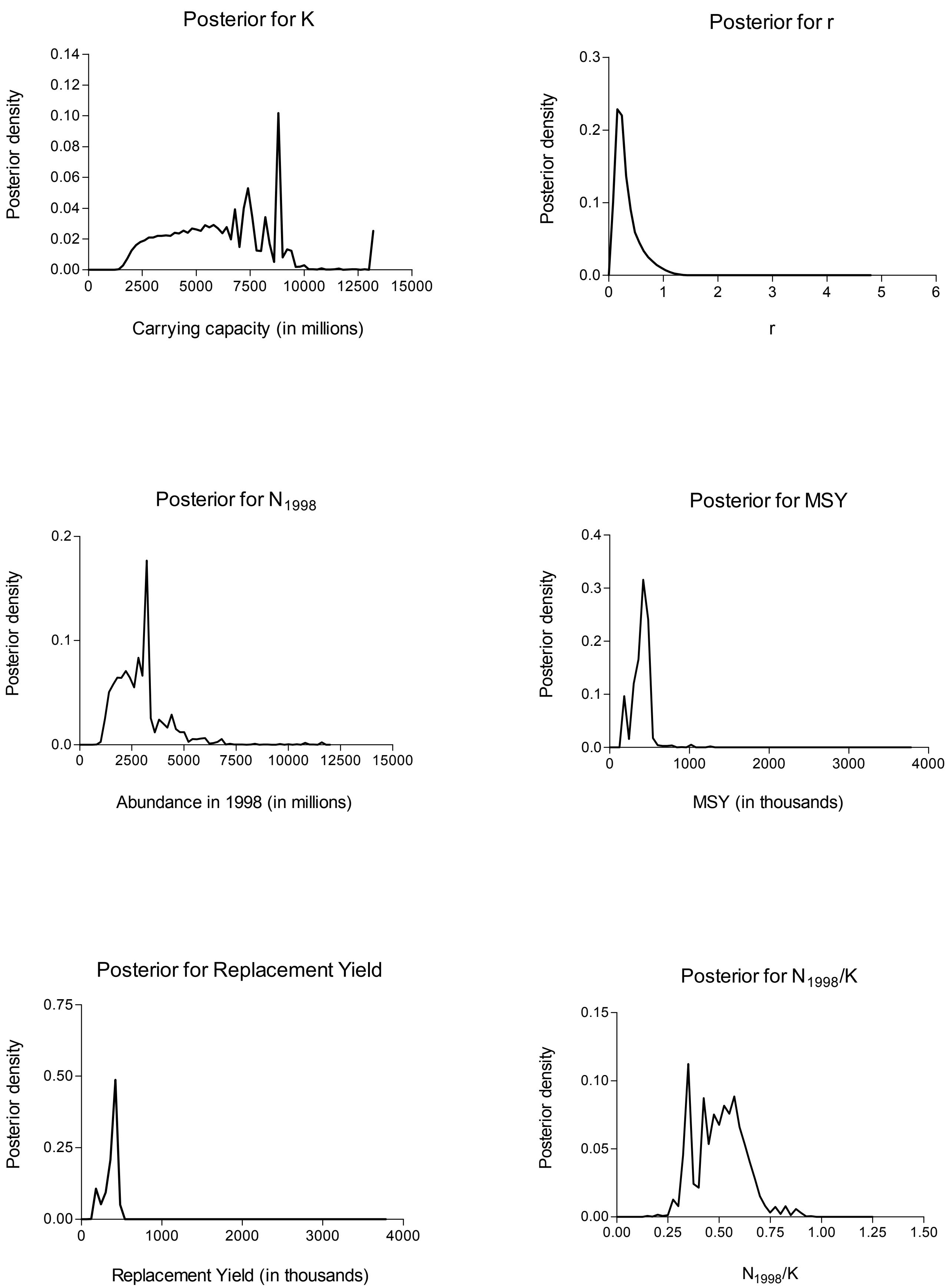


Figure 7. Marginal posterior distributions of baseline parameters (importance function with a variance expansion factor of two, and the Prager form SPM) for the **large coastal complex with only "best" CPUE series (according to one reviewer) used**



Appendix 1. Alternative catch histories (Table 3 in the 1998 SEW report for the large coastal complex and modified from Tables 5 and 4 for the sandbar and blacktip, respectively) to account for increased landings and dead discards. Numbers of fish in thousands.

Large coastal complex

Year	Commercial Landings	Pelagic longline discards	Recreational catches	Unreported catches	Bottom longline discards	Total
1981	24.3	10	265.0			299.3
1982	24.3	10	413.9			448.2
1983	26.2	10	324.6			360.8
1984	35.8	10	254.6			300.4
1985	33.3	10	366.1			409.4
1986	108.0	10	426.1	24.9		603.8
1987	209.4	9.7	314.4	70.3		499.0
1988	549.2	11.4	300.6	113.3		974.5
1989	702.0	10.5	221.1	96.3		1029.9
1990	535.0	8.0	213.2	52.1		808.3
1991	400.4	7.5	293.3	11.3		712.5
1992	430.4	20.9	304.9			756.2
1993	254.1	7.3	249.0		25.4	535.8
1994	228.0	8.8	160.9		22.8	420.5
1995	222.4	6.1	183.4		22.2	434.1
1996	164.5	5.7	184.5		16.4	371.1
1997	98.4	5.6	161.9		9.8	275.7

Sandbar shark

Year	Commercial Landings	Recreational catches	Unreported catches	Total
1986	33.3	123.7	6.2	163.2
1987	127.3	32.5	17.6	177.5
1988	152.5	64.8	56.7	274.0
1989	234.9	27.4	48.1	310.4
1990	224.3	58.8	26.0	309.2
1991	183.4	37.0	5.6	225.9
1992	193.3	36.3		229.6
1993	103.8	26.6		130.4
1994	132.5	15.0		147.5
1995	82.7	24.9		107.6
1996	64.0	35.2		99.2
1997	32.0	40.9		72.9

Appendix 1 (continued).

Blacktip shark

Year	Commercial Landings	Recreational catches	Unreported catches	Mexican catches	Total
1986	88.8	162.4	18.7	15.6	285.5
1987	142.8	129.5	52.7	22.4	347.4
1988	322.0	139.8	56.7	29.0	547.5
1989	373.9	111.4	48.2	35.7	569.2
1990	200.2	94.1	26.0	42.5	362.9
1991	267.7	150.8	5.6	49.2	473.3
1992	352.2	157.7		55.9	565.7
1993	225.9	109.0		62.6	397.5
1994	191.5	66.1		62.6	320.1
1995	139.5	67.0		62.6	269.1
1996	95.1	78.0		62.6	235.7
1997	75.6	68.3		62.6	206.5

Appendix 2. Alternative catch history modified from Table 3 in the 1998 SEW report (scenario run by one of the reviewers) to account for increased landings and non-U.S. catches. Numbers of fish in thousands.

Large coastal complex

Year	Commercial Landings	Pelagic longline discards	Recreational catches	Unreported catches	Bottom longline discards	Non-U.S. catches	Total
1981	32.4	10	265.0			100.0	407.4
1982	32.4	10	413.9			100.0	556.3
1983	35.0	10	324.6			100.0	469.6
1984	47.8	10	254.6			100.0	412.4
1985	44.4	10	366.1			100.0	520.5
1986	162.0	10	426.1	24.9		100.0	723.0
1987	314.1	9.7	314.4	70.3		100.0	808.5
1988	823.8	11.4	300.6	113.3		100.0	1349.1
1989	1053.0	10.5	221.1	96.3		100.0	1480.9
1990	802.8	8.0	213.2	52.1		100.0	1176.1
1991	600.6	7.5	293.3	11.3		100.0	1012.7
1992	645.6	20.9	304.9			100.0	1071.4
1993	338.8	7.3	249.0		25.4	100.0	720.5
1994	228.0	8.8	160.9		22.8	100.0	520.5
1995	222.4	6.1	183.4		22.2	100.0	534.1
1996	164.5	5.7	184.5		16.4	100.0	471.1
1997	98.4	5.6	161.9		9.8	100.0	375.7