3.2 Proposed Rebuilding Programs for Overfished Stocks

The M-S Act and NSGs require the Council to define formal rebuilding programs or plans for stocks that are below the minimum biomass threshold (overfished). These programs define how the Council will rebuild those stocks to the target biomass within the statutory time frame. The Council has approached this issue in two steps. The first step, described in this section, is to identify the fishing mortality strategy that the Council will use as the basis for management measures that will rebuild the stock. The second step is to adopt management measures to achieve these strategies. The formal rebuilding program consists of both elements – they should not be viewed independently. Once a stock is defined as overfished, a rebuilding program must be continued until the stock reaches the target biomass. During the rebuilding programs, adjustments can be made through the annual adjustment process based on the condition of the stock and consistent with this Amendment, as long as statutory requirements are met.

When possible, long-term projections were used to estimate future stock size and landings. Long-term projections are sensitive to the assumptions used in their development and should not be viewed as precise predictions of future stock conditions. Actual future recruitment and the fishing mortality that occurs before implementation of Amendment 13 could result in future stock conditions that differ from the projection results.

3.2.1 Formal Rebuilding Programs

Summaries of stock status for groundfish stocks are in section 9.2.1.1. The M-S Act requires a formal rebuilding program for stocks that are overfished. The determination of whether a stock is overfished - stock size is less than the minimum biomass threshold – depends on the numerical estimate of B_{MSY} and the criteria chosen for the minimum biomass threshold. Another criteria to be considered is whether the stock was previously declared overfished. If a stock was previously declared overfished, and has not rebuilt to the proposed target biomass, a formal rebuilding program is necessary even if the stock is not currently overfished.

The following table (Table 6) identifies those stocks for which formal rebuilding programs are required. This table is based on the GARM (NEFSC 2002b). In two cases there are differences between the information in this table and that contained in the 2002 Report to Congress on Status of Stocks. The Report to Congress did not use assessment information for determining stock status, relying on information in the Report of the Working Group on Biological Reference Points (NEFSC 2002a). This Report said that plaice was not overfished and that pollock was overfished. The GARM, on the other hand, was an assessment meeting that was specifically charged to make status determinations. GARM 2002 concluded that in 2001 plaice was overfished and pollock was not. The following tables reflect the information from the GARM. Because the conclusions of the GARM rely on more current available scientific information, it is being used to make status determinations used in this amendment rather than the Report to Congress, which is based on less current data and assessments.

For each stock, if there is a "yes" in either column, a formal rebuilding program is required. Both columns are shown so it is clear which criteria led to the determination that a formal rebuilding program is required. GB yellowtail flounder is unusual, in that it was previously declared overfished but was rebuilt to the then-current estimate of B_{MSY} in 2001 (TRAC 2001, MSMC 2001). Since the stock was rebuilt prior to the re-estimation of reference points, and is greater than the minimum biomass threshold, a formal rebuilding program is not required for this stock.

Summarizing Table 6, the stocks that require a formal rebuilding program are:

GOM cod, GB cod, GOM haddock, GB haddock, CC/GOM yellowtail flounder, SNE/MA yellowtail flounder, American plaice, white hake, SNE/MA winter flounder, redfish, windowpane flounder (south), ocean pout, Atlantic halibut

The lack of a defined formal rebuilding program for stocks that are not overfished should not be construed as meaning that the Council is ignoring these stocks. The Council will insure fishing mortality remains below the fishing mortality threshold for these stocks. In all cases, these thresholds are defined as F_{MSY} or a suitable proxy for F_{MSY}. As noted by Restrepo et al (1998), *"F_{MSY} is the fishing mortality rate that maximizes long-term yield under a constant-F policy, and B_{MSY} is the equilibrium biomass expected when fishing constantly at F_{MSY}."* Controlling fishing mortality below the threshold should result in stock size fluctuating around the estimate of B_{MSY} over the long term. This is clearly shown in the age-based projections for stocks that are not under formal rebuilding programs (see section 5.2.3). This is approach is consistent with both the M-S Act and the National Standard 1 Guidelines.

Because of a lack of information, it is not possible to develop a formal rebuilding program for Atlantic halibut. The Council has adopted a provisional control rule that reduces fishing mortality on Atlantic halibut to as close to 0 as possible.

SPECIES	STOCK	Was Stock Overfished in 2001?	Was stock previously declared overfished and has not reached proposed biomass target?
Cod	GB	***Yes***	***No***
	GOM	***Yes***	***No***
Haddock	GB	***Yes***	***Yes***
	GOM	***Yes***	***Yes***
Yellowtail Flounder	GB	No	No*
	SNE/MA	***Yes***	***Yes***
	CC/GOM	***Yes***	***No***
American Plaice		***Yes***	***No***
Witch Flounder		No	No
Winter Flounder	GB	No	No
	GOM	No	N/A
	SNE/MA	***Yes***	***No***
Redfish		***No***	***Yes***
White Hake		***Yes***	***No***
Pollock		No	No
Windowpane Flounder	North	No	No
	South	***Yes***	***Yes***
Ocean Pout		***Yes***	***Yes***
Atlantic Halibut		***Yes***	***Yes***

Table 6 – Required formal rebuilding programs, based on minimum biomass threshold Option 2 (1/2 Btarget for all stocks). Formal rebuilding program required for stocks that have a "yes" in either column under a specific biomass target option.

3.2.2 Rebuilding Timelines

The M-S Act requires that for a fishery that is overfished, any fishery management plan, amendment, or proposed regulations shall:

> "…specify a time period for ending overfishing and rebuilding the fishery that shall…be as short as possible, taking into account the status and biology of any overfished stocks of fish, the needs of fishing communities, recommendations by international organizations in which the United States participates, and the interaction of the overfished stock of fish within the marine ecosystem."

Action: Rebuilding programs will be developed to rebuild most overfished stocks with a median (50 percent) probability by 2014. There are three exceptions to the 2014 end date: Georges Bank cod, Cape Cod/GOM yellowtail flounder, and Acadian redfish. These stocks will have longer rebuilding periods.

Rationale: The guidelines to National Standard 1 clearly state that rebuilding programs for overfished stocks begin when the regulations adopting those programs are implemented (50 CFR 600.310(e)(4)(ii)(C)). This action is consistent with that guidance. This action is planned for implementation on May 1, 2004. In addition, there are practical reasons to use this starting date for rebuilding. Initial M-S Act overfishing definitions were adopted under Amendment 9 and implemented in November, 1999. Amendment 9 did not include measures to achieve these rebuilding targets. Indeed, the *CLF vs. Evans et al.* lawsuit argued that the lack of measures to implement the Amendment 9 definitions did not comply with the M-S Act. This lawsuit was not resolved until May, 2002. There has also been extensive further scientific work on the status determination criteria that have considerably changed the understanding of the biology of the groundfish complex. For example, the target biomass for several stocks – GOM cod, GB cod, and GB haddock – doubled or tripled when re-estimated by NEFSC 2002b from previous values. This created considerable uncertainty over the appropriate biomass targets and delayed implementation as those issues were addressed through a peer review process.

The M-S Act and the NSGs require that any time period for ending overfishing and rebuilding the fishery shall be as short as possible, taking into account the status and biology of any overfished stocks of fish, the needs of fishing communities, recommendations by international organizations in which the United States participates, and the interaction of the overfished stock within the marine ecosystem. This option recognizes that the shortest possible rebuilding period, taking into account the needs of fishing communities, is ten years. Analysis of different rebuilding periods showed that net economic benefits increase by $40 million if rebuilding periods are extended until 2014 vice 2009 (see section 5.4.3). Additional analyses showed that all of the proposed alternatives will reduce gross revenues, resulting in negative impacts on fishing communities. As a result, the Council believes it appropriate to extend the rebuilding period to mitigate, in part, the economic impacts of the rebuilding programs. Using a ten year rebuilding period results in an ending date of 2014 for most stocks that require a formal rebuilding program.

Another reason to extend the rebuilding programs is the change in numerical estimates of B_{MSY}. Under most alternatives for biomass targets, there are significant increases. This change in the understanding of the biology of the stocks warrants extending rebuilding programs to the maximum length allowed by the M-S Act.

Rebuilding periods for GB cod, CC/GOM yellowtail flounder, and Acadian redfish are extended consistent with the M-S Act and NSG1 as explained below.

> Georges Bank cod: Projections show that this stock can only be rebuilt by 2014 at very low levels of fishing mortality (similar to 0.05). Because this is a trans-boundary stock and is fished by Canada, this fishing mortality may only be achieved if all U.S. fishing on this stock is eliminated and Canadian fishing is kept at very low levels. Effectively, this is a fishing mortality of 0 for U.S. fishermen. This triggers the exception in NSG1 which allows the period to be extended to the length of time it takes to rebuild in the absence of fishing plus one mean generation. This is calculated to be 2026.
>
> CC/GOM yellowtail flounder: Projections show this stock can only be rebuilt by 2014 at very low levels of fishing mortality (similar to 0.08). Because of the small size of the stock, this limits fishing to several hundred metric tons. This could only be achieved if all fishing – including fishing for non-groundfish species such as scallops – is stopped in the CC/GOM yellowtail stock area. This rebuilding mortality is thus effectively 0. This triggers the extended rebuilding period authorized by the NSGs. The rebuilding period is calculated to end in 2023.
>
> Acadian redfish: Because of the slow growth of this stock, it cannot rebuild by 2014 even if all fishing mortality is eliminated. The rebuilding period is determined as the time necessary to rebuild in the absence of any fishing mortality, plus one mean generation. The end of the period is calculated to be 2051.

3.2.3 Rebuilding Trajectories for Overfished Stocks

There are an infinite variety of ways to alter fishing mortality so that a stock will rebuild within the legally required time frame. The Council considered three variations:

- Constant fishing mortality rate: Fishing mortality is held to the level that is projected to achieve the target biomass in the desired time period. If the stock increases as projected, catch will increase over time. Correctly designed management measures should remain relatively constant over the time period.
- Phased fishing mortality reduction: Fishing mortality is reduced over time so that the target biomass is achieved in the desired time period. Management measures will become progressively more stringent over the early years in the rebuilding period.
- Adaptive rebuilding strategy approach: Fishing mortality is held at F_{MSY} through 2008 for all stocks that require formal rebuilding programs. After an evaluation of the rebuilding program in 2008, mortality is adjusted to an Frebuild that will achieve biomass targets in the time required by the M-S Act.

A fourth option – constant catch rate – was considered and rejected (see section 4.2.1).

In order to calculate a rebuilding trajectory, the target biomass and time necessary to rebuild must be defined. The Council based rebuilding trajectories on the biomass targets recommended in NEFSC 2000a. The Council considered analyzing rebuilding trajectories with greater than a median (50 percent) probability of achieving the biomass targets recommended by the Reference Point Working Group. This was considered unreasonable and the Council rejected this approach for the following reasons. First and foremost, for many stocks, the rebuilding fishing mortalities at the median level require large reductions in fishing mortality – in excess of 50 percent from current fishing mortality. In order to achieve a higher probability of achieving the target, even greater reductions would be necessary. The social and economic implications of the rebuilding programs are already substantial, and larger reductions in mortality would

threaten the continued existence of the groundfish fishery. As discussed later in this document, the present value of the economic net benefits of rebuilding are already marginal and might be negative if more severe mortality reductions are adopted. Given the multispecies nature of the fishery, further reductions in fishing mortality for stocks such as GB cod or GOM cod would result in further reducing catches for stocks that do not need reductions (e.g. GB haddock, GOM haddock, GB yellowtail flounder). Given that the goal of the M-S Act remains achieving OY, the Council believes its selection of rebuilding trajectories is more consistent with this goal. Second, the projection methodology used to generate the strategies is subject to uncertainty, and how well the projections perform with respect to actual stock response is not well understood. While in some cases the projections may be optimistic and overstate rebuilding potential, in other cases they may be pessimistic. These variations are likely to occur from stock to stock. Absent an understanding of how the projection models perform on a stock-by–stock basis, it is not possible to determine the appropriate probability that should be selected. Payne et al. (2003), while concluding that the projection methodology was generally sound, also noted projections should be validated against historical observations of stock dynamics since the projections are based in large measure on the stock recruit relationship observed at MSY rather than during the rebuilding phase. In another comment, Payne et al (2003) noted that a key issue yet to be resolved is the number of years into the future that the projection approach can be deemed to give reliable results. Third, in the case of some stocks, choosing a higher probability of rebuilding success may actually delay rebuilding and/or relax the rebuilding program. For stocks in a depressed condition (such as SNE/MA yellowtail flounder), it may not be possible to rebuild by 2014 with a high probability of success. This would then trigger an extension to the allowed rebuilding period.

The biological success of the rebuilding programs will be measured using two criteria:

- The rebuilding fishing mortality rate must be achieved. This criterion is necessary for two reasons. First, for some stocks, fishing mortality must be reduced below the maximum fishing mortality threshold to end overfishing. Second, only if this target fishing mortality is achieved will the Council be able to make valid judgments concerning the appropriateness of the biomass targets recommended by NEFSC 2002a.
- The target biomass is achieved within the appropriate time period.

3.2.3.1 Combined Rebuilding Trajectories

In public comments received on the draft Amendment 13 DSEIS, the suggestion was made that the Council should use a combination of rebuilding trajectories, rather than use one form of trajectory for every stock. In response to these comments, the Council has decided to use a combination of the phased and adaptive trajectories as described in the following sections. Section 3.2.3.1.1 describes the theoretical basis for the phased fishing mortality reduction. Section 3.2.3.1.2 describes the theoretical basis for the adaptive strategy. Section 3.2.3.1.3 describes the Council's proposed action, which is based on the theory behind the phased and adaptive strategies but adapts those strategies to reflect the expected impacts of the proposed management measures in section 3.6.1.

3.2.3.1.1 Phased fishing mortality reduction

This strategy steadily reduces fishing mortality during the rebuilding period in order to achieve the target biomass with a median probability. When the stock achieves its target biomass, the formal rebuilding program adopted because the stock was overfished will be completed. Once the stock achieves the target biomass, fishing mortality targets will be based on the status determination criteria and MSY control rule. The fishing mortality for the rebuilding program may be adjusted if there are substantial changes in stock status and recruitment from those used in the long-term projections used to estimate this fishing mortality. Stock condition should be evaluated over at least a two-year period to smooth fluctuations that are the result of variability rather than true trends. A wide variety of variables will be considered to determine

stock condition: fishing mortality and biomass (including the uncertainty around the estimates), recruitment patterns, environmental conditions, etc.

Current estimates of the mortality rates necessary to rebuild groundfish stocks are shown in Table 7. The formula used can be described in algebraic terms as:

$$F_{2003} = a * F_{2002}$$

$$F_{2004} = a * F_{2003}$$

$$F_{\text{year}} = F_{2004} * e^{\left[-l(year-2004)+m(year-2004)^2\right]}$$

Values for l and m were selected for each stock to ensure that the median spawning biomass trajectory reached its target value in the last year of the rebuilding program.

In concept, the phased reduction approach can be extended to index-based stocks that require formal rebuilding programs. For ocean pout and southern windowpane flounder, the current landings, landings at the biomass target, and the landings needed to rebuild are so low that this becomes little more than an academic exercise. In the case of GOM haddock, the current exploitation ratio is less than that necessary to rebuild by 2009 or 2014; fishing mortality can increase under the proposed rebuilding program, and there is no benefit to a phased reduction approach.

The phase reduction strategy will be used for the following stocks:

- GB cod
- American plaice
- CC/GOM yellowtail flounder
- SNE/MA yellowtail flounder
- White hake

The fishing mortality rates for the phased rebuilding strategy that were included in the draft amendment document are shown in Table 7. One difficulty with using a phased rebuilding strategy is that the reduction in mortality that is needed each year differs from stock to stock. This makes it difficult to develop effort controls that will precisely achieve the desired reductions. As a result, the measures designed to achieve the phased reduction strategy can only approximate the calculated reductions over time. In the draft amendment document, Alternative 1 included options for implementing a phased strategy that reduced used DAS over four consecutive years to approximate the phased strategy. Comments were received that this approach was very different from that suggested by Table 7, and it was questioned whether these measures could be considered implementing that strategy. As a result of these comments and the practical difficulties of implementing a phased strategy, the Council is not following the trajectories shown in Table 7.

SPECIES	STOCK		Fishing mortality for phased rebuilding program									
		Assumed F2002/2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Cod	**GB**	**0.45**	0.43	0.40	0.38	0.36	0.34	0.32	0.28	0.24	0.22	0.22
	(add ten years)		0.22	0.22	0.22	0.20	0.20	0.20	0.18	0.16	0.16	0.16
	GOM	0.36	0.32	0.29	0.27	0.25	0.23	0.22	0.21	0.21	0.21	0.21
Haddock	GB	0.20	0.22	0.22	0.22	0.22	0.22	0.24	0.24	0.24	0.24	0.24
	GOM											
Yellowtail Flounder	GB	0.14										
	SNE/MA	**0.74**	0.50	0.40	0.30	0.25	0.20	0.17	0.17	0.17	0.17	0.17
	CC/GOM	**0.95**	0.73	0.57	0.45	0.36	0.29	0.24	0.20	0.17	0.15	0.13
	(add ten years)		0.11	0.10	0.09	0.09	0.09	0.09	0.08	0.09		.09
American Plaice		**0.26**	0.23	0.20	0.18	0.16	0.16	0.14	0.14	0.14	0.14	0.14
Witch Flounder	No formal rebuilding program required											
Winter Flounder	GB	No formal rebuilding program required										
	GOM	No formal rebuilding program required										
	SNE/MA	0.45	0.35	0.29	0.25	0.22	0.21	0.20	0.22	0.24	0.25	0.27
Redfish		<0.01										
White Hake												
Pollock	No formal rebuilding program required											
Windowpane Flounder	North	No formal rebuilding program required										
	South											
Ocean Pout												
Atlantic Halibut	Insufficient information to calculate rebuilding mortality											

Table 7 – Original phased reduction fishing mortality rebuilding program, rebuilding most stocks by 2014.

3.2.3.1.2 Adaptive Rebuilding Strategy

NEFSC 2002a provided estimates of B_{MSY} that are beyond the observed range of stock biomasses. Although these estimates of B_{MSY} are based on demonstrated recruitment and current growth and fishery selection parameters, there remains uncertainty in the direction of these critical population rates under stock rebuilding, and thus in the ability of the stocks to attain the calculated B_{MSY} values. The calculated B_{MSY} values may be too high or too low, depending on how dynamic rates of recruitment, growth and natural mortality are as the stock complex is rebuilt. NEFSC 2002a recognized these uncertainties and suggested an adaptive approach be adopted. Similarly, the Peer Review (Payne et al. 2003) reiterated the uncertainty of high targets and also suggested an adaptive approach.

By definition, fishing a stock at or below F_{MSY} will eventually result in the attainment of B_{MSY}, with the stock thereafter fluctuating at or around that value, depending on rates of recruitment and fishing mortality. By allowing the stock to equilibrate when fished at these rates, more information regarding the actual biomasses associated with F_{MSY} will follow. Based on NEFSC 2002a and the recent *Peer Review of Groundfish Science* (Payne et al. 2003), estimates and proxies for F_{MSY} (Table 4) are robust to uncertainty in B_{MSY} and are appropriate thresholds for management. Therefore, attaining fishing mortalities at or below these rates is the cornerstone of this option. The extension of the stock rebuilding time frames (e.g., to ending dates of 2014 for most stocks) allows for fishing plans that are consistent with an overall strategy of initially fishing the stocks at or below F_{MSY}, and adjusting either the fishing rates or the biomass reference points, consistent with the pace of rebuilding relative to the nominal targets. If a 2014 time frame is assumed for all stocks (e.g., 2004-2014 rebuilding period) except GB cod (2004-2026), redfish (2004-2051), and CC/GOM yellowtail flounder (2004-2023), then the strategy of fishing at or below F_{MSY} for a significant portion of the rebuilding period becomes more viable as a strategy, thereby minimizing the influence (and reliance) on a particular value of B_{MSY}.

The proposed strategy outlined in Table 8 and Table 9 below and Figure 1 and Figure 2 implements the following fishing scenario:

> (1) Fishing mortality rates for all stocks are maintained at or below F_{MSY} for the first 5 years of the plan (2004-2008). In 2009-2014, the fishing mortality rates are adjusted to those required to meet B_{MSY} targets initially estimated for the stocks (Table 8) with a 50% probability by the end of the rebuilding period. The Frebuild adopted in 2009 will be estimated in 2003 and will be the default value adopted unless the 2008 evaluation suggests a different value (lower or higher) is appropriate. This strategy will, on average, result in the attainment of B_{MSY} by 2014 for most stocks with a 50% probability, all things being equal (e.g. recruitment growth, natural mortality). The rebuilding program will be judged successful if biomass at the end of the rebuilding period lies within the inter-quartile range (range between the 25^{th} and 75^{th} percentiles of biomass) of the projected 2014 biomass.
> (2) As shown in Figure 1 and Figure 2 and Table 8, there is a median rebuilding path that is described by the results of stochastic population projections under the various fishing scenarios. This path is essentially a series of "way-points" upon which the pace of stock rebuilding can be judged. The values of "SSB_{2008}" represent, then, an interim biomass target along the path to stock rebuilding that can be used as an appropriate benchmark to evaluate the efficacy of the rebuilding program. Analyses of progress towards achieving the final B_{MSY} targets by the end of the rebuilding period wall be based on management measures adopted to achieve the median estimate of biomass at the 5—year waypoint, not the upper or lower quartile of those way-point estimates.
> (3) In early calendar year 2008 progress towards rebuilding the stocks is formally assessed. Based on the findings of that review, one of three determinations can be made:

(a) the stocks are "on track" to rebuilding -that is, the point estimate of 2008 stock biomass lies within the inter-quartile range (range between the 25th and 75th percentiles of biomass in 2008) of the *projected* 2008 biomass (estimated in 2003), consistent with the proposed rebuilding trajectory,
(b) the stock is above the projected strategy, or
(c) the stock is below the proposed rebuilding trajectory.

One key assumption for this strategy is that overfished stocks are not required to be rebuilt prior to 2014.

Depending on the actual stock biomass in 2008, there are a number of default management and scientific actions that are prescribed (Figure 1 and Figure 2). One of the critical elements to be assessed is whether the management program has been successful in achieving F_{MSY} or below for individual stocks. This is important since the condition of the stock and the specific management actions are dependent on the causal factors contributing to the observed stock biomasses. For example, if the stock size in 2008 is judged to be significantly below the projected path, the critical question is why? If fishing mortality rates were consistently and significantly above F_{MSY}, the question to be assessed is if F_{MSYs} *were* attained, would the stock condition intersect the rebuilding path? Alternatively, is there evidence in population dynamics data (recruitment, growth, natural mortality) that show no significant improvement in the stock could have occurred, due to these stock conditions, even though the stock was overfished. The management and scientific responses in these cases may be different.

A brief set of potential factors associated with all nine possibilities for stock and fishing mortality rate conditions during 2008 are given in Figure 1. The intent of this figure is to depict some of the obvious factors that might be influencing the stock, depending on fishery or natural phenomena. These factors would be examined in detail in developing appropriate adaptive management advice pertaining to the second half of the rebuilding period (e.g. 2009-2014). Figure 2 provides pre-defined (default) management and/or scientific review actions that are proposed as a key element of the adaptive approach. These defaults are intended to be illustrative, rather than restricting management response to only the listed actions. These outcomes are conditional on the status of the stock biomass relative to the interim (2008) waypoints, and the 2002-2008 fishing mortality rates relative to F_{MSY}. The nine possible situations (cells of Figure 2) are reviewed briefly below. These responses are not intended to pre-empt the planned review of reference points described in section 3.1.7.

$F_{2004\text{-}2008} > F_{MSY}$ and $B_{2008} > B_{waypoint}$

In this situation the fishing mortality rates for 2002-2008 have exceeded the F_{MSY} values, but the stock is judged to be above the median rebuilding path (way point). This condition may arise due to exceptional recruitment or other biological factors that offset the continued overfishing of the stock. In this case, the management action would be to reduce F to F_{MSY}. More analysis would be required to see if the fishing mortality on the stock should be reduced further to the rebuild value originally projected for the stock (Table 8). Also, it is possible that F_{MSY} or B_{MSY} may have originally been set too low, and re-consideration of the evidence should be done before fishing rates are reduced (e.g. for 2009-2014).

$F_{2004\text{-}2008} > F_{MSY}$ and $B_{2008} = B_{waypoint}$

In this case, F exceeds F_{MSY} but the stock is on the rebuilding trajectory. The default management advice is to reduce F to the F rebuild value, or, if it can be demonstrated to be appropriate, to the F_{MSY} value, whichever is higher. In this situation, stock conditions are apparently offsetting the continued overfishing. This would most likely be due to greater than expected recruitment. While there may be some justification to revise B_{MSY} and F_{MSY} values, they are not likely to be different from those currently in place. The exception may be F_{MSY}, which may need to be re-evaluated if the partial recruitment pattern (gear selectivity-at-age) changes due to additional gear restrictions.

$F_{2004-2008} > F_{MSY}$ and $B_{2008} < B_{waypoint}$

The condition of excessive fishing mortality and biomass below the projected rebuilding path would require, at a minimum, reduction of F to the original F rebuild value. In this case, there may be appropriate analyses to evaluate if the stock would have been on the rebuilding path had overfishing not been occurring. This could be accomplished by simulating the combined impacts of the observed recruitment stream and the F_{MSY} values. If the stock would have been near the path had the stock not been overfished, the managers may consider the feasibility of additional F reductions (below the original Frebuild values) to allow the stock to regain the rebuilding path.

$F_{2004-2008} = F_{MSY}$ and $B_{2008} > B_{waypoint}$

If the fishing mortality rate is held at F_{MSY} for 2002-2008 and the stock is above the rebuilding path, the managers should consider suspending the default reduction in F to Frebuild. Simulations could determine if stock rebuilding to B_{MSY} would be impeded by such a strategy. This scenario is likely to occur due to one or more exceptional year classes spawned, and may, or may not indicate that revisions in B_{MSY} (upward) are warranted (although they would not apply to the 2014 rebuilding program).

$F_{2004-2008} = F_{MSY}$ and $B_{2008} = B_{waypoint}$

In this condition, F targets have been achieved and stock rebuilding is on track. The prescriptive advice would be to reduce F to F rebuild, but new F rebuilds should be considered if the stock can be fished at a higher rate (than the original F rebuild) and still attain the target.

$F_{2004-2008} = F_{MSY}$ and $B_{2008} < B_{waypoint}$

If fishing mortality rate targets are met and the stock lags below the rebuilding trajectory, the nominal management advice is to reduce F to the original F rebuild value. Specific conditions in the stock should be re-evaluated to determine why stock biomass has not responded. Three potential causal factors are (1) continued below-average recruitment due to poor environmental conditions (e.g., regime change), (2) multispecies effects such as increased predation on juveniles or (3) competition with other species for food, resulting in reduced growth rates, or other population dynamics factors. In this case, scientists should re-consider biomass and fishing mortality rate targets in light of prevailing hypotheses for poor stock performance.

$F_{2004-2008} < F_{MSY}$ and $B_{2008} > B_{waypoint}$

If fishing mortality is below F_{MSY} and the stock biomass exceeds the rebuilding waypoint, then the appropriate management advice is to maintain F at or below F_{MSY}. In this situation it is unlikely that F needs to be reduced to F rebuild to meet the 2014 time frame for rebuilt stocks. Revision (upwards) of biomass and especially F targets should be considered, but if biomass targets are revised upwards, they would not apply to the 2014 end point of the original rebuilding program.

$F_{2004-2008} < F_{MSY}$ and $B_{2008} = B_{waypoint}$

If the fishing mortality rate is below the F_{MSY} value but above Frebuild, and the stock is on track, then a re-evaluation of the need to reduce F to F rebuild should be undertaken. If the stock can be rebuilt to the original B_{MSY} fishing at $F_{2002-2008}$, then these rates should be maintained.

$F_{2004-2008} <$ Fmsy and $B_{2008} < B_{waypoint}$

In this condition, there are significant problems with the near-term productivity of the stock likely unrelated to current fishing effects (although there may be ongoing depensatory effects due to historical stock

depletion). The lack of recovery of stock biomass may be due to continued below-average recruitment (e.g., due to environmentally-caused regime change) or other single- or multispecies influences on growth, natural mortality, and maturity. In this case, scientists should re-consider biomass and fishing mortality rate targets in light of prevailing hypotheses for poor stock performance.

The adaptive rebuilding trajectory will be used for the following stocks:

GOM cod
GOM haddock
GB haddock
Redfish
SNE/MA winter flounder
Windowpane flounder (south)
Ocean pout

Stock	F_{2002}	F_{MSY} in 2004-2008	$F_{REBUILD}$ (2009, 2003)[1]	Lower[2] 50th CI of SSB_{2008} (K mts)	SSB_{2008} (Projected SSB_{2002}) (K mts)	Upper 50th CI of SSB_{2008} (K mts)	Pr (SSB_{2014} exceeds SSB_{MSY})
Gulf of Maine cod	**0.33**	**0.23**	**0.22**	**46.9**	**53.3 (23.8)**	**60.7**	**0.51**
Georges Bank cod	0.43	0.18	0.18	41.8	50.9 (26.5)	62.2	
Georges Bank haddock	**0.20**	**0.26**	**0.25**	**180.8**	**214.6 (99.6)**	**249.7**	**0.51**
Cape Cod/Gulf of Maine yellowtail flounder	0.68	0.17	0.07	6.9	7.6 (2.5)	8.4	0.51
S. New England/MA yellowtail flounder	0.85	0.26	0.17	21.6	45.4 (2.0)	71.9	0.51
American plaice	0.27	0.17	0.15	20.7	22.6 (15.6)	24.7	0.51
S. New England winter flounder	**0.44**	**0.32**	**0.23**	**12.7**	**14.3 (6.0)**	**16.1**	**0.51**
Acadian redfish	**<0.01**	**0.04**	**0**	**146.8**	**154.9 (130.2)**	**154.3**	**0.06**
Gulf of Maine winter flounder	0.06	0.43	0.43		4.9 (7.7)		0.62

Table 8 - Age-structured projection results for groundfish based on $F_{2003} = F_{2002}$ (interquartile range in parentheses), F_{MSY} in 2004-2008, and $F_{REBUILD(2009,2003)}$ in 2009-2014. Spawning stock biomass in 2008 (SSB_{2008}) and its interquartile confidence interval, SSB_{2002} (in parentheses), and probability that SSB_{2014} exceeds SSB_{MSY} are tabulated for eight Northeast groundfish stocks. Adaptive approach is proposed for stocks in bold-face.

Notes: (1) Frebuild(2009,2003) means the rebuilding F implemented in 2009 that is estimated in 2003

(2) SSB_{2008} and confidence intervals are derived from stock projections estimated in 2003

(3) F2002 estimated based on 2002 landings, provided by NEFSC October, 2003 (unpublished data)

Stock	F 2001	F_{MSY}
Gulf of Maine Haddock	**0.12**	**0.23**
White Hake	1.36	0.55
Windowpane Flounder South	**0.69**	**0.98**
Ocean Pout	**0.007**	**0.31**

Table 9 – Exploitation ratios for adaptive approach for index-based stocks. Adaptive approach is proposed for stocks in bold-face.

	$B_{2008} > B_{waypoint}$	$B_{2008} = B_{waypoint}$	$B_{2008} < B_{waypoint}$
F2004-8 > Fmsy	Effort controls ineffective. Very strong recruitment **OR** High growth **OR** Lowered M and/or discards.	Effort controls ineffective. Strong recruitment may have offset overfishing.	Effort controls ineffective. Average or low recruitment failed to offset overfishing **OR** Growth lower than expected.
F2004-8 = Fmsy	Effort controls effective. Strong (above projected) recruitment.	Effort controls effective. Recruitment at average projected level. No evidence to reject basis for forecasting approach.	Effort controls effective. Below average recruitment led to below average biomass. **OR** Natural or discard mortality increased.
F2004-8 < Fmsy	Effort control more effective than expected. Average to strong recruitment.	Effort controls more effective than expected. Lower than average recruitment may offset lower F	Effort control more effective than expected. Recruitment or growth well below average ***OR*** Natural or discard mortality increased.

Figure 1 – Adaptive management causal factors/hypotheses table

	$B_{2008} > B_{waypoint}$	$B_{2008} = B_{waypoint}$	$B_{2008} < B_{waypoint}$
F2004-8 > Fmsy	Reduce F to Fmsy, re-consider Bmsy, Fmsy Reconsideration should come before reduction in F. Identify causes—strong recruitment offset overfishing? Re-estimate F_{MSY} , B_{MSY} as appropriate	Reduce F to Frebuild Extra measures will be needed since present measures ineffective. Identify causes—strong recruitment offset overfishing? Re-estimate F_{MSY} , B_{MSY} as appropriate	Reduce F to F rebuild; Consider basis for poor biomass performance Extra measures will be needed since present measures ineffective. Consider extending end date for rebuilding
F2004-8 = Fmsy	Maintain F at Fmsy or below Depends on expected trajectory from B'08 to B'14 at Fmsy. Re-estimate F_{MSY} , B_{MSY} as appropriate	Reduce F to Frebuild Proceed with plan. Consider revising F rebuild if value for 2009-2014 greater than previous value Re-estimate F_{MSY} , B_{MSY} as appropriate	Reduce F to Frebuild; **and/or** re-estimate Bmsy, Fmsy as appropriate Consider regime changes, multispecies effects, changes in vital rates Consider extending end date for rebuilding
F2004-8 < Fmsy	Maintain F </= Fmsy, re-consider Bmsy Reconsider time frame for rebuild. No penalty for early victory. Re-evaluate Fmsy (too low?) Re-estimate F_{MSY} , B_{MSY} as appropriate	If F_{2008} will rebuild to Bmsy, maintain F Re-estimate F_{MSY} , B_{MSY} as appropriate	Consider basis, re-estimate Bmsy, Fmsy as appropriate Consider regime changes, multispecies effects, and changes in vital rates Consider extending end date for rebuilding

Figure 2 – Adaptive management action table

3.2.3.1.3 Proposed action

The Council proposes to use a combination of phased and adaptive rebuilding strategies as described below.

The phased reduction strategy will be used for the following stocks:

- GB cod
- American plaice
- CC/GOM yellowtail flounder
- SNE/MA yellowtail flounder
- White hake

As noted in section 3.2.3.1.1, it is difficult to design a management program that precisely mirrors the changes in fishing mortality that are shown in Table 7. In most cases, the proposed measures in section 3.6.1 achieve more of a reduction than is necessary to comply with the phased reduction strategy in the early years of the rebuilding program. In essence, the proposed management measures "jump start" the phased reduction strategy for GB cod and for CC/GOM yellowtail flounder. This was not inadvertent – the Council made a conscious decision to select these measures in order to lower mortality more rapidly than would be required through strict adherence to the phased reduction strategy schedule. For these stocks, the realized fishing mortality rates that the Council plans to achieve are more restrictive than those shown in the phased strategy. For this reason, the Council modified the phased strategy from the theoretical values shown in Table 7 to take into account the impacts of the proposed management measures, the schedule for assessment updates, and the practical difficulties of making constant adjustments to management measures.

An adaptive rebuilding strategy (as described in section 3.2.3.1.2) will be used for the following stocks:

- GOM cod
- GOM haddock
- GB haddock
- Redfish
- SNE/MA winter flounder
- Windowpane flounder (south)
- Ocean pout

The fishing mortality rate schedule that will result from combining these two approaches is shown in Table 10 below. This table will be used to evaluate the success of the formal rebuilding programs, and to guide future management decisions (unless changed by a later action). It should be noted that this table has been updated to reflect current estimates of the fishing mortality in 2002 and 2003 (developed October, 2003 by the NEFSC). These rates are slightly different than those used to develop the rebuilding trajectories in the draft amendment (as shown in Table 7 and Table 8). In addition to the fishing mortality rates, for each stock the target TACs are shown for calendar years 2004, 2005, and 2006 in Table 11. Projection models calculate catch or landings based on calendar years, not fishing years. If stocks are changing in size, this difference can lead to a misinterpretation of landings information. If a stock is declining, using a TAC based on a

calendar year will over-estimate the TAC for the fishing year. The opposite is true if a stock is growing. One way to adjust for this is to use the average target TAC for two calendar years as the target TAC for the fishing year. These averages can be calculated from the information shown. These target TACs do not include any recommendations resulting from implementation of the US/CA Resource Sharing Understanding.

For ocean pout, the target mortality from 2004 through 2008 will be significantly less than F_{MSY}, but is still three times higher than the estimated exploitation in calendar year 2002. The analytic techniques used to estimate the rebuilding trajectory for this stock are not the same as the techniques used to estimate F_{MSY}. NEFSC 2002a attempted to re-estimate the F_{MSY} value for ocean pout using index based techniques, but found the results uninformative.

Adjustments to management measures will be needed to ensure that rebuilding program fishing mortality rates are met. An adjustment may be needed in fishing year 2006 to reduce mortality on plaice and SNE/MA yellowtail flounder, and a second adjustment may be needed in 2009 to reduce mortality on several stocks. Finally, additional measures may be needed after 2010 to reduce mortality for CC/GOM yellowtail flounder. An update assessment is planned for 2005, which will provide information necessary to adjust the measures for 2006. A benchmark assessment of the complex, including a review of status determination criteria, will be conducted in 2008. Default measures are included in section 3.6.1 that are designed to meet the appropriate fishing mortality rates through 2009.

SPECIES	STOCK	Assumed F2002/2003	Fishing mortality rates for proposed rebuilding program									
			2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Cod	***GB***	***0.43***	***0.21***	***0.21***	***0.21***	***0.21***	***0.21***	***0.18***	***0.18***	***0.18***	***0.18***	***0.18***
	(add ten years)		***0.18***	***0.18***	***0.18***	***0.18***	***0.18***	***0.18***	***0.18***	***0.18***	***0.18***	***0.18***
	GOM	0.33	0.23	0.23	0.23	0.23	0.23	0.21	0.21	0.21	0.21	0.21
Haddock	GB	0.20	0.26	0.26	0.26	0.26	0.26	0.24	0.24	0.24	0.24	0.24
	GOM		0.23	0.23	0.23	0.23	0.23	0.22	0.22	0.22	0.22	0.22
Yellowtail Flounder	GB	0.15	No formal rebuilding program required									
	SNE/MA	***0.85***	***0.37***	***0.37***	***0.26***	***0.26***	***0.26***	***0.17***	***0.17***	***0.17***	***0.17***	***0.17***
	CC/GOM	***0.68***	***0.26***	***0.26***	***0.26***	***0.26***	***0.26***	***0.17***	***0.17***	***0.17***	***0.13***	***0.13***
	(add ten years)		***0.13***	***0.09***	***0.09***	***0.09***	***0.09***	***0.09***	***0.09***	***0.09***	***0.09***	***0.09***
American Plaice		***0.27***	***0.23***	***0.23***	***0.17***	***0.17***	***0.17***	***0.15***	***0.15***	***0.15***	***0.15***	***0.15***
Witch Flounder		0.41	No formal rebuilding program required (see overfishing discussion)									
Winter Flounder	GB	0.10	No formal rebuilding program required									
	GOM	0.10	No formal rebuilding program required									
	SNE/MA	0.45	0.32	0.32	0.32	0.32	0.32	0.23	0.23	0.23	0.23	0.23
Redfish		<0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
White Hake		***0.55 (C/I)***	***1.03***	***1.03***	***1.03***	***1.03***	***1.03***	***0.23***	***0.23***	***0.23***	***0.23***	***0.23***
Pollock		3.30 (C/I)	No formal rebuilding program required									
Windowpane Flounder	North	0.09(C/I)	No formal rebuilding program required									
	South	0.50(C/I)	0.98	0.98	0.98	0.98	0.98	0.49	0.49	0.49	0.49	0.49
Ocean Pout(1)		0.01(C/I)	0.03	0.03	0.03	0.03	0.03	0.01	0.01	0.01	0.01	0.01
Atlantic Halibut	Insufficient information to calculate rebuilding mortality											

Table 10 – Proposed rebuilding trajectories. Stocks using a phased approach in *bold italics*.

(1) Ocean pout F_{MSY} estimated as 0.31 in Applegate et al. (1999), not re-estimated in NEFSC 2002a.

SPECIES	STOCK	2004	2005	2006	Composition
Cod	GB	3,949	4,830	6,361	US, CA landings
	GOM	4,850	6,372	7,470	Comm. landings, discards, rec. harvest
Haddock	GB	24,855	27,692	31,866	US, CA landings
	GOM	4,831	4,735	4,642	Comm. landings
Yellowtail Flounder	GB	11,713	11,341	11,599	US, CA landings and discards
	SNE/MA	707	1,982	3,325	Comm. landings and discards
	CC/GOM	881	1,233	1,034	Comm. landings and discards
American Plaice		3,695	3,625	3,015	Comm. landings and discards
Witch Flounder		5,174	6,992	7,667	Comm. landings
Winter Flounder	GB	3,000	3,000	3,000	Comm. landings
	GOM	3,286	2,634	2,205	Comm. landings, discards, rec. harvest
	SNE/MA	2,860	3,550	4,445	Comm. landings, discards, rec. harvest
Redfish		1,632	1,725	1,803	Comm. landings
White Hake		3,839	3,822	3,805	Comm. landings (all sizes)
Pollock		10,584	10,584	10,584	Comm. landings
Windowpane Flounder	North	534	534	534	Comm. landings
	South	285	273	262	Comm. landings
Ocean Pout		77	77	77	Comm. landings
Atlantic halibut		NA	NA	NA	NA

Table 11 – Calendar year target TACs (mt) estimated in 2003 (Source: NEFSC, unpublished data)