5.0 Environmental Impacts of the Management Alternatives

The impacts of the proposed management alternatives are described in this section. Expected impacts are considered in four broad categories:

Biological impacts: the effect on fishing mortality, bycatch and bycatch mortality, and protected and threatened species

Economic impacts: the effects of the proposed measures on revenues and costs in the fishery, and the impacts of those changes on other entities in coastal communities

Social impacts: the effects of the proposed measures on fishing communities and participants in the fisheries affected by the FMP

Habitat impacts: the effects of the proposed measures and the extent to which they will minimize the adverse effects of fishing on essential fish habitat

5.1 Analytic Approach and Limitations

The Council is proposing changes to address several broad issues: rebuilding overfished stocks, ending overfishing, addressing requirements to minimize bycatch and/or bycatch mortality, tuna purse seine access to groundfish closed areas, expanding the area for the northern shrimp fishery, authorizing a general category scallop fishery exemption area in southern New England, and numerous administrative measures. Analyses are grouped in the same manner, but the emphasis is on analysis of the measures designed to control fishing mortality. In the case of measures designed to control fishing mortality, the impacts of measures are analyzed by combining the measures as much as possible. This is because many of the proposed measures interact with each other and analyzing the measures individually does not capture the true impact of adopting a suite of measures. Where possible, quantitative impacts are estimated, but the Council has limited ability to quantify the impacts of some of the indirect management measures proposed in this framework. As a result, most alternatives are a combination of quantitative and qualitative analysis. Some management measures are included in several alternatives. Where this occurs, the detailed analysis is only described the first time the measure appears in an alternative. In later alternatives, the measure is referenced and its effects summarized.

5.1.1 Closed Area/Effort Control Analysis

One of the primary analytic tools used to analyze both the biological and economic impacts of the proposed alternatives to achieve mortality objectives is the closed area model. Changes in mortality brought about by area closures and revised trip limits were projected through a non-linear programming model using the General Algebraic Modeling System (GAMS). This closed area model allocates effort to specific block, month combinations for each vessel holding a valid year 2001 multispecies permit, and landing groundfish during the time period 1998 - 2001. A four year period is used to smooth out any peaks or valleys in the data. Data used by the model includes average catch per unit effort (CPUE) by species, gear type, block and month, prices by species and month, and effort by vessel and month. Vessels are assigned a specific gear type based on which gear they used to land the majority of their groundfish catch between 1998 and 2001. Cod discards were included in the CPUE figures for each block and time period because cod had several different trip limit regulations during the time period. All prices were deflated to 1996 levels in order to remove the influence of inflation from the analysis. The model attempts to maximize revenue for each vessel by allocating their effort to the highest revenue blocks. However, because the revenue functions embedded in the model are downward sloping, effort

stops flowing to a block when marginal revenue hits zero. The model can also be modified to incorporate changes in allowable days at sea, trip limits, differential days at sea and changes in CPUE by species and stock area.

An initial model run was made based on the no action management regime. The no action alternative includes year round and seasonal area closures which are already in place, the 400 pound GOM cod daily trip limit, and caps effort for each vessel at their average effort level between 1998 and 2001. Additional model runs are then made based on proposed changes in seasonal and year round area closures, changes in trip limits, and changes in days at sea under each management option. The estimated catch stream from each option is then compared to the no action catch stream, and the percentage change in landings is calculated. These numbers should be interpreted as the percent change in exploitation brought about by the proposed management action using the conditions which existed during the 1998-2001 time period. Changes in the exploitation rate can then be interpreted as equivalent changes in mortality. However, results should be interpreted cautiously because some conditions may have changed which are not reflected in the base year data. Additionally, there is variability around the estimates which is not fully captured by the model. One weakness of the model is the uncertainty about catch rates that result from opening areas that have been closed for a lengthy period of time. This is most problematic when changing the boundaries of year round closed areas. Because there is limited trip information in the closed area, the closed area model may under-estimate the catch rates that will result when an area closed to year round fishing is re-opened. This is less of a problem for seasonal closures, since the model incorporates recent trip information that reflects the catch rates that result immediately after opening an area. An advantage of the model is that unlike the "no displacement" analysis of closed areas (that is, assuming that effort in a newly closed area does not fish in another location), it assumes fishing effort moves out of a closed area into an open area based on rational decisions to maximize revenue. A second advantage is that the model output can include predicted impacts on revenues, and this can be broken down by gear sector and tonnage class of vessel. *The model is a simulation of behavioral responses to changes in fishery regulations. It should not be interpreted as a precise calculation of future fishing mortality. While the model output results in apparently precise numerical estimates, it is better to interpret these as broad indicators of relative changes, rather than as precise predictions of mortality impacts. Small percentage changes, for example, should be viewed as less likely relative outcomes than large percentage changes. For stocks where the Council is implementing measures to make large reductions in fishing mortality, it should be clear that the results of the measures will have to be carefully monitored to make sure the objectives are achieved. The model may not capture the exact response of fishermen to the regulations and as a result may over or under estimate the realized impacts.*

As noted earlier, the percentage results should be interpreted as indicators of the relative change in exploitation between options, and not as precise predictions of the result. Changes in exploitation must be converted to a change in fishing mortality in order to determine if mortality objectives are being met. When large reductions in mortality are needed, the PDT uses the criteria that if the estimated reduction is within ten percent of the needed reduction, the proposed measures are successful. The closed area output includes information on the revenues of individual vessels, and this is used in the analysis of economic impacts of the alternatives (section 5.4).

5.1.2 Combination of Quantitative Results

While the closed area model is the primary analytic tool used to estimate impacts of management measures, other models are used as well. The closed area model results show changes in

exploitation, while the model used for estimating the impacts of mesh change shows reduction in fishing mortality. Prior to combining the results from these two models, the changes in exploitation are converted to percentage reductions in fishing mortality.

When quantitative impacts are calculated for more than one measure, they are not additive because the measures interact with each other. They are combined by first calculating a multiplier value for each, then by multiplying those values together. The multiplier is determined from the following formula:

$$\text{Multiplier} = 1 - (\text{Estimated F reduction})$$

Both of these issues are considered in the summary of biological impacts at the end of each alternative. The summary tables show impacts on fishing mortality for GOM cod and GB cod.

5.1.3 Limitations

Analysis of the impacts of the proposed management alternatives is complicated by the following factors.

- The range of proposals and the interaction between management measures precludes analysis of the components on both large and small scales.
- The impacts of changes in trawl mesh size on fishing mortality cannot be accurately estimated for reasons explained in following sections.
- The impacts of minor changes in the boundaries of year round closed areas cannot be quantified. In addition, the catch rates that will result from large changes in the boundaries of year round closures are unknown, making it difficult to estimate the impacts of changes to the Closed Area II and the Western Gulf of Maine Closed Area.
- Many of the management measures interact with each other. Whenever possible, the impacts of each alternative are analyzed as a combination of measures, usually by using the closed area model. When estimates of fishing mortality reductions are obtained from different analytic techniques, they cannot be summed to obtain an estimate of the overall impacts. This is partly because the measures interact with each other, even if analyzed separately.
- The impacts of some measures in the alternatives cannot be quantified. When possible, impacts are expressed in a combination of quantitative and qualitative terms.
- There is limited ability to model long-range economic impacts. Any attempt to model economic impacts into the future assumes no changes in the structure of the economy in the interim. This is an unrealistic assumption over the time periods associated with the rebuilding plans.
- There is limited ability to estimate the economic impacts of changes to the recreational fishing measures. There is both a lack of available data and lack of an ability to predict how recreational fishermen will react to changes. The motivations for recreational fishing are many and varied, and predicting changes in recreational fishermen's behavior is nothing more than guesswork.
- Because of very low catches, the closed area model does not calculate changes for ocean pout, halibut, or the southern stock of windowpane flounder.
- The closed are model was designed to estimate impacts of input controls. It is an imperfect tool for modeling the impacts of hard TACs.