

# Session I: Criteria for Defining Recruitment Overfishing for Fish and Marine Mammals

## Session I Summary

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Rapporteur: Robert Kope, SWFSC

A. Rosenberg presented a survey of overfishing definitions presently incorporated into fishery management plans (FMP). He classified each according to type of definition, assessment method for the stock, quality of life-history data, basis for the definition, and degree of conservatism of the definition. Of the 95 overfishing definitions surveyed, the majority (68) define overfishing in terms of fishing mortality rate and 64 of these are expressed as spawning biomass or egg production per recruit. A substantial number (46) of the stocks are assessed by age-structured methods with indices and surveys constituting the basis of assessments for another 35 stocks. In general we have good life-history data for most stocks (54) and poor data for only 4 of the stocks. In spite of this, overfishing definitions for a majority of stocks (67) are based on analogy to other stocks with similar life histories. Even for the stocks assessed by age-structured methods, 26 out of 46 definitions are based on analogy. For stocks where the conservatism of the overfishing definition could be evaluated (76 stocks), 40 definitions appear cautious or conservative, 33 appear risk neutral, and only 3 appear to be inherently risky.

S. Swartz then presented a review of the definition of depletion and methods of assessing stock status for marine mammals. He noted the differences between marine mammals and fishes in terms of data availability and management objectives. Operationally, marine mammal populations are considered depleted when they are below the maximum net productivity level (MNPL) for the population. For most marine mammal populations MNPL appears to be very close to the pristine population level, or  $K$ . This contrasts with most fish populations where maximum productivity typically occurs at something less than half of the pristine population level. Assessment and monitoring methods also differ from fisheries owing to the protected status of marine mammals. Assessments rely on survey data and comprise back-calculation of population histories from life-history data and removals, dynamic response methods for populations with adequate data, or the default assumption that populations are near carrying capacity if human impacts are insignificant and assessment data are lacking.

### Contributed Papers

R. Methot described the development of overfishing definitions for Pacific groundfish as defining overfishing in the same terms as the management target for groundfish with a buffer between the target and the threshold for overfishing. Overfishing was defined for key species only, with the assumptions that these species experienced higher fishing mortality than other groundfish in the complex,  $F_{opt}$  does not differ significantly for most species, and protecting target species will protect the entire complex. The fishing mortality rate,  $F_{35\%}$ , that reduces spawning biomass per recruit (SPR) to 35% of pristine level was chosen as a harvest guideline, based on the work of Clark (1991). Overfishing was defined as fishing that reduces relative SPR to 20% or less of the unfished level. Methot also reviewed the status of major west coast groundfish fisheries relative to harvest guidelines and overfishing definitions.

F. Serchuk reviewed the history and development of the advice provided by the Advisory Committee on Fishery Management (ACFM) to the Northeast Atlantic Fisheries Commission

on stock status. In the 1980's, the ACFM defined a series of stock categories based on the status of the stocks. Advice currently provided by the ACFM differs in that now, for each stock, a threshold referred to as the minimum biologically acceptable level (MBAL) is defined below which the probability of poor recruitment increases. Stocks are now classified as either below MBAL or expected to be so in the near future, not in imminent danger of falling below MBAL, or the status of the stock cannot be precisely assessed. In addition to stock status, a number of biological reference points are calculated and reported including  $F_{\max}$ ,  $F_{0.1}$ ,  $F_{\text{high}}$ ,  $F_{\text{med}}$ , and  $F_{\text{low}}$ .

G. Thompson presented his results obtained from an analytical model. Thompson argued that overfishing as defined in 50 CFR Section 602 cannot occur unless there is depensation in the production function. He claimed that without depensation a stock can always rebound, and the long-term productive capacity cannot be impaired. He developed a model based on a generalized Beverton-Holt stock recruitment relationship with depensation. His analysis of the model indicated that thresholds of approximately 20% of pristine stock biomass or 30% relative SPR served to safeguard against overfishing over a broad range of values of the depensation parameter in the model.

P. Goodyear presented an evaluation of  $F_{\text{med}}$  based on simulation results. He observed that the plot of stock and recruitment data used to compute  $F_{\text{med}}$  contains no explicit information about fishing mortality. Goodyear developed a simulation model using a Ricker stock recruitment relationship to generate simulated stock-recruit data for the computation of  $F_{\text{med}}$ . He simulated fishing mortality with both random variability and systematic change. Results indicated that  $F_{\text{med}}$  provides an accurate estimate of the average fishing mortality rate over the period of record when fishing mortality is stationary and the stock is in quasi-equilibrium. When fishing is nonstationary,  $F_{\text{med}}$  is influenced by the history of fishing mortality.

M. Prager advocated the use of production models because they include population response, are easy to use and explain, use simple MSY for a management goal, and have minimal data requirements. Using a logistic type Schaefer model, Prager stressed the versatility of production modeling by pointing out that the approach can include internal age structure, be applied to multiple fisheries, be tuned to a biomass index, accumulate residuals in effort, and provide bootstrap estimates of variance. He demonstrated how production modeling can provide a cohesive picture of the history of a fishery with an application to yellowfin tuna data.

## Discussion

Much of the discussion focused on the distinction between "overfishing" and "overfished." For most stocks managed under fishery management plans (FMP), overfishing has been defined in terms of fishing mortality rate without reference to stock abundance. National Standard 1 of the Magnuson Fishery Conservation and Management Act (MFCMA) requires that "Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimal yield from each fishery for the United States fishing industry." To implement Standard 1, the 602 guidelines (50 CFR Section 602) specify in §602.11 (c) (1) that "Overfishing is a level or rate of fishing mortality that jeopardizes the long-term capacity of a stock or stock complex to produce MSY on a continuing basis. Each FMP must specify, to the maximum extent possible, an objective and measurable definition of overfishing for each stock or stock complex covered by that FMP, and provide an analysis of how the definition was determined and how it relates to reproductive potential." These statements were interpreted by some workshop participants as requiring overfishing to be defined as a fishing mortality rate.

However, §602.11 (c) (2) states: "The definition of overfishing may be developed or expressed in terms of a minimum level of spawning biomass ("threshold"); maximum level or rate of

fishing mortality; or formula, model, or other measurable standard designed to ensure the maintenance of the stocks' reproductive capacity." This clearly allows much latitude in the formulation of overfishing definitions. In addition, §602.11 (c) (6) identifies actions that must be taken by the Council when the stock is in an "overfished condition." This subsection, and subsequent requirements for rebuilding programs and reducing fishing mortality when stocks are at low levels, imply that there is a need to identify some threshold level of stock abundance in an FMP below which a stock is considered to be overfished or depleted.

### **Rate vs. Biomass**

A number of workshop participants expressed concern that defining overfishing in terms of mortality rate does not take account of the status of the stock. The intent of the 602 guidelines was to prevent stocks from becoming depleted and to clarify the need to rebuild stocks that are depleted. V. Anthony argued that defining overfishing in terms of fishing mortality skirts the issue and does not force action to rebuild stocks when they become depleted. P. Mace pointed out that defining overfishing in terms of a rate allows other stocks with similar life histories to be used as analogies whereas biomass levels need to be assessed for each individual stock. R. Parrish pointed out that, for monitoring purposes, it makes little difference whether overfishing is defined in terms of mortality or biomass because fishing mortality is effectively the ratio of catch to biomass. Thus the precision of estimates of  $F$  and biomass are comparable.

A. Rosenberg noted the preponderance of rate-based overfishing definitions based on analogy even though good life-history data and age-structured assessments are often available. W. Overholtz recommended that all available data should be used in formulating overfishing definitions. Mace reported that she and M. Sissenwine have an extensive review of biological reference points for assessed stocks in preparation.

### **Target vs. Threshold**

Some concern was expressed that a number of overfishing definitions are specified or interpreted as management targets rather than as limits beyond which fisheries should not pass. In some cases it may be appropriate for management targets to coincide with thresholds, but in most cases targets should be set well away from threshold levels. A number of suggestions about management thresholds were proposed. L. Jacobson and Rosenberg suggested that management targets could be expressed as fishing mortality rates with thresholds in terms of biomass. S. Murawski suggested that rather than a single threshold, multiple thresholds triggering suites of management measures could be employed. B. Brown argued that multiple options allow room for indecision and inaction on the part of councils in implementing measures to rebuild stocks. Threshold definitions should also take into account monitoring imprecision and the risk due to environmental variability. R. Methot and Overholtz both pointed out difficulties in applying thresholds to stock complexes.

### **Defining Overfishing vs. Guiding Recovery**

Defining overfishing is simply providing a dichotomous classification: either a stock is overfished or it isn't. If a stock is considered overfished, the 602 guidelines require that action be taken to rebuild the stock, but there is some ambiguity about what those actions should be. §602.11 (c) (6) requires that an FMP must contain measures to prevent overfishing and to rebuild stocks that are in an overfished condition. Some workshop participants felt that these measures should be incorporated into the definition of overfishing. An overfishing definition could, in effect, explicitly specify how harvest must be reduced as a stock approaches an overfished condition, and what constraints on harvest are needed when the stock is in an overfished condition.

## Control Laws

K. Sainsbury observed that avoiding overfishing, or rebuilding an overfished stock, is a policy objective. To achieve an objective we need to describe a management route in terms of observable measures as a means of getting there. What we may be talking about is a control law relating fishing mortality rate to stock biomass (Fig. 1.1a). The control law may or may not contain a biomass threshold below which no fishing is allowed, and it may increase or level off at some target fishing mortality rate as stock biomass increases (Fig. 1.1b).

In the ensuing discussion, approaching overfishing definitions as control laws was generally viewed favorably. It was recognized that a control law should probably be a continuous function of stock biomass. If abrupt changes in management policy occur at critical points or threshold levels of stock biomass, then when a point estimate of biomass is near a threshold, too much attention will be focused on which side of the threshold the stock is on and how much confidence can be placed in the biomass estimate. If the control law is a smooth function, then small changes in stock biomass can only produce relatively small changes in management policy, rather than large quantum changes. These changes in degree are more likely to be accepted and less likely to result in unproductive contention over point estimates of stock size relative to the threshold. Figure 1.1b incorporates these ideas. The target fishing mortality rate is indicated as a function of the abundance of the stock. At healthy stock levels, this harvest rate is constant and the catches vary appropriately. At abundance levels below the healthy range, the target fishing mortality rate decreases proportionately to stock size. Note that this applies whether the stock is in a rebuilding phase or is in the early stages of being overfished. There is a clear threshold stock abundance where fishing is halted. Along with the target rate, there is also a threshold fishing mortality rate, beyond which, at any given stock level, overfishing is clearly defined. Crossing this threshold implies fishing should be immediately reduced.

T. Smith suggested that we should be focusing on evaluating the performance of different control laws, and Methot pointed out that performance of control laws will depend entirely on the assumed dynamics of the stock at low levels. In effect, this is what the NMFS Risk Assessment Working Group will be investigating and reporting on in the future.

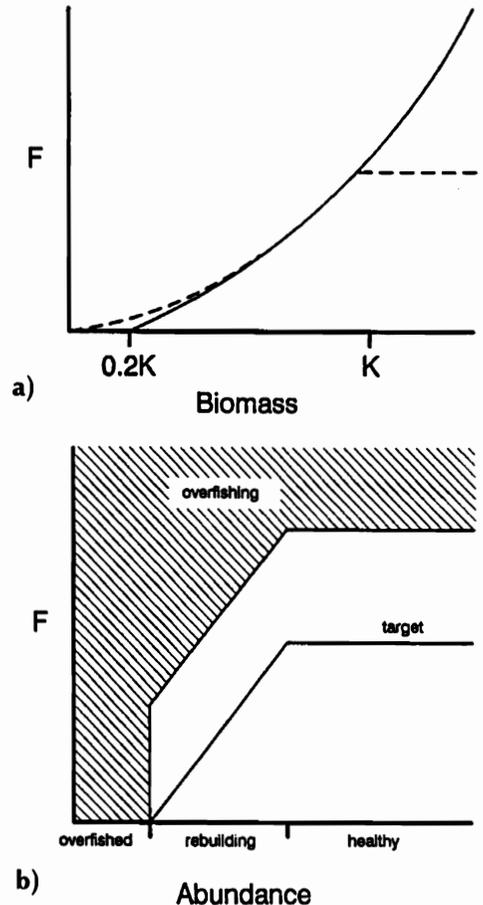


Figure 1.1.— a) Example control laws which specify fishing mortality rate ( $F$ ) as a function of stock biomass. b) Example control law indicating the difference between fishing mortality rates and threshold rates for different stock conditions.

# **Defining Overfishing— Defining Stock Rebuilding**

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