AGENDA D-1(a)
DECEMBER 2002

MEMORANDUM

TO:	Council, SSC and AP Members	
FROM:	Chris Oliver Executive Director	ESTIMATED TIME 2 HOURS
DATE:	November 25, 2002	
SUBJECT:	F_{40} Independent Review	

ACTION REQUIRED

Receive final report from independent scientific review panel.

BACKGROUND

In October 2001, in conjunction with the actions taken to address Steller sea lion issues, the Council also approved a motion to conduct an independent review of our basic F_{40} harvest policy relative to National Standards. The intent of this review was to determine whether changes need to be made to account for individual species needs or ecosystem needs.

The F_{40} review panel included Dr. Terry Quinn (UAF), Dr. Grant Thompson (AFSC), Dr. Marc Mangel (University of California Santa Cruz), Dr. Tony Smith (CSIRO, Australia), Dr. Dan Goodman (Montana State University), Dr. Graeme Parks (Marine Resource Assessment Group, Florida), Dr. Victor Restrepo (ICCAT, Spain), and Dr. Kevin Stokes (New Zealand). The F_{40} review panel met in person at the Alaska Fisheries Science Center on June 17-19, and continued their work by email.

Dr. Dan Goodman served as Chairman of the panel, and he provided a preliminary report at the October 2002 Council meeting. He will be on hand to make a final report at this meeting. The panel's written report was distributed on November 22; an executive summary is attached as <u>Item D-1(a)(1).</u>

1 SCIENTIFIC REVIEW OF THE HARVEST STRATEGY CURRENTLY USED IN THE BSAI AND GOA GROUNDFISH FISHERY MANAGEMENT PLANS

1.1 Executive Summary

1.1.1 Introduction

The North Pacific Fisheries Management Council (NPFMC) convened this panel to provide an independent scientific review of the current harvest strategy embodied in the NPFMC fisheries management plan (FMP) for the Bering Sea/Aleutian Islands/Gulf of Alaska groundfish fisheries, with particular attention to the role played by the $F_{40\%}$ reference point, and to determine whether changes should be made to account for particular species, or ecosystem needs in accordance with the National Standards of the Magnuson-Stevens Fisheries Conservation and Management Act (MSFCMA).

1.1.2 Charge to the Panel

The review panel was charged specifically to carry out three tasks.

1. To define and explain the harvest strategy currently used in the management of the BSAI and GOA groundfish fisheries; i.e., develop an educational primer on the Council's current procedure.
2. To determine if the current quota setting approach (Tier ABC determination, OFL derivation, and TAC specification) is consistent with the Magnuson-Stevens Act. In particular, determine if F_{40} is an appropriate MSY substitute for all species, and if not, to explain the alternative(s) and describe the data available to implement them.
3. To determine if the current quota setting approach is considerate of ecosystem needs in the BSAI and GOA, and if not to explain how it should be changed, what data are available for implementation of the changes, and how the transition to the changed approach might be carried out.

1.1.3 Explanation of the Current Harvest Strategy

The current harvest strategy is essentially a maximum sustainable yield (MSY) single-species approach, modified by some formal safeguards incorporated to ward against *overfishing* as defined from the single-species standpoint, and with opportunities of a less-structured nature for reducing harvest rates further in response to perceived social, economic and ecological concerns. No quantitative standards or specific decision rules are stated for these latter considerations, except as they are imposed, from outside the MSFCMA, by the Endangered Species Act (ESA) or the Marine Mammal Protection Act (MMPA), and only for particular populations.

The overfishing level (OFL) set for each stock is an estimate either of the fishing mortality rate associated with MSY (F_{MSY}) or an estimate of a surrogate for F_{MSY}. The OFL is treated in the management system as a limit that should not be exceeded except with a very low probability. The acceptable biological catch (ABC) set for each stock is an estimate of a target rate, which is intended to establish some margin between it and the OFL. The hope is that managing so as to achieve this target on average will accomplish the desired compliance with exceeding the limit (OFL) only rarely. The ad hoc downward adjustments of harvest in response to other social, economic, and ecological considerations takes place in the deliberations where the total allowable catch (TAC) is set subject to the constraint that it be less than or equal to the ABC.

The formulaic component of the reduction of harvest rate from the theoretical MSY harvest rate (from OFL to ABC) is by an amount that is often modest, when expressed as a fraction of the harvest rate; but in terms of the total tonnage involved, or its dollar value, the amount is considerable. The margin is also small relative to real natural variation, and small relative to the practical uncertainty about stock status or population parameters for many of the target stocks and indeed for most of the ecosystem. By contrast, in actual practice, the reduction of the TAC from the ABC has for some stocks and some years been quite large, but there is no explicit and general formula for this reduction.

The formal and standardized quantitative portions of the process of determining OFL and ABC begin with the assignment of each stock to one of six "Tiers" based on the availability of information about that stock. Tier 1 has the most information, and Tier 6 the least. The so-called $F_{40\%}$ construct, which is one focus of our review, plays a prominent role in some of the Tiers (2, 3, and 4) but not the others. Notably, in Tier 3 (which is where many of the major BSAI/GOA stocks are assigned) and Tier 4, the estimate of $F_{40\%}$ is used as a surrogate for a fishing mortality rate that is somewhat below F_{MSY}.

$F_{40\%}$ is the calculated fishing mortality rate at which the equilibrium spawning biomass per recruit is reduced to 40% of its value in the equivalent unfished stock. This is an esoteric, but useful, measure of the amount by which the associated fishing rate reduces the stock size, in the long run. The useful features of this particular measure are two-fold. First, its calculation is less sensitive to the details of the stock-recruitment relationship than is the calculation of F_{MSY}, so it is practical to estimate $F_{40\%}$ for stocks that are not well enough studied for estimation of F_{MSY}. The second is that, for a range of dynamics encompassing many, but not all, of the BSAI/GOA target groundfish stocks, modeling studies have shown that harvesting at $F_{35\%}$ accomplishes about the same thing as harvesting at F_{MSY}, so harvesting at the slightly lower rate, $F_{40\%}$, establishes a modest margin of safety.

In fact, the dynamics of only one stock covered by the FMP, BSAI pollock, are well-enough quantified to qualify for Tier 1. In Tier 1 the limiting F_{OFL} is the equivalent of the point estimate of F_{MSY} (that is to say, roughly, the "best" estimate without adjusting for uncertainty), and the target F_{ABC} is the harmonic mean of the distribution of the estimate for F_{MSY}. The harmonic mean has the mathematical property that it is less than the simple average (roughly, the point estimate) by an amount that increases with the spread of the distribution, so this establishes a margin that increases with the uncertainty in the estimate. However, this mechanism for adjusting the F_{ABC} downward from the F_{OFL} does not have the statistical property of ensuring a *constant specified* *confidence* that the F_{ABC} does not exceed the true F_{MSY}, as would be ensured by using a lower confidence limit of the estimate of F_{MSY} for the F_{ABC}.

Tier 2 differs from Tier 1 in that only point estimates of the key population parameters are available, so the *distribution* of the estimate for F_{MSY} is not known. In this Tier, the limiting F_{OFL} is the point estimate of F_{MSY}, much as in Tier 1, but a different formula (based on the adjustment used in Tier 3) is used for adjusting the F_{ABC} downward from F_{OFL}. The mathematics of the different formulas used for adjusting the F_{ABC} downward from F_{OFL} in Tier 1 and Tier 2 does not guarantee that the margin so established in Tier 2 will be wider than the margin in Tier 1.

Tier 3 differs from Tier 2 in that information is insufficient for any estimation of MSY. In this Tier, the limiting F_{OFL} is the point estimate of $F_{35\%}$ and the target F_{ABC} is the point estimate of $F_{40\%}$. The width of the margin between F_{ABC} and F_{OFL}, in this Tier, therefore, will be essentially the same as in Tier 2, and the relation to the width of the margin in Tier 1 is variable. Most of the major target stocks in the BSAI/GOA are in Tier 3.

Tier 4 differs from Tier 3 in that information is insufficient for estimation of target biomass levels. In this Tier, the limiting F_{OFL} is the point estimate of $F_{35\%}$, and the target F_{ABC} is the point estimate of $F_{40\%}$, both as in Tier 3. The width of the margin between F_{ABC} and F_{OFL}, in this Tier, therefore, will be identical to that in Tier 3, and essentially the same as in Tier 2, and the relation to the width of the margin in Tier 1 is variable.

Tier 5 differs from Tier 4 in that information is insufficient for estimating $F_{40\%}$ or $F_{35\%}$, so the limits and targets use different surrogates to attempt to approximate management for MSY. In this Tier, the limiting F_{OFL} is the point estimate of the natural mortality rate of the stock, and the target F_{ABC} is three fourths of that value. The limiting F_{OFL} in this Tier maybe either conservative or aggressive relative to the limiting F_{OFL} of $F_{35\%}$ in the three Tiers above. Theoretical work [Deriso 1982 among others and Thompson] has shown that M is often higher than F_{MSY}, so it would be a better as a limit than a target. The margin between F_{ABC} and F_{OFL} in this Tier, corresponding to a 25% reduction of fishing mortality rate, is wider than the margin in Tiers 2 through 4. Most of the minor target stocks in the BSAI/GOA are in Tier 5.

Tier 6 differs from Tier 5 in that information is insufficient for estimating any of the stock parameters, and all that is known is the catch history. In this Tier, the limiting F_{OFL} is the average historic catch, and the target F_{ABC} is three fourths of that value. In practice, without estimates of stock size, the control is exerted simply through a limit on amount of catch. The margin between F_{ABC} and F_{OFL}, in this Tier, considered as a fractional reduction, is the same as in Tier 5.

In Tiers 1 through 3 there are provisions for rapid rebuilding of stocks from an overfished condition, by reductions in the target fishing mortality rate triggered whenever the estimate of stock biomass is below the target biomass. There is no such provision in Tiers 4 through 6.

In Tiers 1 through 5, the information on the stock is sufficient to give clear indications if the stock status is departing substantially from the management goals. In Tier 6, this is not the case.

We see that for the most part there is not a clear systematic progression in increasing conservatism in the targets or in the width of the margin between target and limit, in moving from the Tiers with more information to those with less. Similarly, there is not, for the most part, a clear systematic incentive, in terms of potential for greater harvest, to improve the information base in order to move a stock from Tiers with less information to Tiers with more. Finally, the control rule provisions to accelerate rebuilding of stocks from an overfished condition do not apply to the 3 Tiers with the least information, and which, therefore, are subject to the greatest uncertainties. Within Tier, almost all the inputs to the control rule are point estimates, and so these do not adjust in response to uncertainty either. .

Over time, the evolution of this management system has been in the direction, overall, of greater conservatism. By the standards of most of the world's large commercial fisheries, this management system is conservative.

The adequacy (and safety) of $F_{35\%}$ as a surrogate for F_{MSY} depends on the inherent productivity of the stock. For most of the BSAI/GOA target stocks this surrogate appears to be adequate, though the case of the GOA pollock stock, which has declined from its 1985 stock size under this management system, warrants a closer look. This surrogate is now believed to be inappropriate for less productive stocks, such as sharks and rockfish, and it is now thought that considerably lower harvest rates (considerably lower than $F_{40\%}$ as well) should be applied for those stocks.

In practice, this management system seems to have worked well, judged simply by the continuing productivity of the target stocks, for the bulk of the BSAI/GOA stocks in recent decades, most of which period has corresponded to a regime phase which began in 1976 and is thought to have ended only recently. The definite exceptions to this empirical record of success are the rockfish, which were overfished early on, and have not recovered (except that GOA Pacific ocean perch have rebuilt above the $B_{40\%}$ level). A further possible exception is the GOA pollock which has declined since 1985. The robustness of the management system to large regime changes is largely untested in practice, and has been explored in models only in a limited way. If the regime has in fact recently changed it is possible that some of the stocks are entering a period of lower productivity, which may itself cause some populations to decline. Overall, there has been only limited modeling analysis of the theoretical performance of the system as a whole, in realistic scenarios. Realistic scenarios should include realistic representation of the spatial distribution of stock abundances and the spatial distribution of fishing, with various possible underlying stock-recruitment relationships, and various kinds of uncertainty in the input information that becomes the basis for the stock assessments which in turn are the sources of the estimates that are used to assign stocks to Tiers and to generate the values for F_{OFL} and F_{ABC} according to the rules for that Tier.

1.1.4 Single Species Considerations

The $F_{35\%}$ and $F_{40\%}$ proxies for MSY used in the groundfish FMPs are defensible, for this purpose, in that these values are supported by a body of scientific literature as being reasonable F_{MSY} proxies for "typical groundfish" species. However, the Council should be aware that harvests taken at these levels may be too high for species that have very low productivity and that are characterized by highly episodic recruitment. The Tier system could improve if allowances were made for the different life history types covered by the FMPs.

The management system contained in the groundfish FMPs is generally consistent with the single-species/target-stock components of the MSFCMA. While the FMPs specify only one of the two status determination criteria that are required by NMFS' National Standard Guidelines, the FMPs are sufficiently conservative, with respect to the target stocks evaluated from a single-species perspective, and incorporate automatic rebuilding plans to such a degree for stocks in Tiers 1 through 3 (the Tiers with the better availability of information) that this lack of conformity with the Guidelines should not pose a conservation danger from a single species viewpoint, except possibly for Tiers 4 through 6.

In terms of Optimum Yield, there is uncertainty about the conformity of the FMP definitions with the MSFCMA. The Council should review and revise its OY specifications in order to make more explicit links with environmental considerations and to more directly specify the relationship between OY and MSY for GOA groundfish.

In a single-species/target-stock context, the TAC-setting process employed by the Council is a very conservative one, at least for Tiers 1 through 5, and the in-season monitoring and management system seems adequate for implementing the TACs with little risk of exceeding them.

We recommend that a management strategy evaluation (MSE) analysis, along the lines described in Section 3 of this report, be undertaken to provide additional assurance that the current NPFMC ABC harvest strategy is a robust one and is likely to continue to meet the objectives of MSFCMA and of NPFMC itself (noting that the actual harvest strategy is difficult to define except to say that it is ≤ABC). We recognize that an MSE analysis can be potentially a time-consuming and technically difficult undertaking. Sufficient resources in time and people would need to be allocated to undertake the work. The skills and expertise to undertake the work already reside within AFSC.

There is obviously a wide range of alternative harvest strategies that might be considered, and MSE methods are a useful way to design and evaluate alternatives. If this "comparative" approach is used, a wider set of performance measures, including utilization as well as conservation objectives, should be evaluated and the tradeoffs across objectives highlighted. We suggest that wider stakeholder discussion on alternative approaches be held before embarking on a major exercise to evaluate alternatives.

Apart from exploring and evaluating generic harvest strategies, several of the target species in the BSAI/GOA groundfish fishery are of sufficient value (and importance) to warrant the effort to formally evaluate species-specific harvest strategies (e.g., for pollock). This would allow more of the detailed knowledge and understanding about these species and associated fishery to be incorporated in the operating models, and could potentially lead to better performing harvest strategies for those species. It would also allow changes to harvest strategies that occur for other reasons to be more formally evaluated. An example is the recent change to the pollock harvest control rule to set zero ABCs if the stock falls below the MSST. This change was brought in because of concerns about food chain impacts of the fishery on Steller sea lions.

Overall, the current NPFMC approach to advising on ABCs appears to meet the requirements of MSFMCA, from a single-species/target-stock management perspective for most of the target stocks (the exceptions are primarily the rockfish). Precautionary elements in the current NPFMC approach derive from the additional constraints in the overall management system that often result in catches well below ABCs. Nevertheless, the review panel recommends that additional work be undertaken to more formally test the robustness of the current NPFMC harvest strategy to various uncertainties, and to explore alternative harvest strategies that may be more appropriate for some groups of species or individual species. Existing staff at AFSC have the expertise and a range of suitable models to undertake the MSE approach suggested, but time and resources will need to be allocated for such a task.

1.1.5 Ecosystem Considerations

The panel was asked to consider two basic questions about the ecosystem aspects of the present NPFMC groundfish fishery management plan and the role of $F_{40\%}$ in it. These are (1) Is the approach "considerate" of ecosystem needs in the BSAI and GOA? and (2) Are data available to implement an alternative approach for satisfying ecosystem needs? Our brief response is that the MSY based approach in the setting of F_{ABC} in the current NPFMC system for groundfish management, which is consistent with the explicit OY goals of the MSFCMA, makes only a slight adjustment for *possible* ecosystem needs; while the TAC setting adjustment downward from ABC allows for considerable reduction in harvest, but the procedure for doing so is *ad hoc*. The available data could be used for a more ambitious, and more formalized, decision system that might be more protective of ecosystem considerations. However, the available data have not, to date, proven sufficient to demonstrate conclusively that more protection is or is not needed. Present legislative policy mandates in the MSFCMA are not explicit enough about the burden of proof in deciding between utilization and protection goals to determine how much protection of ecosystem considerations is legally required when the uncertainty about the needs for such protection is great. Other legislation, notably MMPA and ESA, is much clearer about the burden of proof and the required standards of protection for special species, and actual FMPs have been modified to conform when those regulatory frameworks have come into play. Resolution of this question for other non-target species, and for the ecosystem as a whole, will require the articulation of more specific policy.

These comments are not peculiar to the $F_{40\%}$ driven aspects of the FMP. They would apply to any single species MSY-based, or MSY-surrogate, approach, as indeed they apply to the management of Tier 1, Tier 5 and Tier 6 stocks in the BSAI/GOA FMP where $F_{40\%}$ does not play a role. Regardless of the use of $F_{40\%}$ as a F_{MSY} surrogate, fishing so as to achieve MSY-related objectives will inevitably reduce the equilibrium biomass very substantially from the unfished condition, and will inevitably shift considerably the age and size structure of the target stock. These changes to the target stock *could* propagate through the food web, and effect large changes in the populations of other species. However, the theoretical models for predicting such effects in practice have low predictive power, and the intensity of monitoring required to document such changes for particular species, and to attribute causation convincingly, require a major undertaking. Furthermore, with the exception of species listed under the ESA, there are no general policy standards for whether effects of this kind, or of any particular magnitude, are acceptable consequences of management.

The $F_{40\%}$ approach to estimating the ABC, by itself, is inherently a single species approach. It is thought that for most of the target species in the FMP, a fishing mortality rate of $F_{35\%}$ would be appropriate for achieving long-term catches near MSY, under the condition of an unchanged oceanographic regime. The main exceptions among the target species are the rockfish, which apparently need a considerably lower fishing mortality rate to avoid overfishing. That the actual target fishing rate is $F_{40\%}$ rather that $F_{35\%}$ creates some additional margin of safety, from a single species perspective, for target species excluding rockfish. The decision to use $F_{40\%}$ rather than $F_{35\%}$ was deliberately protective, and was intended to function as a buffer against several sources of uncertainty, including the concern that theoretical models have shown that managing each species for its single species MSY will not achieve MSY for the aggregate. Nevertheless, it is not clear *how much* of the margin between $F_{35\%}$ and $F_{40\%}$ was "allocated" to ecosystem considerations. Nor was a calculation carried out to demonstrate what amount of escapement is needed for ecosystem purposes, or to assess whether the margin between fishing at $F_{35\%}$ and $F_{40\%}$ supplies this amount.

The TAC setting process has provisions for adjusting the allowed catch downward from the ABC, and in practice the TAC is adjusted downward. Such adjustments are made for considerations of by-catch, protected species, and general concern about the ecosystem. Again, except for the adjustments in response to the very specific requirements of ESA, it is not clear how the magnitude of this downward adjustment of the TAC from a $F_{40\%}$-based ABC is chosen, how much of it is attributed specifically to ecosystem considerations, and whether there are specific grounds for believing the magnitude is enough for those purposes.

It is easy enough to say that a management system could be made more protective of ecosystem properties by building additional margins of safety into a fishing mortality rate rule (such as shifting to $F_{50\%}$ or $F_{60\%}$ for example) or stipulating a more stringent threshold on the total allowed depression of equilibrium biomass (such as the limit adopted in the Commission for the Conservation of Antarctic Marine Living Resources Convention). But current knowledge does not allow precise scientific specification of what margin or threshold would be appropriate to achieve what level of protection of various ecosystem properties.

Modeling can offer up hypothetical scenarios to illustrate various possible outcomes, but multispecies ecosystem modeling has not yet developed to the point where it has documented predictive power in real applications. Nevertheless, this modeling is very interesting on several grounds, and continued investment in developing and testing such models is warranted.

At present, we essentially face a sliding scale of possible ecosystem protective measures, where the choices are largely policy choices. Current policy guidance is insufficiently specific, and the available science is insufficiently conclusive about the precise magnitudes of expected effects. Given the scientific uncertainty, there is merit in approaching ecosystem management in the spirit of cautious experimentation supported by a large investment in carefully-designed monitoring.

In chapter 4, this report explores a variety of frameworks for expressing ecosystem goals, and a spectrum of management approaches that might be conducive to achieving those goals. The large uncertainties, and the overt appeal to experimental management, put a high premium on continuing and expanding the regular monitoring in this ecosystem, along with surveys of the fishery resources, and oceanographic survey programs.

Currently available data might well be adequate for implementing imaginable ecosystem control rules. But currently available data almost certainly are not sufficient for specifying the quantitative details of such general ecosystem control rules in the absence of more explicit policy formulations. We can hope that continued research and monitoring will improve our general understanding of the BSAI/GOA ecosystems. There is reason to expect that the present increases in research directed specifically at population dynamics of the Steller sea lion will bring more satisfactory resolution to the vexing outstanding questions about causes of the decline of *that* population and its possible relation to the fishery. Elucidation of broader aspects of the ecosystem, and their relationship to the fishery, may prove to be an even greater challenge.

In the context of fishery management that takes ecological and ecosystem considerations into account, reserves (marine protected areas) play two extremely important roles. First, a no-take marine reserve of sufficient size will allow one to maintain a source of baseline data for components of the ecosystem. This is important because we should expect change to occur in ecosystems. Without having a source of baseline data in which there is no (or at least limited) human intervention, it will often be difficult to ascertain whether changes are due to fishing or other factors. Second, for stocks that have complicated social structure (eg sex-changing fish or harem or lek breeding marine mammals or birds), a no-take marine reserve will allow a full representation of the social structure of that stock; such social structures might otherwise be truncated by either direct or indirect effects of fishing. The effectiveness of a reserve for conservation purposes will depend on the relationship between the reserve size, and the natural spatial structure and dispersal rates of the populations. If these spatial scales coincide, the results could be counter productive: then closed areas may result in protection within the area but an *increased* chance of depression outside.

Monitoring plays a crucial role in making less tractable problems more tractable. Monitoring of catch, by-catch and fishing effort is of course critical to the data gathering that supports the assessments of status of the target stocks. Thus we recommend that the Observer Program be maintained and improved to provide even more precise and accurate information about directed catches and bycatch of all species. Systematic and well-designed monitoring is also essential for determining the magnitudes and timing of real environmental variation, such as regime shift, and it is at the heart of all experimental approaches to ecosystem management which hopeful will increase our knowledge about the ecosystem and reveal which management strategies work and which do not. It is important that the program of surveys in the BSAI/GOA ecosystem be continued, and perhaps extended even further to provide adequate information for addressing the ecosystem question.