# Report of the ad-hoc working group on standard projection model (SPM) methods for N. Pacific groundfish

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# Background

During the November 2004 groundfish Plan Team meetings the Teams requested that work on enhancing the standardized projection model (SPM) methodology. The current projection model and methods have been used since 1999 and were designed to provide the needed projection scenarios for the annual Environmental Assessment (EA) for the TAC specifications. Additionally, two other scenarios were conducted to determine whether a stock is currently in an overfished condition or is approaching an overfished condition. The details for the projection scenarios are given in Fig. 1.

The current methodology is problematic for a number of reasons. First, the model software was not designed to provide the basis for ABC and OFL recommendations beyond the coming year. Under amendment 48/48, and as was done in 2004, the Council is required to make ABC, TAC, and OFL recommendations for the next two years (i.e., for 2005 and 2006). The projection model and software needs to be modified to accommodate this. Also, there are a number of assumptions in the projection model that should be explored more fully (e.g., the underlying stock-recruitment relationship assumptions, and the estimated uncertainty in current stock abundance levels). A list of discussion points handed out at the meeting is presented in Fig. 2.

Since this activity relates to ongoing research on the North Pacific groundfish Management Strategy Evaluation (MSE) studies, the overlap between these activities was acknowledged. Also, as the National Standard Guidelines (NSG) are under revision, it was anticipated that the projection model and code could easily be adopted to meet any new demands.

# Tasks

### New ABC/OFL specification requirements

The group concurred that at a minimum the projection model should be made to have a consistent, easy to use interface that will deal appropriately with the new projection demands of the Plan Teams and Council. Specifically, the ability to compute projected ABC and OFL levels in future years given specific actual catch levels (as opposed to catch levels determined internally based on control-rule *F’s*) should be given the highest priority. This will be implemented in future versions of the code for the projection model and will be facilitated with the NMFS headquarters initiative to develop a common software “Toolbox.”

The group discussed alternatives to the technical interaction model used for the PSEIS. Namely, that simpler approaches to modeling future catch levels may be appropriate, especially given that we now have a fair number of years where ABC, OFL, TAC, and actual catch levels are available by species. It was suggested that a model simply using these data and a number of constraints may be straightforward. Bayesian relational networks was mentioned as an approach that might be useful.

In response to this discussion, it may be useful to develop the GUI (graphical user interface) from the toolbox to allow for multispecies specifications. A user interested in a single species can simply set the model up as being for one species. This way, linkages between stocks and fisheries can be implemented as time permits

### Uncertainty in current stock size estimates

A number of methods were discussed to implement this as a permanent feature in the projection model code. One approach that has already been implement in PSEIS Alternative 3b, calls for estimates of the covariance estimates in begin-year numbers at age used for the projection model. This development was based on the same code as the current projection model code. For this to easily be implemented in future versions of the projection model, **assessment authors would be required to submit estimates of the covariance matrix associated with the begin-year numbers at age vector.** For the PSEIS, this was done as a one-time implementation but not formally incorporated in all current assessment model code. Since Alt 3b has been selected as the preferred alternative, scientists at the AFSC have recognized the requirement to develop this approach further. For assistance, some code-snippets and output conventions will be distributed to authors so that it can be easily incorporated. The projection model could then be used to adjust ABC’s accordingly (e.g., as in Alt 3b) or form the basis for simulating the posterior distribution of current stock sizes.

An alternative approach would be to have a projection model operate from a matrix of parameter vectors that describe the full joint-posterior distribution of model estimates. I.e., **the assessment models would have to be designed to provide MCMC-like output on parameters critical for the projection model.** The group anticipated that this will be a bit more demanding (on the part of individual assessment authors) and that more research is needed on how current age-structured assessments behave under MCMC evaluations compared to the current practice of using modal estimates.

### Stock-recruitment relationship specifications

The group discussed options for improving the projection model assumption about recruitment (i.e., that it varies about the mean level estimated from 1978 to the most recent estimated). In particular, having recruitment that is affected by spawning stock biomass (SSB) levels was considered to be more realistic. Also, specifying some degree of autocorrelation in residuals was considered desirable.

The options for using an alternative stock-recruitment relationship in the projection model as a function of SSB were given as:

1. assume *Bmsy*=*B35%* , and *Fmsy* = *F35%* and solve for the parameters
2. assume *Fmsy* = *F35%* and estimate stock-recruitment parameters given stock-recruitment output from the assessment model
3. simply estimate the stock-recruitment parameters from input stock-recruitment output from assessment model
4. use estimates of stock-recruitment parameters from within the assessment model
5. use prior distributions for stock-recruitment parameters (or *Fmsy* and *Bmsy* levels)…

The actual specification of the type of stock-recruitment curve will initially be either Ricker or B-Holt.

The group suggested that option 2) would be a good place to start. They noted **that assessment authors will need to supply estimates of SSB to match the current estimates of recruitment** for the projection model.

Adding autocorrelation to future recruitment is considered important, especially given medium-term patterns in environmental variability that apparently affect recruitment. The specification for autocorrelation function will need to ensure that the expected values are correct.

## Other

An option for writing files with all the annual (simulated) output be allowed so that different analyses can be undertaken (currently, the results are summarized internally).

The standard projection model developed for the purposes of the Council and authors of the EA are not exclusive—individuals are encouraged to undertake their own projection analyses as time permits. The SPM is intended to provide a tool for the Council and assessment models to have a common utility from which to project ABC and OFL levels.

# Summary

The results from this meeting have provided direction for further development of SPM. First, the ability to easily configure different catch scenarios for relevant stocks will be implemented through a single common GUI so to facilitate providing the Council and NMFS RO with the ABC and OFL levels they require for future years. Second, the addition of options to specify stock-recruitment relationships will be added. As an option, autocorrelation in recruitment residuals will be allowed. Third, the ability to simulate from estimates of current stock-size uncertainty will be added (and easily extended to apply to Alt 3b from the PSEIS). Finally, the code will be revised to allow technical interactions (in general) and this will include simpler forms (i.e., by supplying stock-specific catch levels by year) than the “optimized” (LP) method used in the PSEIS. The participants agreed to assist by testing the integrity of SPM assumptions and any estimation and simulation. Coordinating and comparing with similar age-structured projection model (e.g., AGEPRO from the Woods Hole NEFSC software kit) will also be conducted.

### Standard Harvest Scenarios and Projection Methodology (assessment year=2004)

A standard set of projections is required for each stock managed under Tiers 1, 2, or 3, of Amendment 56. This set of projections encompasses seven harvest scenarios designed to satisfy the requirements of Amendment 56, the National Environmental Policy Act, and the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA).

For each scenario, the projections begin with the vector of 2004 numbers at age estimated in the assessment. This vector is then projected forward to the beginning of 2004 using the schedules of natural mortality and selectivity described in the assessment and the best available estimate of total (year-end) catch for 2004. In each subsequent year, the fishing mortality rate is prescribed on the basis of the spawning biomass in that year and the respective harvest scenario. In each year, recruitment is drawn from an inverse Gaussian distribution whose parameters consist of maximum likelihood estimates determined from recruitments estimated in the assessment. Spawning biomass is computed in each year based on the time of peak spawning and the maturity and weight schedules described in the assessment. Total catch is assumed to equal the catch associated with the respective harvest scenario in all years. This projection scheme is run 1000 times to obtain distributions of possible future stock sizes, fishing mortality rates, and catches.

Five of the seven standard scenarios will be used in an Environmental Assessment prepared in conjunction with the final SAFE. These five scenarios, which are designed to provide a range of harvest alternatives that are likely to bracket the final TAC for 2004, are as follow (A “*max* *FABC*” refers to the maximum permissible value of *FABC* under Amendment 56):

*Scenario 1*: In all future years, *F* is set equal to *max* *FABC*. (Rationale: Historically, TAC has been constrained by ABC, so this scenario provides a likely upper limit on future TACs.)

*Scenario 2*: In all future years, *F* is set equal to a constant fraction of *max* *FABC*, where this fraction is equal to the ratio of the *FABC* value for 2005 recommended in the assessment to the *max* *FABC* for 2005. (Rationale: When *FABC* is set at a value below *max* *FABC*, it is often set at the value recommended in the stock assessment.)

*Scenario 3*: In all future years, *F* is set equal to 50% of max *FABC*. (Rationale: This scenario provides a likely lower bound on *FABC* that still allows future harvest rates to be adjusted downward when stocks fall below reference levels.)

*Scenario 4*: In all future years, *F* is set equal to the 2000-2004 average *F*. (Rationale: For some stocks, TAC can be well below ABC, and recent average *F* may provide a better indicator of *FTAC* than *FABC*.)

*Scenario 5*: In all future years, *F* is set equal to zero. (Rationale: In extreme cases, TAC may be set at a level close to zero.)

Two other scenarios are needed to satisfy the MSFCMA’s requirement to determine whether a stock is currently in an overfished condition or is approaching an overfished condition. These two scenarios are as follow (for Tier 3 stocks, the MSY level is defined as *B35%*):

*Scenario 6*: In all future years, F is set equal to FOFL. (Rationale: This scenario determines whether a stock is overfished. If the stock is expected to be 1) above its MSY level in 2005 or 2) above ½ of its MSY level in 2005 and above its MSY level in 2015 under this scenario, then the stock is not overfished.)

*Scenario 7*: In 2005 and 2006, *F* is set equal to *max* *FABC*, and in all subsequent years, *F* is set equal to *FOFL*. (Rationale: This scenario determines whether a stock is approaching an overfished condition. If the stock is expected to be above its MSY level in 2017 under this scenario, then the stock is not approaching an overfished condition.)

###### Figure 1. Standard harvest scenarios used for the projection model (e.g., for assessments done in 2004).

# Projection model discussion points

1) Uniformity among approaches

a. Transparent ability to deal with split sex, multi-fishery cases

*To be implemented under the GUI with toolbox*

b. Tiers 4 & 5

c. New NSG1 (modification of current scenarios)

d. Woods Hole and West coast projection models

2) Stock status uncertainty

a. MVN based on covariance matrix of begin-year N-at-age

Done for Alt 3b, but requires a standard sdreport vector to be declared within the assessment model to produce an estimated covariance matrix

b. MCMC approach

c. Stock-recruitment relationship estimation

Conditional on stock-recruitment form and assumptions (e.g., Fmsy=F35% etc)

i. Estimate w/in model or outside

ii. Specify priors

iii. Autocorrelation?

3) Alternative 3b calculations

a. Conforming to this approach as an option

b. Another method using actual stock-recruitment estimates?

c. How to mesh with management strategy evaluations

Use projection model in “automatic mode” for

4) Tier 1 implementation methods for two and three-year projections

5) Ability to evaluate catch-variability

E.g., Grant’s Mean-Var/2 maximization

6) Multi-species technical interaction projection model

Linked by fishery bycatch rates

Constrained optimization (LP) used, develop alternative?

Bayesian Relational Networks?

Development needs:

Adding Stock-recruitment relationship

Tier 1

Modeled bycatch processes

E.g., function of abundances

Add stochasticity

7) Production versions of model (e.g., for lower tier spp?).

Split sex, multiple fisheries

8) Additional requests from assessment models

Correlation matrix for N-at-age in most recent year

9) Other

Documentation

Scenario development (NSG)

Implementing MVN in N-at-age

Implementing output from MCMC (develop standard input file format) MSE-like stuff

Retaining consistent interface with MSPPTIM Documentation Testing Interface?

###### Figure 2. Random outline of discussion points prepared for ad-hoc working group meeting.