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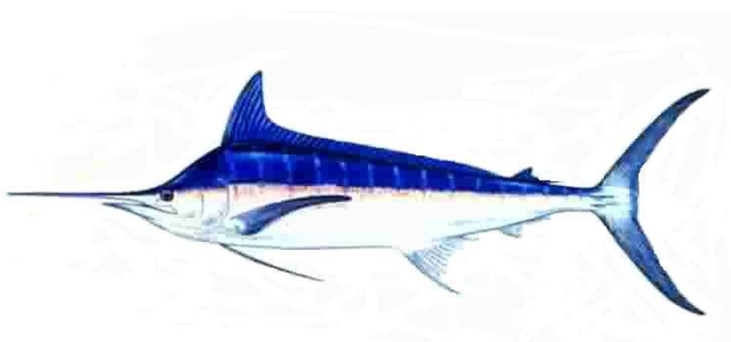

[1] Working document submitted to the ISC Marlin and Swordfish Working Group Workshop, July 19-21, 2007, Pusan, Korea. Document not to be cited without author's written permission.

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# Evaluation of Model Performance from the 2007 ISC Striped Marlin Stock Assessment

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## Abstract:

A stock assessment of striped marlin in the North Pacific Ocean was completed in March 2007. A series of model investigations were completed after the meeting to test the assessment models performance. It was noted that the size composition of the driftnet fishery was not consistent with the growth curve assumed in the model. However, further evaluations of the model to discount or eliminate this inconsistency did not show marked differences in results relative to the assessment produced during the March meeting. Other assumptions in the model also appear to be reasonable and small changes would not unduly affect assessment results. Our results support the use of Spawner/Recruit steepness as the axis of uncertainty. This work also supports the use of the stock assessment as a basis for making management recommendations.

## Introduction:

In the March, 2007 meeting of the Striped Marlin WG (SMWG) a draft assessment of the stock status of the north pacific striped marlin was conducted. The assessment was based upon SMWG papers presented during the meeting and at previous meetings. More specifically, the stock assessment was built upon a series of preliminary model runs described in Piner et al. (2006). However, many changes to the models described in that working paper were incorporated into the final models used to characterize stock status. This paper reflects additional work that was done after that meeting to understand model performance issues that could not be dealt with during the meeting.

In this paper we explore model improvements, specifically how to deal with the model in several years (primarily the 1970) hitting the upper bound of the specified harvest rates. We also explore the sensitivity of the results to our assumed variation in the length-at-age relation. We also characterize the information available to estimate steepness of the Spawner/Recruit (S/R) function.

## Methods:

The base stock assessment agreed upon by the WG was used to develop several additional model configurations to eliminate or minimize the effect of the F penalty. An F penalty is an additional contribution to the likelihood resulting from a harvest rate (observed catch/available biomass) that approaches a specified threshold. They are useful to prevent the model from crashing due to zero fish. However, penalties are also useful diagnostics that can show data inconsistencies within the model.

The 2007 baseline assessment had a penalty on the JPN Driftnet fishery in 2 years that were the result of the model wanting to remove at any one time more than 90% of the available biomass. We constructed alternative model scenarios that attempted to remove this penalty without altering the structure of the assessment as specified by the WG during the 2007 meeting by the following methods:

1) increased the lambda (multiplier for the contribution to the likelihood) on the penalty to sufficient size to insure that all catch was removed.
2) removed the length samples from the driftnet fishery and assumed the driftnet fishery had the same selectivity pattern as the Japanese Distant-Water longline fishery.

We compare model fits to the data and estimated time series and biomass trajectories to determine the effect of the penalty on model results.

In addition, we did additional sensitivity analyses to assumed levels of 1) steepness and the variability on the length at age relation.

## Results and Conclusions:

The results indicate that striped marlin stock status is not greatly influenced by the conditions leading to the F-Penalty (Figures 1 and 2). This is not surprising as only ~3% of the total catch was not being removed in the base model with h=0.7. Specifically, the model failed to remove all the catch from the driftnet fishery during the 1970s. Our investigations show that the proportion-at-length data used to describe the removals of the driftnet fishery was larger fish than the asymptotic length of the assumed growth curve. The population was already much reduced below historical levels by the 1970's which contributed to the lack of larger fish. The model therefore had difficulty producing enough large fish to remove. Removal of the driftnet proportion at length data or more intensely penalizing excessive harvest rates resulted in very similar starting and ending biomasses, but somewhat changed the magnitude of the peak population size during the 1970's (Figures 1 and 2). The rapid increase and decline in spawning biomass seen in the 1970's is partially due to the model creating sufficient fish to prevent approaching the maximum harvest rate.

In hindsight, I probably would have recommended not including the driftnet length composition information as it is somewhat inconsistent with the assumed growth form. This is consistent with the decision to remove the EPO purse seine data for similar reasons. A further benefit to the removal of driftnet lengths composition was improved fit to the cpue series (Tables 1 and 2). However, the inconsistency between driftnet length composition and the growth model is relatively minor and not consequential to the assessment results. The size composition from the driftnet fishery may very well be an accurate representation of the size structure of the removals from that area and gear, and improvements in our understanding of growth of striped marlin may eliminate this issue altogether. It is likely that growth of striped marlin is quite variable across the North Pacific Ocean and capturing that variability is beyond the capability of modeling processes at this time. We note that that the EPO purse seine data may also be reasonable representation of the EPO despite suggesting a radically different size structure to the population. Until we better understand these issues, the removal of inconsistent data may be an appropriate method to deal with the uncertainty. Further work on this issue is certainly warranted.

Results of additional sensitivity runs indicated that the assumed level of S/R steepness (h=0.7) was consistent with the data in the model. Estimating steepness resulted in h=0.73 (Figure 3), which results in a spawning biomass trajectory very similar to the h=0.7. The model that assumed h=1 was not as consistent with the other data resulting in a degradation of ~50 likelihood units (Table 1 and 2) and a different biomass trajectory. In contrast, the model does not appear to be very sensitive to the assumed variability in the length-at-age relationship (Figure 4). Increasing or decreasing this variability over a reasonable range has the effect of only slightly rescaling the population size but similar trends in abundance.

In the March SMWG meeting, the WG chose to bound uncertainty using the assumed level of S/R steepness. Magnitude of changes to parameters such as M can be seen in Piner et. al. (2007). It is clear from these sensitivity runs, that S/R steepness is a very influential assumption governing the trend in stock biomass and appropriate for bounding the range of uncertainty.

All alternative models described essentially the same population dynamics. It is therefore the conclusion of this work that management based upon the models developed at the March meeting are not unduly affected by the driftnet data or assumption made at the meeting. However, there needs to be more work done to understand the length data from the driftnet fishery and more work on the growth parameters of striped marlin in the NPO.

## Literature Cited

**Piner,K**., Conser, R., Dinardo, G., and Brodziak, J. 2007. SS2 sensitivity runs for striped marlin assessment WG 2007. Taipei, Chinese Taipei. ISC/07/SM-WG/02

Table 1. Likelihood table (total and by component) for the base model (h=0.7), increased penalty and elimination of driftnet length composition. Total likelihood and components are given.

| | base | heavy penalty | eliminate dftn lengths |
|---|---|---|---|
| Total LIKELIHOOD | 8752.48 | 8796.05 | 8364.29 |
| indices | -74.4887 | -63.2932 | -79.6824 |
| length_comps | 8823.81 | 8869.18 | 8454.48 |
| Equil_catch | 4.22E-06 | 4.26E-06 | 2.06E-06 |
| Recruitment | -10.3388 | -9.83807 | -10.5122 |
| penalties | 13.5016 | 0.00110179 | 0 |
| fishery 1 length | 1401.96 | 1410.7 | 1401.68 |
| fishery 2 length | 881.276 | 885.684 | 878.522 |
| fishery 3 length | 806.34 | 824.328 | 822.232 |
| fishery 4 length | 810.879 | 812.409 | 818.323 |
| fishery 5 length | 563.805 | 559.72 | 561.685 |
| fishery 6 length | 447.229 | 447.252 | 449.106 |
| fishery 7 length | 723.024 | 726.088 | 708.571 |
| fishery 8 length | 681.412 | 683.05 | 683.603 |
| fishery 9 length | 1323.2 | 1321.2 | 1338.98 |
| fishery 10 length | 354.984 | 349.926 | 343.787 |
| fishery 11 length | 395.651 | 415.43 | 0 |
| fishery 12 length | 251.843 | 251.385 | 258.592 |
| fishery 13 length | 182.202 | 182.004 | 189.404 |
| survey 1 | -20.7967 | -18.0172 | -21.5017 |
| survey 2 | -3.99067 | -2.91193 | -4.78928 |
| survey 3 | -6.54767 | -5.57398 | -6.89764 |
| survey 4 | -4.78025 | -3.66424 | -5.34132 |
| survey 5 | -4.25124 | -4.63078 | -5.31881 |
| survey 6 | -8.97889 | -7.0031 | -9.66144 |
| survey 7 | -7.51216 | -6.43643 | -7.83768 |
| survey 8 | -2.87079 | -0.617386 | -4.09317 |
| survey 9 | 2.29687 | 2.2958 | 2.42262 |
| survey 10 | -8.72403 | -8.82489 | -8.89742 |
| survey 11 | -8.04436 | -7.89052 | -7.93061 |
| survey 12 | -1.1163 | -1.05659 | -0.974481 |
| survey 13 | 0.827522 | 1.03802 | 1.13853 |

Table 2. Likelihood table (total and by component) for the base model (h=1.0), increased penalty and elimination of driftnet length composition. Total likelihood and components are given.

| | base | heavy penalty | eliminate dftn lengths |
|---|---|---|---|
| Total LIKELIHOOD | 8801.76 | 8854.98 | 8414.51 |
| indices | -34.5509 | -29.441 | -37.434 |
| discard | 0 | 0 | 0 |
| length_comps | 8825.84 | 8884.42 | 8451.92 |
| age_comps | 0 | 0 | 0 |
| size-at-age | 0 | 0 | 0 |
| mean_body_wt | 0 | 0 | 0 |
| Equil_catch | 1.05E-05 | 0.000107947 | 3.33E-05 |
| Recruitment | 0 | 0 | 0 |
| Parm_priors | 0 | 0 | 0 |
| Parm_devs | 0 | 0 | 0 |
| penalties | 10.4698 | 0.00262081 | 0.024528 |
| fishery 1 length | 1403.47 | 1417.22 | 1407.03 |
| fishery 2 length | 883.489 | 890.304 | 880.397 |
| fishery 3 length | 812.326 | 833.041 | 828.324 |
| fishery 4 length | 806.908 | 802.439 | 809.911 |
| fishery 5 length | 557.926 | 544.156 | 545.893 |
| fishery 6 length | 447.791 | 449.951 | 450.488 |
| fishery 7 length | 726.035 | 732.328 | 710.164 |
| fishery 8 length | 685.187 | 695.313 | 687.772 |
| fishery 9 length | 1322.36 | 1323.08 | 1337.8 |
| fishery 10 length | 352.834 | 359.445 | 348.298 |
| fishery 11 length | 395.958 | 408.297 | 0 |
| fishery 12 length | 250.395 | 248.907 | 257.398 |
| fishery 13 length | 181.164 | 179.94 | 188.442 |
| survey 1 | -14.4196 | -12.2804 | -15.0051 |
| survey 2 | 2.51622 | 2.33772 | 2.452 |
| survey 3 | -7.16038 | -6.755 | -8.00542 |
| survey 4 | 1.29436 | 0.52008 | 1.10748 |
| survey 5 | -3.32329 | -0.548603 | -3.11956 |
| survey 6 | -1.99371 | -2.54089 | -2.21892 |
| survey 7 | -8.21552 | -8.00422 | -9.21184 |
| survey 8 | 10.8891 | 8.92011 | 10.4844 |
| survey 9 | 2.30136 | 2.31339 | 2.43051 |
| survey 10 | -8.26494 | -6.34428 | -8.03585 |
| survey 11 | -7.81254 | -6.807 | -7.82754 |
| survey 12 | -1.11026 | -0.948963 | -1.11038 |
| survey 13 | 0.748323 | 0.697013 | 0.62631 |

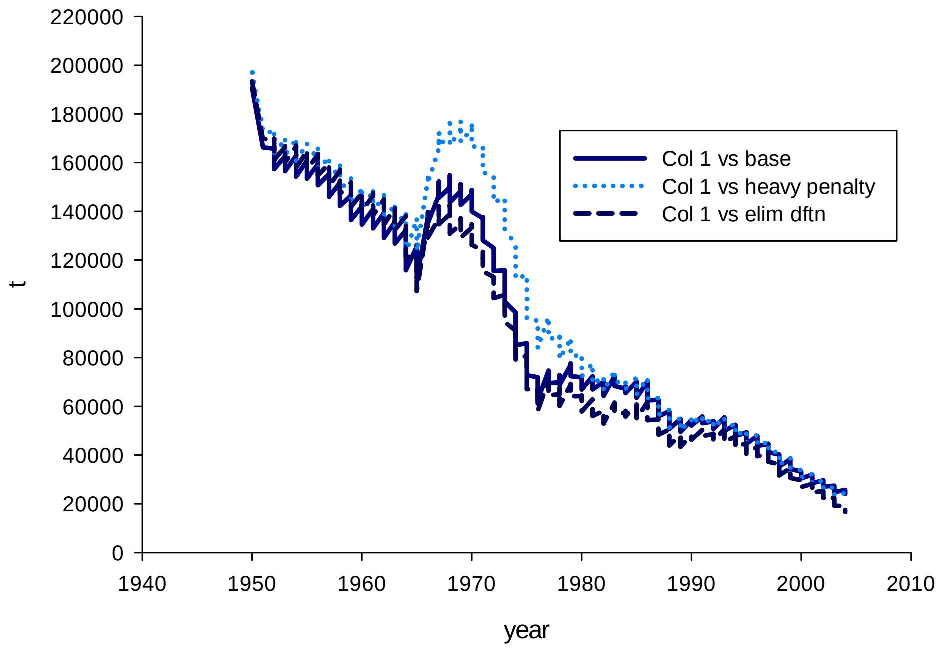


Figure1. Age 1+ biomass from 3 alternative models 1) base, 2) heavy F penalty and 3) eliminate the driftnet length compositions. All models assumed h=0.7

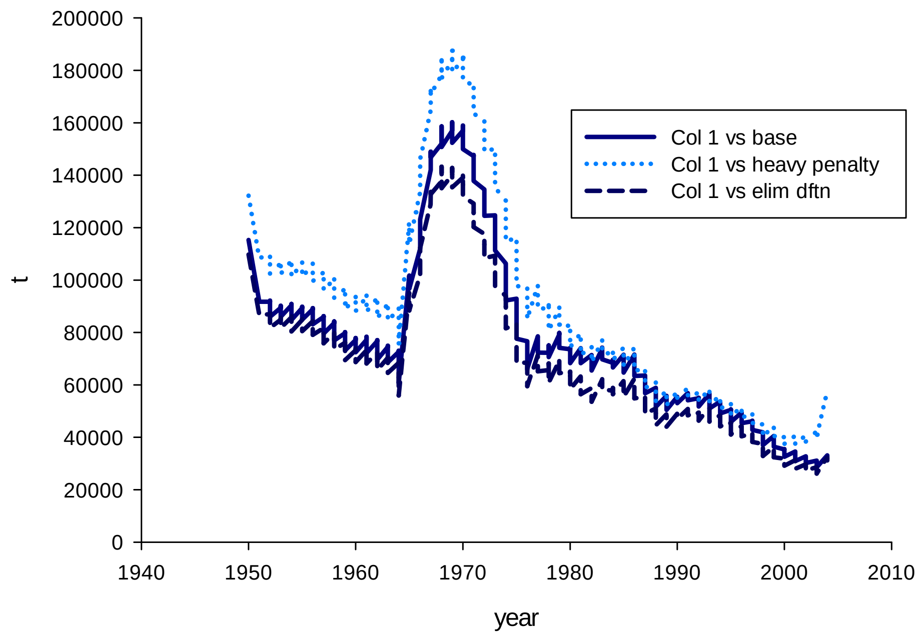


Figure2. Age 1+ biomass from 3 alternative models 1) base, 2) heavy F penalty and 3) eliminate the driftnet length compositions. All models assumed h=1.0

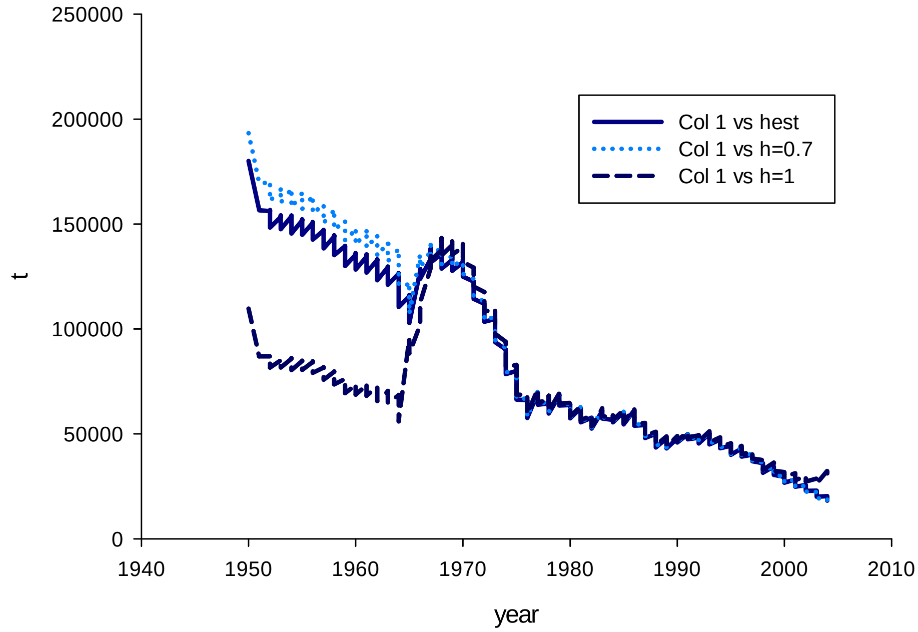


Figure3. Age 1+ biomass timeseries resulting from different levels of h 1) h=0.7, 2) h=1.0 and 3) h estimated.

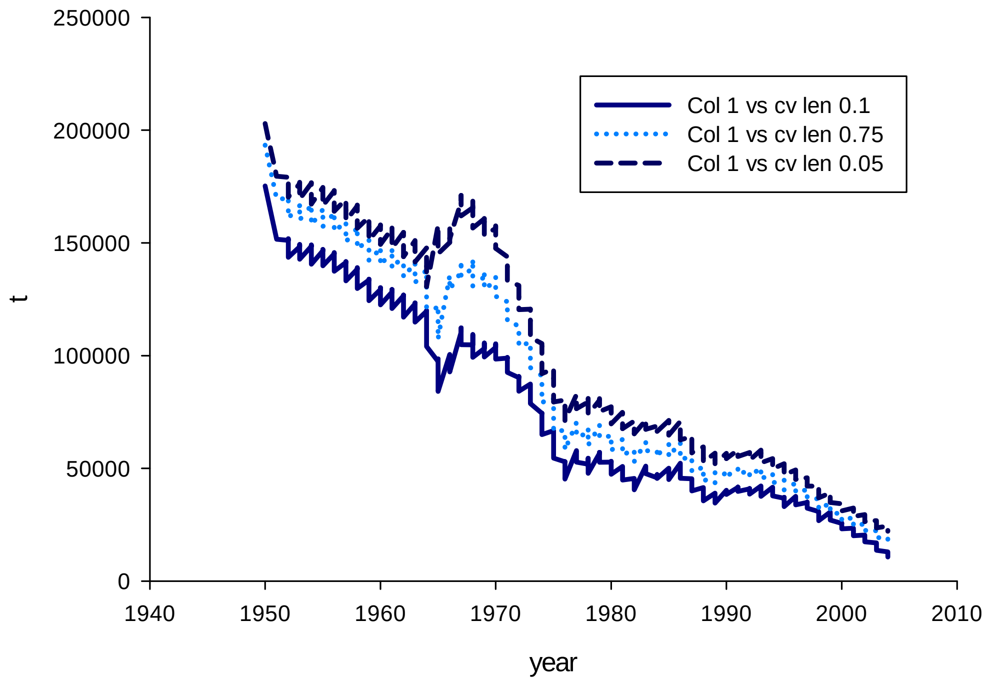


Figure 4. Age 1+ biomass resulting from different levels of the CV around length at age 1) CV=.1, Cv=0.75 (base) and CV=0.05. This model assumed h=0.7 and eliminated driftnet length compositions.